UNIVERSITY OF CALIFORNIA SAN DIEGO

Centering the "M" in STEM: A Critical Examination of Black Students' Experiences with Secondary Math in an Urban District

A Dissertation submitted in partial satisfaction of the requirements
for the degree Doctor of Philosophy

in

Education

by

Kirk D. Rogers, Jr.

Committee in charge:

Professor Thandeka K. Chapman, Chair
Professor Amanda Datnow
Professor Christopher Jett
Professor Makeba Jones
Professor Kevin Lewis
Professor Mica Pollock

2022

The Dissertation of Kirk D. Rogers, Jr. is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

University of California San Diego

2022

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHS

ACKNOWLEDGEMENTS

The adage it takes a village can be applied to my experience as a Black graduate student and educator. My path to completing my doctorate has been long, winding, and tumultuous but I am so grateful for the journey and for the folks who supported me throughout and along the way.

First, I would like to thank my committee members. Dr. Chapman, thank you for the thorough feedback, late night edits, and for keeping me on the path to graduation. You really pushed me to be a stronger writer and more critical researcher overall. We finally made it! Thank you for the push.

Dr. Datnow, thank you for your supportive and calming energy. I have appreciated our conversations at every step of the way and your expertise in math education. Thank you also for introducing me to Dr. Yonezawa who was instrumental in this process. Words cannot express how grateful I am to you both.

Dr. Jett, thank you for being one of my first mentors. You really taught me a lot about math teaching pedagogy before I even knew I liked teaching math. I wanted to be a science teacher primarily, but fate had other plans for me. Thanks for being with me and in my corner for well over 10 years and for all the letters of recommendation you have written along the way. Your guidance and support have been instrumental in my successful progression to now.

Dr. Jones, thank you for your words of wisdom, positive energy, and advice on our walks to the parking lot after your class. You talked me down many times and taught me to be "gentle on myself" amongst other things. I appreciate you for being in my corner from the very beginning.

Dr. Lewis, thank you for the unwavering support you have shown me since we first met in your social networks course. Thanks for also building my quant knowledge and for working

with me for over a year on my quant chapter, especially given you were supposed to be on sabbatical! I learned so much from you in the short time that I have known you. Thanks for teaching me your quantitative ways and for making me feel like a quant expert.

Dr. Pollock, thanks for sharing your wisdom and expertise and for allowing me to work on several projects with CREATE. I greatly appreciate you sharing your qualitative expertise and for the thoughtfulness in your feedback, always. Your commitment to equity and anti-racism is important and I have appreciated being able to learn from you.

Second, I would like to thank my family. Family, thank you for your unwavering support and for laying the foundation for my academic trajectory. Mom and Dad, the examples you provided allowed me to persist despite any barriers. Thank you for instilling resilience, cultural relevance, and resourcefulness.

I would also like to acknowledge Dr. Susan Yonezawa, Dr. Ovie Soto, and other members of The Center for Research on Educational Equity, Assessment & Teaching Excellence (CREATE) at UC San Diego. Without your wisdom, feedback, and constant expertise this dissertation would have taken much longer and would have been less thorough.

Finally, I would like to thank my partner. Liane, this dissertation would not have been written without your constant feedback. Thank you, babe, for sticking with me through one of the most difficult and most isolating experiences I have ever had. You kept me and our pups (Mako and Roti) fed and held our home together these past few months, and I could not have done this without you. Love you three thousand.

In addition, I would like to acknowledge that Chapter 2 in part is a reprint of material as it appears in The Negro Educational Review, 2020, Rogers Jr., Kirk D., Centering the “M” in

STEM: A Review of Black Students' Math Experiences. The dissertation author was the primary investigator and author of this paper.

Chapter 6 is also in part a reprint of material as it appears in The Negro Educational Review, 2020, Rogers Jr., Kirk D., Centering the "M" in STEM: A Review of Black Students' Math Experiences. The dissertation author was the primary investigator and author of this paper.

VITA

2009 Bachelor of Arts in Sociology, The University of Georgia

2011 Master of Arts in Teaching, Georgia State University

2015 Education Specialist in Educational Psychology, The University of Georgia

2022 Doctor of Philosophy in Education, University of California San Diego

ABSTRACT OF THE DISSERTATION

Centering the "M" in STEM: A Critical Examination of Black Students' Experiences with Secondary Math in an Urban District

by

Kirk D. Rogers, Jr.

Doctor of Philosophy in Education

University of California San Diego, 2022

Professor Thandeka K. Chapman, Chair

Algebra I is considered a "gatekeeper course" as it is required for students to gain access to higher-level coursework. 80% of K-12 students are eligible to take Algebra I in eighth grade, yet only 24% of eighth graders actually take the course. Black students are even less likely than their peers to be enrolled in Algebra I in the eighth grade, which ultimately impacts their math

options in high school. The purpose of this critical race mixed-methods (CRMM) study is to demonstrate how tracking policies and inequitable access to high-quality and culturally relevant math teachers, and curriculum act as mechanisms that push Black students out of the STEM pipeline by influencing their options before they even make it to high school.

In this convergent critical mixed methods study (QUAN + QUAL) the researcher collected and analyzed qualitative interviews with 21 Black high school students and three years of student transcript data for 1,561 Black seniors in one K-12 public school district in southern California. Ultimately, this project seeks to determine which variables contribute to the likelihood that a Black student is enrolled in a course "Beyond IM3" by their senior year of high school.

My hope is that this study will help researchers understand the limited racial diversity in STEM fields, while also situating math as one of the major deterrents of Black students' interest and persistence in STEM. This research could be impactful for developing systems of multilevel support for Black students in STEM classrooms and could serve as an impetus for changes in math curriculum, policy, and teaching practices.

Chapter 1: Introduction

Roughly four decades after the Nation at Risk Report (1983) placed literacy and mathematical ability as critical to the "future [of our] nation," the U.S. government continues its push for higher student achievement and increased student engagement with, math. Math and literacy competencies remain at the forefront of school accountability practices. According to the 2017 National Assessment of Educational Progress (NAEP), math scores have increased dramatically since the passing of No Child Left Behind (NCLB) in 2002. Yet, as of 2018, the Black-White achievement gap in math remains (Hansen et al., 2018). The term "achievement gap" is problematic in many ways due to the racial and social structural factors that have created the ever-widening resource gap between Black and white students (Ladson-Billings, 2006). However, I use the term to implore readers to think about how the educational system continues to contribute to the gaps in academic achievement between Black and white students.

The racial disparities and limited diversity within STEM fields can be attributed to larger institutional and structural barriers in math education that impede access to rigorous and engaging STEM coursework for racially minoritized students. Moreover, according to Ladson-Billings (2006) any conversation regarding the academic outcomes of Black students, must also acknowledge the educational debt that is owed to historically marginalized communities. Ladson-Billings (2006) elucidates the ways in which the US has failed Black, Indigenous, or other People of Color[1] (BIPOC)[2] communities on multiple levels, so much so that instead of

[1] I draw from Perez Huber et al.'s (2008) definition of Person of Color (POC) which is defined as a person from a non-white racial group that includes, but is not limited to, people of Black or African American heritage, people who identify as Latina/o/x, people who identify as Native or Indigenous, and people who identify as Asian or Southeast Asian.

[2] BIPOC is a newer term that re-centers the Black and Indigenous experience, an experience that is often erased or co-opted when using the blanket term Person of Color (Garcia, 2020).

thinking in terms of academic achievement gaps, the field must shift the conversation to discuss the historical, sociopolitical, economic, and moral elements that have accumulated into an educational debt. Any discussion surrounding gaps in the academic achievement of BIPOC students must be placed within this sociohistorical context. But educators also must acknowledge contemporary contributions of their own, both systemic and everyday – and the race and racism issues embedded in such contemporary actions and situations creating math achievement. The following study is an attempt to address such current factors related to the continued "achievement gap," which, I demonstrate, will never be closed unless educators and stakeholders explicitly address issues of race and racism that impede Black students' progress in math explicitly (Jett, et al., 2015; Larnell, et al., 2016; Martin, 2009b, 2012). In this study, I focus on math, the "M" in STEM, and the factors that impact Black students' progress in taking four years of secondary math. The fourth year of secondary math is often an overlooked area in students' course taking that makes them that much more competitive for admission to elite colleges and universities. In this mixed methods study, I employ the multi-level contextual factors of Martin's (2000) Multilevel Framework to conceptualize the mechanisms that contribute to Black secondary students' decisions to (dis)continue enrollment in math coursework into their senior year of high school -- a crucial moment for their higher education.

Rationale – Math and the STEM Pipeline

Scholars argue that math is an essential component that acts as the foundation of the entire STEM curriculum (NCSM & NCTM, 2018; US Department of Education, 2018). Duncan et al. (2007) assert that a student's knowledge of math is a significant predictor of later academic achievement. Thus, math is a key component of the STEM pipeline, a pre-kindergarten to graduate level (P-20) educational pathway that students must traverse to gain access to STEM-

related postsecondary opportunities and careers. In addition, high levels of math achievement have been linked to having higher income, career success, and psychological well-being (Levine & Zimmerman, 1995; Parsons & Bynner, 2005; Rivera-Batiz, 1992; Rose & Betts, 2004). Importantly, students who are proficient in math and science are currently in high demand, and Science, Technology, Engineering, and Math (STEM) jobs are growing at significant rates (Langdon et al., 2011; Noonan, 2017). The racial disparities and the continued lack of ethnic and gender diversity within STEM careers are of specific concern to Black communities due to the economic benefits of building a STEM career (Langdon et al., 2011; National Science Foundation, 2017; Noonan, 2017). Therefore, access to high-quality math curriculum and instruction across the K-12 math pipeline, especially at the elementary-middle school transition is crucial for students' future success in STEM (Blanton et al., 2019; Faulkner et al., 2014; Francis, 2012; Riegle-Crumb, 2006; US Department of Education, 2018).

Secondary Math and Post-Secondary Outcomes

The number of Black students enrolled in advanced secondary math courses (courses Beyond IM3) continues to be dismal in comparison to their peers (Education Trust-West, 2015; Ngo & Velasquez, 2020). This is important because secondary math remains an increasingly significant component of the STEM pathway, ultimately having the potential to create barriers to high school graduation and post-secondary degree attainment. Not to mention, rigorous math coursework beyond Algebra II or IM3 better prepares students for college (Adelman 1999, 2006; Byun et al., 2015; Hoyt & Sorensen, 2001; Kim et al., 2016).

Research has also shown that earning additional credits in secondary math – beyond the minimum to graduate from high school – has a profound impact on baccalaureate degree completion and a positive effect on students' math proficiency (ACT, 2007; College Board,

2011; Rogers, 2020; Zelkowski, 2011). Graduation requirements vary from state to state and from district to district, however the California Department of Education requires three credits (three years) of math to graduate from high school. However, research indicates that earning at least four secondary math credits has implications for students' post-secondary outcomes (Schiller & Muller, 2003; Teitelbaum, 2003). For students who earn credit in four secondary math courses, the likelihood they will enroll in remedial math courses in college decreases drastically (ACT, 2007; Hoyt & Sorensen, 2001) and continuous enrollment in secondary math has had positive effects on the postsecondary outcomes of students (ACT, 2007; Zelkowski, 2011). Moreover, when students complete a rigorous math course, a course beyond Algebra II (or IM3), such as Precalculus, the chances that students will also complete their baccalaureate degree significantly increases (Adelman, 1999; Byun et al., 2015; Kim et al., 2016; Long et al., 2012; Trusty & Niles, 2003; Zelkowski, 2011).

In addition to having an impact on post-secondary degree attainment, taking more consecutive years of math in high school, including Calculus, is significantly related to increased student interest in STEM careers (Sadler et al., 2014). Relatedly, several scholars found that taking Advanced Placement (AP) Science, AP Calculus, Calculus, physics, or a second year of chemistry significantly increased student interest in STEM majors and careers (Robinson, 2003; Sadler, et al., 2014; Warne et al., 2019). While other scholars found that taking AP Science and AP Calculus courses increased the likelihood that a student would obtain their baccalaureate degree in a STEM field (Robinson, 2003; Tyson et al., 2007).

Finally, taking additional years of secondary math coursework has been linked to higher income, career success, and psychological well-being (Levine & Zimmerman, 1995; Parsons & Bynner, 2005; Rivera-Batiz, 1992; Rose & Betts, 2004). In a longitudinal study of the benefits of

taking additional years of math and science classes in high school, Levine and Zimmerman (1995) found that the additional math coursework increased wages for female college graduates in particular. Similarly, Rose and Betts (2004) found that students who were enrolled in more advanced math coursework in high school were more likely to earn higher salaries than their peers. Ultimately the research on secondary math confirms that continuous exposure to secondary coursework beyond IM3 has a positive impact on students' post-secondary outcomes.

Algebra as a "Gatekeeper" to Beyond IM3 Coursework

The literature also indicates that eighth grade math is a critical turning point in many students' mathematical futures (ACT, 2007; Gao and Johnson, 2017; Paul, 2005; Oakes, 1990, 2005; Trusty & Niles, 2003; Zelkowski, 2011). Algebra I is often considered one of the "gatekeeper courses" in math since it is required for students to progress through the math pathway and into higher-level coursework (Blanton et al., 2019; US Department of Education, 2018). According to the US Department of Education (2018) 80% of public-school students are eligible to take Algebra I in the eighth grade, yet only 24% of eighth graders actually take the course. Black students are even *less* likely than their peers to be enrolled in Algebra I in the eighth grade (Faulkner et al., 2014; Francis, 2012; US Department of Education, 2018). Many scholars agree that not taking Algebra in middle school has unfortunate effects on the academic trajectories of Black students, often limiting their ability to reach courses Beyond IM3 by their senior year of high school (Clotfelter et al., 2012; Gao & Johnson, 2017; Spielhagen, 2006; Walston & McCarrol, 2010; Wells, 2018).

Multiple scholars have revealed that baccalaureate degree attainment is often reliant upon student enrollment in rigorous math coursework, starting as early as middle school (ACT, 2007; Gao and Johnson, 2017; Paul, 2005; Trusty & Niles, 2003; Zelkowski, 2011). Gao and Johnson

(2017) determined that less than half of California high school graduates from the class of 2016 completed college preparatory coursework[3] at all in high school, and that the numbers were lowest for Black males from lower socioeconomic backgrounds. They also found that completion of these course sequences was a strong indicator of success in community colleges, with math and English being critical indicators of future academic attainment. Specifically, students who took Algebra I in middle school were significantly more likely to complete the A-G requirements. The findings indicated that Black students were the least likely to complete the A-G requirements, typically opting out of the math pathway after Algebra I, the first credit bearing secondary course in the math sequence. Gao and Johnson (2017) emphasized "non-academic factors, such as school placement policies and course counseling" (p.13) as the major culprits affecting student course taking patterns. Similarly, many scholars have found that academic tracking practices, often fueled by teacher biases in placement, impede Black students' ability to reach those essential courses (Berry, 2005; Faulkner et al., 2014; Francis, 2012; Oakes, 1990, 2005).

Research in secondary math education highlights how the structural and institutional components of the math pipeline create gaps in math proficiency and add to the overrepresentation of Black students in lower-level math coursework. An examination of literature that reviews some of the sociohistorical, community, school, and individual level factors that impact Black students' math experiences, and how this literature has shifted over time can help guide future research by shedding light on the policies and practices that have been both problematic and effective for stifling Black students' math academic trajectories. The

[3] Also known as the A–G courses, these courses are required to be considered for admission to the California State University and the University of California college systems.

section that follows will explore the theoretical framework that guides this study and the sociohistorical and contextual factors that continue to shape the mathematics course taking patterns and mathematics socialization of Black students.

Research Questions

This mixed-methods study investigated what informed Black students' enrollment in math coursework "Beyond IM3" before graduating from high school. I define a course as "Beyond IM3" if the prerequisite for enrollment in the course was Integrated Math III (IM3) or Algebra 2. Beyond IM3 courses include Pre-Calculus, Statistics, Calculus, Discrete Math, and several other courses as described by the math course sequence guidelines from the district.

In this convergent mixed methods design (QUAN + QUAL), I collected and analyzed both qualitative and quantitative data concurrently to better understand the experiences of Black students in math classrooms in a large K-12 school district in Southern California. The goal was to explore the reasons why Black students, who have passed Integrated Math 3 (IM3) in the district, were opting into or out of taking an additional fourth year of math following IM3. The following questions guided this study:

> ***RQ: What informs Black students' decision-making processes as they choose to take, or not take, a fourth year of math, beyond IM3, in high school?***
>
> > ***A:*** *How do the schooling experiences of Black students shape their dispositions towards math?*
> >
> > ***B****: How do the schooling experiences of Black students shape their decision to (dis)continue an academic trajectory in high school math?*
> >
> > ***C****: To what extent do institutional and structural factors influence the likelihood that a Black student will enroll in a Beyond IM3 math course by their senior year of high school?*
> >
> > ***D****: How does the concentration of Black math teachers in a school impact the likelihood that a Black student will enroll in a Beyond IM3 math course by their senior year of high school?*

Using a mixed methods framework, I sought to uncover the barriers and systems of support that allowed for Black[4] students' successful progression through the math component of the STEM pipeline. The supporting literature for these questions will be discussed more thoroughly in the sections to come.

Theoretical Framework

Multilevel Framework for Analyzing Mathematics Socialization and Identity Among African Americans

This dissertation study utilized Martin's (2000) Multilevel Framework for Analyzing Mathematics Socialization and Identity Among African Americans (Figure 1). Martin (2000) charges that the mathematics identities and socialization of Black students are affected by the sociohistorical, community, school, and individual factors that work together to shape Black students' math achievement outcomes, math course taking patterns, and ultimately their dispositions towards math. Martin (2000) defines the term mathematics socialization as the "experiences that individuals and groups have within a variety of contexts such as school, family, peer groups, and the workplace that legitimize or inhibit meaningful participation in mathematics" (p. 19). Mathematics identities refer to students' "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). The mathematics socialization and mathematical identities of Black students are often disrupted at an early age due

[4] Black is used throughout this proposal to encapsulate all members of the African diaspora. The term Black includes people who identify as African American, African, Afro-Caribbean, Afro-Latina/o/x, and mixed race (Griffin et al., 2016). In addition, Black is intentionally capitalized to emphasize the critical importance of this racial identity. This rule will also apply to 'People of Color,' 'Students of Color,' and 'BIPOC' throughout this paper.

to multiple factors as described by Martin's (2000) Multilevel Framework for Analyzing Mathematics Socialization and Identity Among African Americans.

Key Themes
Sociohistorical
• Differential treatment in mathematics-related contexts
Community
• Beliefs about African American status and differential treatment in educational and socioeconomic contexts • Beliefs about mathematics abilities and motivation to learn mathematics • Beliefs about the instrumental importance of mathematics knowledge • Relationships with school officials and teachers • Math-dependent socioeconomic and educational goals • Expectations for children and educational strategies
School
• Institutional agency and school-based support systems • Teachers' curricular goals and content decisions • Teachers' beliefs about student abilities and motivation to learn • Teachers' beliefs about African American parents and communities • Student culture and achievement norms • Classroom negotiation of mathematical and social norms
Agency and Mathematics Success Among African American Students (Individual)
• Personal identities and goals • Perceptions of school, climate, peers, and teachers • Beliefs about mathematics abilities and motivation to learn • Beliefs about the instrumental importance of mathematics knowledge • Beliefs about differential treatment from peers

Figure 1.1. Martin's Multilevel Framework for Analyzing Mathematics Socialization and Identity Among African Americans (2000, p. 30)

Martin's (2000) Multilevel Framework for Analyzing Mathematics Socialization and Identity Among African Americans situates students' "mathematics achievement and persistence outcomes in broader sociohistorical, cultural and community contexts" (p. 17). This framework is a valuable tool for investigating the factors that influence Black students' mathematics identities, mathematics socialization, and ultimately their math course taking patterns. Martin's (2000) Multilevel Framework for Analyzing Mathematics Socialization and Identity Among African Americans was chosen for this dissertation study because it allows for an analysis that

centers race and racism as components that influence Black students' math trajectories while taking into consideration the multilevel factors that impact the formulation of students' math identities. I quote Martin at length to emphasize the ways in which the framework posits the interactions of race and racism in each facet of Black students' experiences in math classrooms.

> The socially constructed meanings for race are important for mathematics education in three ways. First, they are important to consider when mathematics education is situated in its larger sociopolitical context, a context characterized by long-standing inequitable patterns of access to mathematical opportunities on the one hand, and the simultaneous rhetoric of *Mathematics for All* on the other. Furthermore, patterns of inequity in mathematics education mirror those in other areas of life, in which racism is a major factor in producing these inequities…
>
> Second, the socially constructed meanings for race are important in considering the aims and goals of mathematics education research and policy. A common outcome of these research and policy efforts is the designation of students who are deemed proficient or less than proficient. These labels are typically juxtaposed with the social categories used for race…
>
> Third, socially constructed meanings for race are important in the everyday contexts in which individual students must struggle for mathematics literacy and negotiate both their racial identities and their identities as doers of mathematics. In many mathematics classrooms, teachers and students participate in a range of practices in which they develop, contest, and internalize beliefs about what counts as math literacy and who is mathematically literate, contributing to the construction of these classrooms as highly racialized spaces…

Central to Martin's framework is the belief that Black students experience the math classroom in radically different ways than their peers, and these experiences ultimately play a role in how Black students' see themselves in math-related contexts. In the paragraphs that follow, I will explain each component of the framework in detail to demonstrate the importance of this framework and how it was utilized in this dissertation study.

Sociohistorical Factors

The first level of Martin's (2000) Multilevel Framework for Analyzing Mathematics Socialization and Identity Among African Americans (henceforth abbreviated as the FAMSI

framework) is the sociohistorical level. Martin (2000) defines the sociohistorical context within the FAMSI framework as the "historically based discriminatory policies and practices that have prevented African Americans from becoming equal participants in mathematics and other areas of society" (p. 29). This level highlights African Americans' problematic history in the U.S. and the social and historical mechanisms that have served as barriers to their socioeconomic and educational advancement. The sociohistorical level emphasizes the ways in which structural and institutional factors have disrupted the math pathways of Black students and influenced their differential treatment in mathematics-related contexts.

Institutional and structural factors like state and local laws operate unjustly and under a sociohistorical context. False narratives of equal opportunity, race-neutrality, meritocracy, objectivity, and colorblindness are the sociohistorical tools that have developed into the structural and institutional barriers that inhibit academic and economic growth for Black, Indigenous, or other People of Color[5] (BIPOC)[6] (Babar, 2020; Bullock, 2017; Leonard, 2009; Martin, 2009a; Mensah & Jackson, 2018; McGee, 2020; Ray, 2019). Martin (2009b) interrogates a concept he deems the "racial hierarchy of mathematics ability," which situates Black students at the lowest rungs of the academic ladder. According to Martin (2009b), this racial hierarchy is directly related to sociohistorical narratives that presume the intellectual and academic inferiority of Black students, especially in regard to mathematical ability. Martin's (2009a) racial hierarchy of mathematics ability has significant implications for the (mis)education of future

[5] I draw from Perez Huber et al.'s (2008) definition of Person of Color (POC) which is defined as a person from a non-white racial group that includes, but is not limited to, people of Black or African American heritage, people who identify as Latina/o/x, people who identify as Native or Indigenous, and people who identify as Asian or Southeast Asian.

[6] BIPOC is a newer term that re-centers the Black and Indigenous experience, an experience that is often erased or co-opted when using the blanket term Person of Color (Garcia, 2020).

mathematicians from the Black community and their treatment in schools. Because of this racialized and assumed hierarchy, the intellectual capacities of Black students are often not valued by teachers, which results in a lowered likelihood for placement into rigorous middle and high school math courses (Berry, 2005; Chambers & Spikes, 2016; Faulkner et al., 2014; Francis, 2012). The differential treatment of Black students by math teachers in racialized math classrooms has direct connections to whether Black students are able to see themselves as mathematicians and genuinely engage with math in a meaningful way.

This study further explores and challenges how these institutional and structural factors influence Black students' relationships with math and acts as the symptoms of larger sociohistorical elements. Specifically, the findings in this study speak to the role of academic tracking as an additional sociohistorical tool that continues to inhibit Black students' access to higher-level STEM coursework. Academic tracking limits the math trajectories of Black students because their later high school choices, for example coursework Beyond IM3, are limited due to their previous math placements in elementary and middle school (Ngo & Velasquez, 2020; Wells, 2018). Moreover, the practice of academic tracking reiterates the racial hierarchy of mathematical ability (Martin, 2009b) because the students more likely to be enrolled in higher level coursework are often white or Asian (Ballon, 2008; Ngo & Velasquez, 2020; Wells, 2018). For students enrolled in the lower academic tracks, tracking impedes academic progress, fosters low self-esteem, and encourages disengagement from school (Davis, 2014; Martin, 2000; Oakes, 2005; Stanley & Chambers, 2018).

Importantly, several of my student participants only made it to coursework Beyond IM3, because they were tracked into upper-level math coursework by their eighth-grade year. The over placement of Black students into remedial math coursework can be linked to the sociohistorical

elements of the Black experience in the US (Baber, 2020; Ladson-Billings, 2006). Baber (2020) expounds on the ways in which colorblind meritocratic rhetoric in STEM disregards the lingering effects of colonialism and slavery. According to Baber (2020), the push to diversify the STEM pipeline fails to consider the historical contexts and oppression that have created the perfect conditions for the underrepresentation of People of Color in STEM fields. Specifically, Baber (2020) denotes that the sociohistorical use of race-neutral meritocratic ideologies in STEM have created a system in which failure then becomes an "individual consequence rather than a reflection of systemic oppression" (p. 20). Like Ladson-Billings' (2006) educational debt, the sociohistorical element of the FAMSI framework allows for further analysis of the sociohistorical, structural, and institutional elements that impede Black students' math trajectories.

As it relates to K12 education, the sociohistorical level includes structural factors, such as the laws and policies at federal, state and district levels that impact school level processes, programs, and resources. These factors include statewide high school graduation requirements that contribute to the perpetuation of structural racism through institutional factors, such as available courses and quality teachers and counselors. As it stands, the high school graduation requirement of two to three years of math coursework for California, and thirty-three other states, is an example of a structural factor that discourages Black students' enrollment into Beyond IM3 coursework. Graduation requirements are varied across states with only 17 states requiring four years of math to graduate from high school (Macdonald et al., 2019) (See Table 1.1).

Table 1.1. High School Math Graduation Requirements, by State (Macdonald et al., 2019)

States that Require 4 Years of Secondary Math	States that Require 2 or 3 Years of Secondary Math	States that Allow School Districts to Decide
Alabama	Alaska	Colorado
Arizona	California	Massachusetts
Arkansas	Connecticut	Pennsylvania
Delaware	Hawaii	Vermont
the District of Columbia	Idaho	
Florida	Illinois	
Georgia	Indiana	
Louisiana	Iowa	
Michigan	Kansas	
Mississippi	Kentucky	
New Mexico	Maine	
North Carolina	Maryland	
Ohio	Minnesota	
Rhode Island	Missouri	
South Carolina	Nebraska	
Tennessee	Nevada	
West Virginia	New Hampshire	
	New Jersey	
	New York	
	North Dakota	
	Oklahoma	
	Oregon	
	South Dakota	
	Texas	
	Utah	
	Virginia	
	Washington	
	Wisconsin	
	Wyoming	

In California, and other states with lower requirements, the math pathway is considered controversial given the number of required years of math and the current lack of cultural relevance in the current curriculum (Fortin, 2021; Hong, 2021). Even though the California high school graduation requirements are in alignment with the UC/CSU admissions standards, the competitive nature of college admissions indicates that students should have enrolled in at least four years of secondary math coursework to be a *competitive* applicant into most colleges and universities (Anderson & Burman, 2022). In the Georgia educational system students are required to take four years of math in high school, which as the research reiterates, sets them up

for future success in postsecondary education (Blanton et al., 2019; Schiller & Muller, 2003; Teitelbaum, 2003).

Community Level Factors

The second level of the FAMSI framework is related to challenges and systems of support in geographical and socially constructed communities. According to Martin (2000), community forces include the individual and collective life histories, experiences, beliefs, and attitudes of Black parents and community members about mathematics. Martin situates the community within the context of the sociohistorical level by defining community in terms of the shared, collective experiences of African American parents and Black people within larger sociohistorical and educational contexts. Specifically, Martin focuses on how parents think about the sociohistorical differential treatment of Black people in math related contexts. The community level centers parents and their beliefs about math abilities, the importance of math, and their expectations for their students in math related contexts. Parents play a major role at the community level, and as many scholars have shown parental influence is a major factor on academic achievement for all students, but especially for Black students (Berry, 2005; Carter Andrews, 2020).

As I will discuss later in this dissertation, parents were instrumental in my recruitment process at Rose HS. Specifically, many parents would not proceed with signing consent paperwork for student participation without a phone call or zoom meeting with me first. Once I was vetted as an ally, students were often "voluntold" to participate by their parents. Parents also were impactful to my student participants' decisions regarding their future college and career goals, as well as which math classes to take. Several of my student participants mentioned parents as a major factor in their decision to enroll in coursework Beyond IM3. This finding fits

within Martin's conception of community. Martin's (2000) conceptualization of community forces helps to "explain how [Black parents'] deep, psychological orientations toward education can develop as a result of experiences in societal and socioeconomic contexts…[which] in turn can shape [Black students'] behaviors in school contexts" (p. 23). Martin (2000) suggests that these external realities and narratives that Black students face within their schools, communities, and society writ large may shape Black students' inclinations towards math and could quite possibly impact whether or not they decide to enroll in coursework Beyond IM3.

School Level Factors

The third level of the FAMSI framework involves school level factors that contribute to or prohibit Black students' success along K-12 math pathways. Institutional factors are school level factors, also known as school-based support systems, that influence the academic trajectories of Black students. These factors occur within the institution itself. An example of an institutional factor that may inhibit Black students' enrollment into Beyond IM3 coursework are the course placement policies and practices at each school. For some students, math placement is easy and seamless when teachers, counselors, and school systems help facilitate the process. For others, institutional factors such as high student-to-counselor ratios make the process difficult for Black students attending overcrowded and underfunded school by reducing the likelihood that a counselor is able to thoroughly work to get to know each student on their caseload and to develop individualized plans with every possible option, given the nature of a students' future career interests.

The school level highlights the role of teacher beliefs about: Black students, their mathematical aptitude, their motivation to learn, and teacher views about Black parents and the Black community. This level also highlights teachers' curricular goals and content decisions and

the school's dominant school culture and achievement norms (Figure 1; Martin, 2000, pp. 30-31). The school level of Martin's framework situates teachers as a major factor in the identity development and math socialization of Black students.

The school level is also informed by the sociohistorical context of race. The implicit and explicit biases of the predominantly white teaching force are often informed by the sociohistorical context of the US in which Black people are seen as incapable and on the deficit end of the achievement gap rhetoric. The school level of the FAMSI framework is of particular importance because biases in teachers' placements of Black students into rigorous math and science coursework, especially in and around middle school, can severely limit a student's math trajectory (Campbell, 2012; Faulkner et al., 2014; Francis, 2012; Griffin, 2018) and interest in STEM careers (Alexander et al., 2012; McClure, 2017; Sarama et al., 2012; Sawchuck, 2018). Moreover, in their study of teacher implicit biases, Starck et al. (2020) found that teachers were not immune to holding racial prejudices. In fact, Starck et al. (2020) found that teachers held equivalent explicit and implicit racial biases as other adults with similar characteristics and backgrounds. The findings from Starck et al. (2020) counters the narrative that teachers are "post-racial" or objective adults who espouse and uphold the ideals of racial equity. Such studies are significant because teachers often act as gatekeepers to higher-level STEM coursework.

In this study, my analyses focused on various teacher and school characteristics in order to measure to what extent teachers impact Black students' math trajectories. Specifically, in the quantitative analysis I integrated variables such as teacher age, race, gender, and years of experience, as well as the demographics of the student body. In my qualitative analysis I centered Black students' experiences with the math curriculum and math teachers. In both my

quantitative and qualitative analyses, the school level factors had major implications for Black students' math course taking patterns.

Individual Factors

The fourth and final level of the FAMSI framework highlights individual factors that contribute to Black students' success in math despite the contextual factors that impede their academic progress. This level includes students' identities and goals, their perceptions of the school climate, their peers, and their teachers, their beliefs about their mathematical abilities, and their opinions about the importance of mathematics knowledge (Figure 1; Martin, 2000, pp. 30-31). This level of the framework is a necessary addition that shifts the narrative from what has not worked for Black students in math towards a discussion of the agency of students who have successfully traversed the mathematics academic pathway. Many scholars have noted the incredible persistence of Black students in STEM (Alexander, 2015; Joseph et al., 2019; Martin, 2012; McGee, 2020; McGee & Pearman, 2015; Nasir et al., 2009; Spencer, 2009). The stories of Black student success across the STEM pipeline are of central importance to this dissertation. As my findings will show, much can be gleaned from the stories of my participants, all who have had varying levels of success within the math classroom.

Gender and Intersectionality. Intersectionality (Collins, 2019) can be defined as the ways in which various components of one's being interact with institutional, structural, and representational factors to shape the individual experience, typically with increased persecution and discrimination based upon multiple levels of marginalization. The extent to which individuals' identities interact with systems of power or privilege, given their context, informs their experiences and access to opportunity. For example, in the STEM context, Women of Color continue to be highly underrepresented in STEM careers, even more so than Men of Color

(National Science Foundation, 2017). According to an analysis of longitudinal student data by Saw et al. (2018), girls from all racial/ethnic and SES groups consistently had significantly lower persistence rates in math and science coursework and lower rates of interest in STEM careers.

STEM spaces are often hostile and uninviting for Black students, girls, in particular (Morris, 2007; Joseph et al., 2019). In STEM classrooms Black girls are often rendered as invisible as dually marginalized women in the STEM field (Chavous & Cogburn, 2007; Farinde & Lewis, 2012; Neal-Jackson, 2018; Ricks, 2014). In addition to being underrepresented due to their gender, Black girls must also contend with the anti-Black nature of STEM, often being tracked out of upper-level STEM coursework (Joseph et al., 2017), experiencing under identification in gifted education (Ford, 2014; Collins et al., 2020), attending underfunded schools with inequitable access to rigorous upper-level STEM coursework (Morgan & Amerikaner, 2018; Collins et al., 2020), experiencing anti-Blackness in STEM classrooms (Joseph et al., 2016; Joseph et al., 2017; Joseph & Cobb, 2019), and experiencing exclusionary discipline in schools (Annamma et al., 2016; Morris, 2016; Wood et al., 2019). Black boys face similar patterns of anti-Blackness and also experience the math classroom in racialized and gendered ways (Jett et al., 2015; Jett & Davis, 2020). In fact, in my study Black males were significantly less likely to take coursework Beyond IM3.

The findings speak to the nuance nature of intersectionality as it pertains to Black students in STEM. The concept of intersectionality compels educators to contend with the marginalization in STEM-based on gender and racial-ethnic identities, and the particular types of struggles that Black girls and boys face throughout the STEM pipeline because of their intersectional identities (Riegle-Crumb et al., 2011; Joseph et al., 2019).

Summary

The underlying premise of this dissertation study is that race and racism are embedded inside and outside of the mathematics classroom. The purpose of this dissertation is to determine how these sociohistorical, school, community and individual factors inform Black student enrollment in Beyond IM3 coursework. Ultimately, as this dissertation will showcase, Black students' math course taking decisions are disrupted by a multitude of factors. Martin (2000) emphasizes the importance of sociohistorical, community, school, and intrapersonal themes that impact Black students' mathematics socialization, dispositions towards math, and their mathematics identities. This study utilized the multi-level factors within the FAMSI framework to demonstrate how multiple factors work together to impede the math trajectories of Black students. Each level of Martin's framework works in symbiosis with the other levels. Within the sociohistorical, community, school, and individual levels, each set of factors influences, informs, and responds to the other set of factors to either create moments of equity or reinforce barriers to learning. Each level of Martin's framework overlaps with the next to interrupt the mathematical socialization and mathematical identity development of Black students. Whether it be at the school level, through the lack of culturally relevant curriculum and instruction or the racialized nature of course placement and advising, or at the community or sociohistorical levels, Black students' mathematical lives are inherently impacted by processes of racialization and the perpetuation of racial inequities (Francis & Darity, 2021; Moody, 2004; Rogers, 2020).

In the chapters that follow I will dig deeper into the math literature, my methodology, findings, and discussion. Specifically, in Chapter 2, research and scholarship relevant to developing the design of this study and the guiding questions is examined. Chapter 2 centers the

multilevel factors of the FAMSI framework and the ways that Black students' secondary math pathways are often disrupted at multiple levels. The disruption of Black students' math trajectories can be attributed to systematically racist policies and practices that act as institutional and structural barriers. As Chapter 2 highlights, barriers such as academic tracking, school placement policies, teacher implicit biases, and the racialized perceptions teachers hold of their Black students disrupt Black students' pathways into upper-level math coursework Beyond IM3. In Chapter 3, the mixed methodology that was used in this study will be discussed at length. The qualitative and quantitative approach will be detailed, and the analysis process explained. Chapters 4 and 5 will present the quantitative and qualitative findings respectively. Chapter 6 discusses the implications, and recommendations for policy and research.

Chapter 2: Review of the Literature

The background literature presented in the previous chapter makes it overwhelmingly clear that early and consistent access to rigorous, high-quality, math curriculum and teaching has positive implications for STEM interest, high school graduation rates, and post-secondary degree completion. Recent scholars have been vigilant in emphasizing how racialized math classroom experiences and the anti-Black nature of STEM, contributes to Black students' dispositions toward math, their mathematics socialization, and STEM identity development (Ispa-Landa & Conwell, 2014; Leath et al., 2019; Martin, 2012; McGee, 2020; McGee & Pearman, 2015; Nasir & Shah, 2011; Nestel, 2016; Strutchens, 2000). Ultimately, the positive or negative interactions that Black students are having with math content and within math classrooms have major influences on their mathematical identities and may impact their decisions to take additional math courses Beyond IM3 in high school.

Given the multilevel factors that influence the math outcomes of Black students, this review of literature is focused on exploring institutional and structural barriers at the sociohistorical, community, school, and student level that affect Black students' successful progression along the math pathway (Martin, 2000). An examination of literature that addresses how this literature has shifted over time can help guide future research by shedding light on the policies and practices that have been both problematic yet effective at stifling Black students' math academic trajectories. The review of literature that follows will cover four critical concepts: 1) access to high-quality math coursework and pathways and the impacts of academic tracking, 2) the influence of math teachers on the academic trajectories of Black students, 3) the role of community (parents, peers and other external influencers), and 4) the role of individual level

(identity, agency, and self-efficacy) influencers on Black students' persistence along the math pathway.

Sociohistorical Factors - Access to Early, High-Quality Math Curricula and Pathways

Black students deserve greater access to highly rigorous secondary math coursework to support their future persistence in STEM-related majors and foster their interest in STEM careers. In addition, advanced math courses in middle school as an impetus for obtaining four units of secondary math continues to be a highly controversial topic, with mixed results on student achievement outcomes (Finkelstein et al., 2012; Ma, 2000; Smith, 1996; Walston & McCarroll, 2010; Wang & Goldschmidt, 2003). However, Black students are less likely to participate in the prerequisite courses in elementary and middle school that would facilitate access to upper-level secondary coursework (Archbald & Farley-Ripple, 2012; Paul, 2005; Ngo & Velasquez, 2020; Oakes, 1990, 2005; Walston & McCarroll, 2010; Wells, 2018). Essentially, Black students' math pathways are often obstructed due to institutional and structural barriers such as bias in teacher placement (Faulkner et al., 2014; Francis, 2012; Walston & McCarroll, 2010) and limited access to the appropriate math courses that would facilitate a clear path through secondary math to Beyond IM3 coursework.

Math Courses, Pathways, and Proficiency

The types of math courses offered and the organization of the mathematics curriculum, have significantly impacted secondary students' academic outcomes. Research suggests a relationship between particular course sequences and proficiency in math (Bozick & Ingels, 2008; College Board, 2011). More specifically, course sequences that include classes beyond Algebra II, or Integrated Math 3 result in higher proficiency levels on math assessments (Bozick & Ingels, 2008; College Board, 2011). Research highlights the ways in which earlier access to

higher-level math courses and achievement in previous math coursework act as critical variables for increasing Black students' access to the highest levels of math.

Middle School Algebra and Student Outcomes. The later elementary to middle school years (3rd to 8th grade) serve as a crucial area of time that often dictates how students feel about math and ultimately how far they progress in secondary math coursework (Ma, 2000; Smith, 1996; Spielhagen, 2006; Walston & McCarroll, 2010; Wang & Goldschmidt, 2003). Specifically, scholars have investigated and documented the overrepresentation of Black students in remedial math coursework as early as middle school (Oakes, 1990; Walston & McCarroll, 2010; Wang & Goldschmidt, 2003). Wang and Goldschmidt (2003) found that these disparate outcomes increased as students progressed through the math pipeline. By the time they reached eleventh grade, Black students were twice as likely to be enrolled in remedial math courses and often were not enrolled in a math course at all in their junior year. Additionally, to measure growth in math scores, Wang and Goldschmidt (2003) used hierarchical linear modeling to compare students' California Test of Basic Skills (CTBS) scores to students' district ninth, tenth, and eleventh grade math assessments. They found that the math course taken by a student in the eighth grade had a statistically significant impact on their high school math achievement scores. Students who earned credit in an advanced math course in the eighth grade scored significantly higher on high school math assessments than those who enrolled in regular or remedial math courses in the eighth grade.

Using transcripts from the High School and Beyond dataset, Smith (1996) analyzed the multiple impacts of being enrolled in Algebra before high school on future mathematical attainment. The sample for this study included two student populations (n=6,894): public high school students who had taken an Algebra course at some point in high school and received their

high school diploma (n=5,818), and high school students who had taken an Algebra course before high school (n=1,076). The findings indicated that early Algebra takers were less likely to be Students of Color or students from lower socioeconomic backgrounds. Students who took Algebra before high school had higher math achievement scores, higher educational aspirations, and were more likely to be in the "academic" or college-preparatory track by the tenth grade. On average, these students obtained a full-year more math credits by their senior year. These students were also more likely to take a math course during their senior year and were more likely to have taken Calculus at some point in high school. In addition, students who enrolled in Algebra prior to high school had higher math achievement scores by their senior year of high school (Smith, 1996). Another finding indicated that earlier access to higher levels of math had a socializing effect on students. Students who enrolled in eighth grade Algebra developed a "math-taking mentality" that made them more likely to enroll in additional math courses throughout their high school career (Smith, 1996).

Ma (2000) explored the effects of math coursework on subsequent math achievement. The sample for this study included one cohort of 3,116 students from the Longitudinal Study of American Youth (LSAY), which included student transcripts from seventh to twelfth grade. The researcher measured math achievement by using a math assessment explicitly created for the project. Using students' transcripts, the researchers conducted a linear regression analysis where they annually compared students' assessment scores to students' math coursework. Ma (2000) found that taking Pre-Algebra or Algebra I in seventh or eighth grade was a statistically significant predictor of future math achievement.

In a similar study, Spielhagen (2006) explored the longitudinal impact of taking Algebra in the eighth grade. The sample for this quantitative study included 2,634 high school graduates

from a large public-school district in the Southeast. Spielhagen (2006) studied two student populations: those who took Algebra in the eighth grade and those who did not. Spielhagen (2006) found that Black students were highly underrepresented in eighth-grade Algebra. Researchers also found that students who earned credit for Algebra in the eighth grade were more likely to successfully progress through four years of the secondary mathematics pipeline. They found that these students attended college at higher rates as well. Furthermore, Spielhagen (2006) found that being identified as gifted was the strongest predictor of eighth-grade Algebra enrollment. This is an important finding since research has shown that Black students are significantly less likely to be identified by schools as gifted (Ford, 2014; The Education Trust-West, 2015) thus the underrepresentation of Black students in eight grade Algebra is in alignment with these findings.

Kurlaender et al. (2008) investigated the link between middle school math and high school dropout rates. The study used district wide data for three diverse California school districts (n = approximately 15,000). They found that students with higher math achievement levels in middle school were more likely to graduate from high school. Most importantly, taking Algebra I by the eighth grade was a strong predictor of high-school graduation. Neild and Balfanz (2006) also examined the relationship between eighth grade math and high school graduation. The researchers analyzed transcript data for six cohorts of students from the high school classes of 2000-2005. They found that Black and Latinx graduation rates from the Philadelphia school district were the lowest in comparison to their peers. For eighth graders, two factors outweighed the others: attendance and receiving a failing grade in eighth grade math or English. Of the eighth graders from the Class of 2000 who failed English and/or math in their eighth-grade year, 77 percent of them eventually dropped out of high school. Black and Latinx

students made up over 75 percent of the students labeled "At-risk" for dropping out in the eighth grade.

Walston and McCarroll (2010) compared math achievement within subgroups, finding that Black students in eighth-grade Algebra or higher tended to earn better math assessment scores than Black students not in Algebra in the eighth grade. In addition to having higher math scores, Walston and McCarroll (2010) found that Black students who took Algebra by the eighth grade developed higher expectations about their future educational attainment and enjoyed mathematics more than those who had not taken Algebra by the eighth grade.

Similarly, in a report created from the 2005 National Assessment of Educational Progress (NAEP) High School Transcript Study (HSTS), Brown et al. (2013) found statistically significant differences in average credits earned in math courses, average GPA in math courses, and average overall NAEP math scores for students who took Algebra I or Geometry in middle school. The students who took Algebra I or Geometry in middle school had more positive academic outcomes overall than their peers. Moreover, to determine the relationship between middle school math achievement and secondary math course enrollment, Finkelstein et al. (2012) analyzed the course taking patterns of 24,000 California students between seventh and twelfth grade. The researchers found that students were more likely to take rigorous math courses in high school if they earned an A in their seventh-grade math course. Finkelstein et al. (2012) also found that students who were on the accelerated math pathway (taking Algebra I in eighth grade, Geometry in ninth grade, and Algebra II in 10th grade) demonstrated proficiency on the math CST in high school.

Academic Tracking and Black Students' Secondary Math Trajectories. Academic tracking is a tool used by most educational institutions to categorize and classify students by

educational and career aspirations, and/or ability levels (Akos et al., 2007). Yet, research has shown that students are often not categorized by *actual* ability levels but based on *perceived* ability levels (Faulkner et al., 2014; Francis, 2012; Yonezawa et al., 2002). The placement of Black students into lower-tracked math coursework is a direct result of teacher perceptions of their mathematical abilities (Berry, 2005; Faulkner et al., 2014; Francis, 2012). As a result, Black students are grossly overrepresented within the lowest rungs of the academic hierarchy, and academic tracking is the social tool that exacerbates the widening academic achievement gap between Black and White students (Ballón, 2008; Braddock, 1990; Kelly, 2009; Ngo & Velazquez, 2020; Oakes, 1990, 2005; Paul, 2005; Wells, 2018).

The practice of tracking and ability grouping has become a systematic method of de facto segregation that continues to hinder Black students in their growth as potential mathematicians (Oakes, 1990, 2005; Faulkner et al., 2014; Walston & McCarroll, 2010). Black students continue to be consistently underrepresented in higher-ability level coursework (Ford, 2014; Oakes, 1990, 2005; Solórzano & Ornelas, 2004). Relatedly, Riegle-Crumb (2006) found that Black students began high school at lower levels of the math sequence and remained at these levels throughout their high school career. Riegle-Crumb (2006) also found that even after taking prior math achievement and grades into consideration, Black males were still significantly underrepresented in rigorous secondary math coursework. Unlike previous studies that saw differences by race and ethnicity, Riegle-Crumb (2006) saw differences by race, ethnicity, and gender. Specifically, for Black males, she found that taking Algebra I in ninth grade did not significantly impact the level of math attainment achieved by senior year. The results remained negative and statistically significant for Black males regardless of their demonstrated math achievement levels in the ninth grade. Black males remained the least likely to be enrolled in the highest levels of math by their

senior year even if they demonstrated high math achievement in the ninth grade. These findings are salient as an indicator of more insidious and systemically racist policies and placement practices that thwart the math pathways of Black students, males in particular.

In general, Black students are more likely to be placed on the lowest rungs of the math academic hierarchy than their white peers (Archbald & Farley-Ripple, 2012; Ballón, 2008; Braddock, 1990; Kelly, 2009; Oakes, 1990, 2005; Riegle-Crumb, 2006). Moreover, not taking Algebra I in middle school has been shown to be a significant impediment to upper-level secondary math coursework for Black students (Paul, 2005). However, even when Black students demonstrated high achievement in previous math courses, they were still less likely to be placed into Algebra I in middle school (Faulkner et al., 2014). Due to the sequential nature of math coursework, the findings in this section reiterate that the math coursework Black students are exposed to in elementary and middle school dictates their course taking possibilities in high school (Oakes, 1990; Paul, 2005) and that much of their opportunities are impacted by teachers' placement decisions and institutional and structural policies (Faulkner et al., 2014; Riegle-Crumb, 2006). The section that follows focuses on some of the school level factors that contribute to the underrepresentation of Black students in upper-level math coursework Beyond IM3.

School Level Factors - Black Math Students' School and Classroom Experiences

Researchers have documented the racialized experiences of Black students in math classrooms for over twenty years. According to recent studies, racial discrimination continues to be a major component of the classroom experiences of Black students (Ispa-Landa & Conwell, 2014; Leath et al., 2019; Martin, 2012; McGee & Pearman, 2015; Nasir & Shah, 2011; Nestel, 2016; Strutchens, 2000). The racialized nature of the classroom experience has profoundly

negative effects on Black student engagement and achievement (Davis, 2014; Leath, et al., 2019) and their sense of belonging (Boston & Warren, 2017). Although these discriminatory practices take many forms, the role of racialized the mathematics teacher is the greater focus of this section.

School Racial Composition and Math Placement

Concluding an analysis of high school transcripts from 5,000 students in 367 schools, Kelly (2009) found a possible connection between school racial composition and math course taking differences between Black and white students. One of the regression models specifically compared Black students in predominantly Black schools to Black students in non-Black and integrated school settings. An important finding was that Black students were more likely to be enrolled in upper-level math courses in predominantly Black schools. Meanwhile, Black students were most likely to be placed into lower-level math classes in predominantly white school settings. According to Kelly (2009), the course taking disadvantage for Black students "gradually disappears as the school becomes more integrated and eventually predominantly Black" (p. 58).

Diette (2011) found similar results in his analysis of the relationship between access to Algebra 1 in the eighth grade and the percentage of white students in North Carolina schools. Diette (2011) found that the likelihood of a Black student being in Algebra 1 decreased as the number of white students enrolled at a school increased. Specifically, Diette (2011) found that the likelihood that a Black student enrolled in Algebra 1 in the eighth grade was significantly lower in a more integrated school than in a more segregated school. These findings offer a unique take on academic tracking, math placement, and the racial composition of schools.

The Impact of Racialized Narratives on Black Students' Academic Outcomes

Berry (2005) found that institutional racism (Scheurich & Young, 1997), aggregated individual discrimination (Berry, 2005; Sidanius et al., 1998), and racialized narratives (Nasir & Shah, 2011) played a role in the impediments Black males faced on their road towards high levels of math achievement. Other researchers found similar results (McGee & Pearman, 2015; Nasir & Shah, 2011) indicating that the math trajectories of Black students may be hindered by the racialized narratives they experience in math classrooms.

Nasir and Shah (2011) argue that racialized narratives are frequently seen in schools and classroom settings. According to Nasir and Shah (2011) the model minority myth is one such narrative, as well as its antithesis, the narrative that characterizes Black students as athletic yet unintelligent, lazy, and criminal. Nasir and Shah (2011) found that not only were their participants aware of racialized narratives, but the students also articulated the ways in which they were being treated differently in school due to their race. The differential treatment aligns with Martin's (2009a) racial hierarchy of mathematical ability, placing Asian students at the top and Black students at the bottom of the hierarchy. Research emphasizes that race and racism are endemic in this country (Bell, 1992; DeCuir-Gunby et al., 2019; Ladson-Billings & Tate, 1995; Milner & Howard, 2013; Solorzano, 2007; Solorzano & Yosso, 2000).

Similarly, in their narrative analysis of thirteen high achieving Black male high school students, McGee and Pearman (2015) found that experiences with negative stereotypes had a major impact on the students' perseverance through math. A common theme across student narratives in their study, were the feelings of anxiety students felt regarding the threat of being seen as a Black male stereotype. The narratives placed limits on the possibility of having strong mathematical abilities for many of the Black male participants, diminishing their

accomplishments as students who were good at math. Notedly, the students demonstrated strong individual agency and strong mathematics and racial identities, which allowed for their persistence despite the racialized narratives they faced. Although the students in their studies ultimately proved to be resilient in their pursuit of mathematical excellence, McGee and Pearman's (2015) and Nasir and Shah's (2011) findings highlight the possible impediments that racialized narratives create even for highly achieving Black students.

Griffin and Allen (2006) investigated the racialized high school experiences of high achieving Black students from two different high schools. One school, Twin Oaks, was described as academically above-average with mostly upper-middle class students, in a suburban setting. The student population of Twin Oaks consisted of only eleven percent Black students, with 50 percent White, 32 percent Latinx, and seven percent Asian students. The faculty at Twin Oaks was predominantly White (68 percent). The other school, Bennett High, was described as under-achieving in an inner-city community, with mostly students from lower socioeconomic backgrounds. The student population of Bennett high consisted of 41% Black and 58% Latinx students, with a combined one percent White and Asian students. The faculty at Bennett High was predominantly Black (53 percent). The students from Twin Oaks emphasized the racialized climate that impeded Black student achievement. Black students felt they had to work harder than their peers and overcome racial stereotypes to get into college prep courses. At Bennett High, Black students felt supported in their collegiate aspirations. The predominantly Black teachers and school administrators went above and beyond to ensure students felt supported and cared for. The findings speak to the importance of Black teachers and the community that can be built in schools with large populations of Black students.

The Multiple Impacts of Teacher Bias

Not only do racial narratives create isolating racialized experiences for Black students in math classrooms, but teachers also contribute to the racialized nature of the math classroom that Black students' experience. In their qualitative study of the experiences of four high-achieving Black male high school students, Thompson and Davis (2013) observed that student participants were highly aware of teacher beliefs regarding their academic ability levels. They also found that the students appreciated the rapport built with Black male math teachers in particular. These relationships had significant impacts on student outcomes, interests, and attitudes about math. The findings by Thompson and Davis (2013) are salient because scholarship indicates that classroom teachers heavily influence the persistence of Black students along the math pathway (Davis, 2014; Gershenson, et al., 2017; Klopfenstein 2005; Strayhorn, 2010; Thompson & Davis, 2013; Young et al., 2017). Therefore, biases in teacher perceptions of Black students can severely limit a student's access to rigorous secondary math coursework (Berry, 2005, 2008; Francis, 2012; Faulkner et al., 2014) and may exacerbate racial gaps in math achievement (Robinson-Cimpian et al., 2014).

Several scholars have explored the relationship between teacher perceptions of Black students and their placement into rigorous coursework (Berry, 2005; Francis, 2012; Faulkner et al., 2014; Walston & McCarroll, 2010). These studies also found that teacher evaluations had a significant impact on the placement of Black students into rigorous math coursework. Berry (2005) found that teacher evaluations of student behavior were used to determine intellectual potential and limited Black male student access to rigorous math coursework. Relatedly, Francis (2012) illuminated the experiences of Black girls, finding that teachers perceived Black girls as less attentive and more disruptive than their White, Asian, or Latinx peers. They also found that

teacher perceptions of student attentiveness significantly impacted Black girls' placement into rigorous courses in eighth-grade math. Similarly, Campbell (2012) investigated the likelihood for a Black girl to be recommended for advanced math courses based on school, family, peer, and individual student factors. Campbell (2012) found that teacher expectations of the student's postsecondary opportunities had a statistically significant impact on the likelihood of being recommended for an advanced or honors math course. For example, if a teacher expected the student was going to graduate from high school and not attend college, they were less likely to recommend the student for an honor's course than if the teacher expected the student would earn a bachelor's or graduate-level degree.

Copur-Gencturk et al. (2020) also investigated teacher biases in their interpretation of student mathematical ability. Copur-Gencturk et al. (2020) analyzed the interpretations of 390 teachers' evaluations of students' mathematical abilities. Copur-Gencturk et al. (2020) gave fictitious students pseudonyms "commonly associated with Black, Hispanic, and White (Non-Hispanic) males and females" (p. 33) to fictitious incorrect and correct solutions to math problems. Teachers were then asked to rate the correctness of each solution. The participants were also asked to rate the mathematical ability of the student based on their solution to the problem. The names were the only information teacher participants had about the students as they reviewed student responses to the math problems. Copur-Gencturk et al. (2020) found that the teacher ratings for partially correct solutions from students with names that were classified as "White-sounding" were significantly higher than the ratings for students with Latinx or Black sounding names. In addition, they found that White teachers favored boys over girls, rating boys higher on average than girls in their ranking of partially correct solutions. They also found that Teachers of Color favored students with White-sounding names over students with Black or

Latinx sounding names. These findings demonstrate a frightening possibility: that a student could be given the benefit of the doubt (and receive partial credit for the partially (in)correct answer) based on their *perceived* racial-ethnic and gender identity.

In a similar study, McGrady and Reynolds (2012) examined the relationship between teacher-student racial-ethnic identities and teacher perceptions of students. The researchers found that Black students were the least likely to be rated as attentive by White English and math teachers and Asian students were most likely to be rated as attentive. In addition, White teachers labeled Black students as having lower levels of scholastic ability than White and Asian students.

The findings in this section showcase the ways in which race, racism, and intersectionality continue to contribute to how math teachers interact with and value their Black students. These findings also illuminate the centrality of race and racism within placement practices and policies that guide Black students' math pathways. The findings of Campbell (2012), Copur-Gencturk et al. (2020), and Francis (2012) center the intersections of race and gender and contribute to an extensive body of literature related to the invisibility of Black girls in upper-level STEM coursework and within STEM careers (Chavous & Cogburn, 2007; Campbell, 2012; Farinde & Lewis, 2012; Francis, 2012; Neal-Jackson, 2018; Ricks, 2014). The intersectional nature of Black students' STEM placement has implications for future STEM success and could be a contributing factor for the underrepresentation of Black women in STEM careers (National Science Foundation, 2017; NCES, 2020). Taken together, these findings demonstrate the impact that racialized math classroom experiences and biased teacher perceptions could have on the math trajectories of Black students.

Teacher matching by race and gender

Recent scholarship has shown that student engagement and achievement increase significantly when the race, ethnicity, or gender of the student aligns with the teacher's race, ethnicity or gender (Dee, 2006; Egalite et al., 2015; Gershenson et al., 2017; McGrady & Reynolds, 2012; Miller, 2018). McGrady and Reynolds (2012), Egalite, et al. (2015), Gershenson et al. (2017), and Klopfenstein (2005) had similar findings regarding the importance of teacher race on the academic outcomes of Black students. Importantly, McGrady and Reynolds (2012) found that Black math teachers recognized and valued the growth, potential, and progress of their Black students the most. McGrady and Reynolds' (2012) findings highlight the value of Black teachers and have implications for positively encouraging Black students' academic trajectories and their STEM identity.

Egalite, et al. (2015) investigated the relationship between student achievement outcomes on the math and reading sections of the Florida Comprehensive Assessment Test (FCAT) and the racial-ethnic identity of their teacher. Egalite et al. (2015) found that for all students matching the race of the student to the race of the teacher had a statistically significant effect on student achievement outcomes in both reading and math. The effects of student-teacher race matching were most significant at the elementary level. When considering Black students, the impact of having a Black teacher was statistically significant in both reading and math, but the impacts were larger in math at both the elementary and secondary levels. Student-teacher race matching demonstrated positive effects on the academic outcomes of lower performing students across the elementary and secondary levels as well.

Similarly, Gershenson et al. (2017) investigated the effects of teacher matching in the third, fourth, or fifth grade to the secondary level academic outcomes for students. Gershenson et

al. (2017) found that Black males benefited most from teacher matching. The likelihood that he would graduate high school significantly increased if he was exposed to one or more Black teachers in elementary school. The researchers also found that Black males and females were more likely to aspire to attend college if they had a Black teacher in the third, fourth, or fifth grade. In contrast, Klopfenstein (2005) found that the effects of having a Black teacher were only significant for students if the teacher was from the opposite gender. Klopfenstein (2005) explored the impact of having a large percentage of Black teachers in a school on the successful progression of a Black student from Geometry to Algebra II. Klopfenstein (2005) found that having more Black teachers in a school had a positive statistically significant impact on the likelihood that a Black student enrolled in a secondary math course beyond Geometry, but only if the teacher was of the opposite sex. In this study, the significance of having a same-sex, same-race student-teacher match was indiscernible, having a minimal effect on the course taking decisions of Black students. However, Dee (2006) examined the impact of same gender teachers on student achievement. Dee (2006) accomplished this by assigning same gender teachers to students and comparing students' pre and post assessments. The results showed that same gender teachers significantly improved the achievement of both boys and girls. In addition to measuring student achievement, Dee (2006) also used a perception survey to gather teachers' opinions about student engagement. The results showed that both genders of teachers perceived students of the same gender as having a better attitude, better motivation, and a better ability to succeed (Dee, 2006). This study exposes even further, the potential biases in education based solely on gender. Given that most teachers are both white and female, these findings provide strong implications for the underrepresentation of Black boys in Beyond IM3 coursework.

The findings in this section uncover the racialized math classroom experiences that continue to push Black students out of the STEM pipeline (McGee & Pearman, 2015; Nasir & Shah, 2011). This section also illuminates the importance of Black teachers. As the literature suggests, classroom teachers play a significant role in students' persistence and achievement within the math pathway (Davis, 2014; Gershenson et al., 2017; Klopfenstein, 2005; Strayhorn, 2010; Thompson & Davis, 2013; Young et al., 2017). The biased perceptions of Black students that teachers hold can severely limit a student's opportunities in rigorous secondary math coursework (Berry, 2005, 2008; Francis, 2012; Faulkner et al., 2014). These racialized experiences have significant implications for Black students' learning and achievement in secondary math and may potentially exacerbate racial gaps in math achievement (Robinson-Cimpian et al., 2014). The findings in this section have significant implications for math education as a whole. They demonstrate how explicit and implicit biases contribute to broader structural and institutional limitations that Black students face when attempting to traverse the math pathway.

Community Level Factors - Influencers on Black Students' Math Trajectories

While there is no denying that institutional and structural forces play an influential role in Black students' math trajectories, interpersonal factors also contribute to Black students' course taking patterns and their persistence in secondary math. Research indicates that peers significantly impact academic achievement in classrooms (Bates, 2004; Darensbourg & Blake, 2014; Kunjufu, 1988; Ryan, 2001). For most students, having friends who support academic attainment, follow school norms, and have high educational aspirations is quite impactful on their academic achievement and school behavior. This is especially true for Black students in math (Strayhorn, 2010). Moreover, peers play a significant role in Black students' mathematics

persistence and academic resilience, especially in upper-level math coursework (Datnow & Cooper, 1997; Thompson & Davis, 2013; Walker, 2006; Yonezawa et al., 2002).

Yonezawa et al. (2002) demonstrated how the underrepresentation of Black students in upper-level coursework influenced Black students' decision to take lower-level coursework instead of more rigorous coursework. According to Yonezawa et al. (2002) students who opted to take upper-level coursework often felt isolated because they were one of only a few Black students in the class. Therefore, Black students often chose to remain in lower-level classes with their supportive peers. This study showcases how important peer relationships are on upper-level course taking patterns.

Raabe et al. (2019) illuminated the importance of peer influence on the development of STEM identity and mathematical success in historically underrepresented groups. In their qualitative study of the experiences of four high-achieving Black male high school students, Thompson and Davis (2013) found that peers made a major difference in the participants' achievement levels in secondary math. Similarly, Walker (2006) investigated how peers, parents, and school communities fostered mathematical achievement among Black high school students. She found that like-minded peers were very influential in the persistence and achievement of the Black student participants in their secondary math coursework. Datnow and Cooper (1997) discovered that Black students in predominantly White schools used informal and formal peer networks of Black students for academic support and to lessen feelings of isolation in their mostly White classes. These peer groups actively encouraged high academic achievement through tutoring and by modeling academic behaviors (Datnow & Cooper, 1997).

For Black students, same-race peers play a major role in their sense of belonging. Sense of belonging can be defined as the "extent to which students feel personally accepted, respected,

included, and supported by others- especially teachers and other adults in the school social environment" (Goodenow & Grady, 1993, p. 80). According to a growing body of literature, sense of belonging is essential to the ways in which students see themselves and engage with their teachers and peers at school. This is especially true for Black students (Boston, 2017; Faircloth & Hamm, 2005; Garces & Jayakumar, 2014; Jayakumar, 2015). In addition, sense of belonging has been indicated as a major influencer on Black student academic achievement (Boston, 2017; Faircloth & Hamm, 2005; Jayakumar et al., 2018; Miller et al., 2005; Murphy & Zirkle, 2016; Smalls et al., 2007). Moreover, Black students who attend schools with a critical mass of same-race peers develop an increased sense of belonging (Garces & Jayakumar, 2014; Jayakumar, 2015), which contributes to better academic achievement outcomes (Boston, 2017; Davis, 2014; Faircloth & Hamm, 2005; Jayakumar et al., 2018; Miller et al., 2005; Murphy & Zirkle, 2016; Smalls et al., 2007).

External support systems, including involved parents, extended family, and role models, have also been indicated as key factors crucial to Black students' mathematical success (Carter Andrews, 2020; Stinson, 2009; Strayhorn, 2010; Walker, 2006). Carter Andrews (2020) investigated the persistence of Black engineering majors. Of the five Black engineering majors she interviewed, they all attributed their successful progression through the K-12 math pathway and persistence in their undergraduate degree to several factors including having high-achieving peers, and family with high expectations. In a similar study, Stinson (2009) explored the counterstories of four successful Black males. He identified several major themes that contributed to their successful progression through the K-12 mathematics pathway. These themes included having family, community members or role models who held high expectations and encouraged academic achievement, as well as having high-achieving peers with similar goals

and interests. The counterstories of the young men in this study speak to the importance of family, community, and peer groups on Black students' math trajectories and postsecondary outcomes.

Strayhorn (2010) examined the impact of schools, teachers, families, and social-psychological factors on Black student math achievement, using the NELS:88 dataset. Strayhorn (2010) applied Bronfenbrenner's (1979) ecological systems theory to describe how multiple systems, such as the school and the family, work together to influence math achievement outcomes for Black students. Ultimately, Strayhorn (2010) found that Black students earned higher math achievement scores when their parents demonstrated high expectations and school involvement. Walker (2006) also found that the overlap of parents' high expectations, with teacher support and interventions demonstrated significant influence on student achievement. Similarly, Berry (2005) explored factors that contributed to the mathematical success of two Black middle school males. He found that external support systems including involved parents, extended family, and role models, were important to the mathematical success of the two participants. In addition, Berry (2005) found that community support systems including the church and athletic teams provided spaces for additional support and external motivation.

The findings in this section highlight the ways in which community level factors influence Black students' mathematical achievement and their dispositions towards math. Peers play a significant role in the mathematics persistence and academic resilience of Black students, especially in upper-level math coursework (Datnow & Cooper, 1997; Stinson, 2009; Thompson & Davis, 2013; Walker, 2006; Yonezawa et al., 2002). Peers also greatly influence Black student persistence and resilience within the math pathway by helping to strengthen Black students' STEM identities (Datnow & Cooper, 1997; Thompson & Davis, 2013; Walker, 2006; Yonezawa

et al., 2002). For Black students, having a critical mass of same-race peers is instrumental in building a sense of belonging in academic settings, with implications for their academic achievement and success along the math pathway (Boston, 2017; Faircloth & Hamm, 2005; Jayakumar et al., 2018; Miller et al., 2005; Murphy & Zirkle, 2016; Smalls et al., 2007). External support systems including involved parents, extended family, and role models are also important to the mathematics success of Black students (Stinson, 2009; Strayhorn, 2010), and Black parents play a significant role in the academic identities of Black students (Berry, 2005; Carter Andrews, 2020).

Individual Level Factors - The Impact of Identity-Related Factors

In addition to parental and peer influence, identity-related factors are also associated with Black students' success in math. Specifically, scholars have thoroughly investigated the role of mathematics identity and racial identity on Black students' academic outcomes and mathematics socialization, generally finding that a strong mathematics and racial identity is imperative for the sustained persistence of mathematically successful Black students through the math pathway (Alexander, 2015; Collins, 2018; Ireland et al., 2018; Joseph et al., 2017; McGee & Pearman, 2015; Spencer, 2009). The section that follows discusses identity and its impact on Black students' academic outcomes.

Mathematics Identity, Racial Identity, and Academic Outcomes

Mathematics identity is intricately linked to academic identity (Martin, 2000; Spencer, 2009). For example, in her study of 32 Black middle school students, Spencer (2009) saw that students with a positive mathematics identity tended to be more academically successful and chose careers that were academic in nature such as a medical doctor, architect, or engineer. In contrast, students with a negative mathematics identity tended to be less successful academically

and had career aspirations that were less academically inclined, jobs in entertainment. Similarly, Alexander (2015) investigated the relationship between Black students' math identities and their math self-efficacy by analyzing components of the High School Longitudinal Study of 2009 (HSLS:09) Dataset. According to Alexander (2015), there was a demonstrated relationship between math self-efficacy and math identity. Shifts in students' self-efficacy and identity beliefs "were attributed to students' school sense of belonging, school engagement, and their mathematical learning environments" (Alexander, 2015, p. 109). Alexander's (2015) and Spencer's (2009) findings indicate a relationship between strong mathematical identities and persistence in math coursework.

In a mixed-methods study of the relationships between Black high schoolers' racial and academic identities, Nasir et al (2009) found that a stronger racial-ethnic identity facilitated a positive orientation towards mathematics and school. Similarly, in her study of eleven high achieving Black male high schoolers, McGee (2013) sought to determine the aspects of student identities that accounted for their academic resilience and success in mathematics. McGee (2013) found that in order to successfully navigate unwelcoming math classroom spaces, the students felt it necessary to strengthen and hone both their mathematics identities as well as their Black identities. To accomplish this balancing act, some participants attended mathematics afterschool and summer programs while also maintaining elements of their Black male identities, including "acting hard" to avoid being mistreated by their Black peers. These findings illuminate the juxtaposition of being a Black male and a high-achieving math student. For these participants, their racialized gender identities conflicted with their mathematical identities. By projecting their Black maleness in the neighborhood, these students allowed themselves space to engage with their academics in positive ways, while not having to assimilate into an anti-Black STEM

persona. Collectively, these studies showcase the relationship between Black students' racial identities, mathematics identities, and academic resilience, demonstrating the importance of individual level factors on the academic outcomes of Black students.

This section highlights how individual factors such as mathematics identity and racial identity influence Black students' math course taking patterns. It is clear that academic resilience in math is bolstered by strong racial and mathematics identities (Alexander, 2015; McGee, 2013; McGee & Pearman, 2015; Nasir & Shah, 2011; Nasir et al., 2009; Spencer, 2009), allowing students to overcome obstacles such as stereotype threat (Steele, 2003). Taken together, the findings in this section seem to reveal the complex nature of identity and the varied ways in which racial identity, mathematics identity, and other contextual factors work in tandem with each other to shape the math pathways of Black students.

Summary

Collectively the literature seems to reveal the complex nature of mathematics course taking patterns for Black students. The literature also illuminates the ways in which structural, institutional, sociohistorical, school, community, and individual factors work in tandem to shape the math outcomes of Black students. However, there appears to be limited literature that recognizes the interrelationship among these factors. Moreover, the research has only provided a partial view of Black students' math experiences by focusing on either quantitative or qualitative approaches. There is a need for a more complex mixed methods approach that compares and synthesizes interrelated quantitative and qualitative data. To address these gaps, Il utilized a mixed methods analysis that incorporates sociohistorical, community, school, and individual factors to explore and interrogate the ways in which these overlapping concepts impact Black

students' math course taking patterns. Chapter 3 will detail the methodological approach of this study.

Chapter 2 in part is a reprint of material as it appears in The Negro Educational Review, 2020, Rogers Jr., Kirk D., Centering the "M" in STEM: A Review of Black Students' Math Experiences. The dissertation author was the primary investigator and author of this paper.

Chapter 3: Methods

My interest in increasing Black student representation in STEM emerged from my role as a middle school STEM teacher for six years. I witnessed, first-hand, the disproportionate placement of Black students into remedial STEM coursework in middle school. Those experiences illuminated the impacts of teacher bias on student placement and the role that schools play in fostering Black students' STEM interest, identities, and persistence. As a doctoral student, I continue to utilize my STEM educator lens. I lean on my own experiences as a Black male who felt pushed out of the STEM pipeline while pursuing a Pre-Pharmacy degree in college. Yet, my lived experiences have not only been informed by barriers, but also by unique opportunities. As an African American from the Metro-Atlanta area, I was fortunate to have been raised around a critical mass of Black people at various levels of personal, academic, and financial success. These variations allowed me to see the Black community's full spectrum of potential at an early age, which I believe was significant in my development into the person I am today. Through this intricate balance, I have often contemplated the factors that fostered my academic persistence through college yet stifled my development in STEM. My research focus on the educational trajectories of Black youth in STEM is a result of those reflections.

My broader research agenda explores issues of equity and access across the P-20 STEM pathway. My aim is to understand and reduce the substantial leaks throughout the STEM pipeline for all students, especially students who have been historically marginalized and are underrepresented in STEM careers. Ultimately, my goal as an educator and scholar is to use my research, teaching, and service as a tool for excavating safe spaces for Black, Indigenous, and other Persons of Color (BIPOC). I would like my future research, teaching, and service to push conversations about social-justice, anti-Blackness, and anti-racism in STEM education. As I

proceed with my journey in academia, I hope to further my impact, reaching students across the entire educational pathway.

In this convergent mixed methods design, I collected and analyzed both qualitative and quantitative data concurrently to better understand the experiences of Black students in math classrooms in a large K-12 school district in Southern California. The goal was to explore the reasons why Black students, who have passed Integrated Math 3 (IM3) in the district, were opting into or out of taking an additional fourth year of math following IM3. The study revealed quantitative and qualitative factors that affect students' ability and desire to complete a fourth year of math in high school. These barriers and systems of support were interrelated with institutional, structural, identity, and parental factors related to their experiences in the K12 education pipeline. The following research question and sub-questions guided this critical mixed methods dissertation study:

> ***RQ: What informs Black students' decision-making processes as they choose to take, or not take, a fourth year of math, beyond IM3, in high school?***
>
> > ***A:*** *How do the schooling experiences of Black students shape their dispositions towards math?*
> >
> > ***B****: How do the schooling experiences of Black students shape their decision to (dis)continue an academic trajectory in high school math?*
> >
> > ***C****: To what extent do institutional and structural factors influence the likelihood that a Black student will enroll in a Beyond IM3 math course by their senior year of high school?*
> >
> > ***D****: How does the concentration of Black math teachers in a school impact the likelihood that a Black student will enroll in a Beyond IM3 math course by their senior year of high school?*

The qualitative data for this study included focus group and individual interviews with Black seniors and juniors who completed the district requirement for three years of math. The

quantitative data included student transcript data and school specific (publicly available) data. Figure 3.1 summarizes the design of this study.

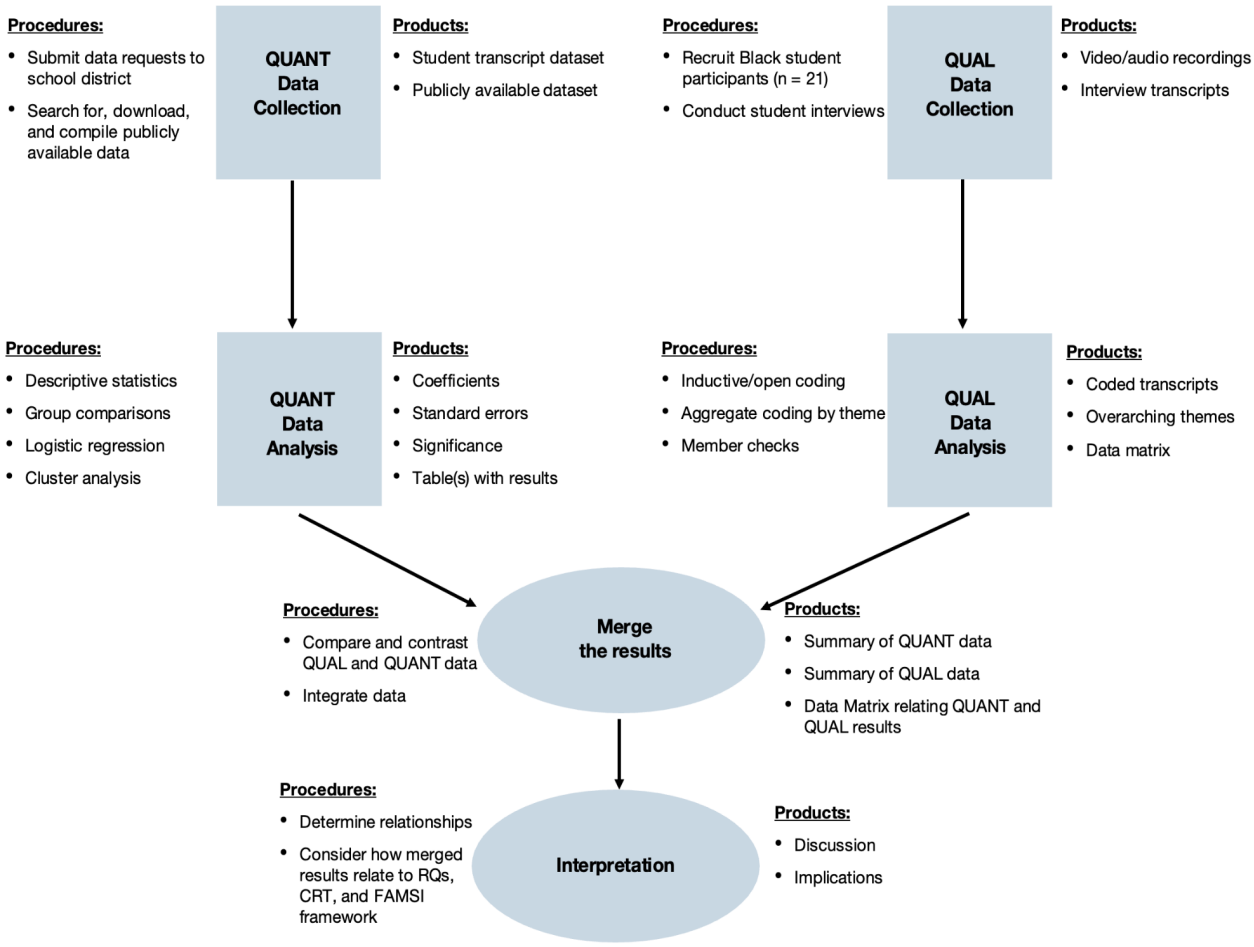


Figure 3.1 Convergent Mixed Methods Design Diagram
Source: *Adapted from Creswell & Plano Clark (2018)*

Figure 3.1. Convergent Mixed Methods Design Diagram

Each component of this convergent mixed methods study (Creswell & Plano Clark, 2018) aligned with one or more aspects of Martin's (2000) FAMSI Framework (see Table 3.2). The FAMSI framework provided tools for merging the quantitative and qualitative data in this dissertation. Decuir-Gunby and Schutz (2019) stress the importance of expanding the types of methodologies used while engaging in critical race work, emphasizing the need for more studies using a mixed methodology. A mixed methodology was imperative because it allowed for the

corroboration of results to achieve a deeper level of understanding of the multilevel factors that shape Black students' secondary math course taking patterns (Creswell & Plano Clark, 2018; Decuir-Gunby & Schutz, 2017). Moreover, the use of a mixed-methods design provided greater insight into the factors that shaped Black student participants' decision making as it pertained to secondary math coursework. By merging the results from the quantitative and qualitative datasets, I was able to amplify the voices of my participants while also reporting statistical trends at the district level (Creswell & Plano Clark, 2018).

Setting and Context

The data for this study were gathered from a large school district in Southern California[7] that enrolls over 120,000 Pre-K to 12th grade students. According to the district website, "the student population is extremely diverse, representing more than 15 ethnic groups and more than 60 languages and dialects." Despite this diversity within the student body, approximately 63% of teachers are White (Schroeder et al., 2020). White students make up 25% of the total district population, Latinx students make up 51% of the total district population, and Asian/Pacific Islander students make up 15% of the total district population. The percentage of Black students is higher in The District (9%) than in The County (4%) and the state overall (5%), making it a good location for examining the impacts of race and racism on Black students' secondary math course taking patterns because of the relatively large numbers of Black students within The District. All high schools in The District provide students with similar math options and trajectories (Figure 3.2). As presented in Figure 3.2, students must enroll in Integrated Math I, II, and III, prior to moving to Beyond IM3 course work. Students who enroll in these courses earlier also have the option to take Beyond IM3 courses sooner.

[7] I will refer to this location as "The District" for the remainder of this dissertation.

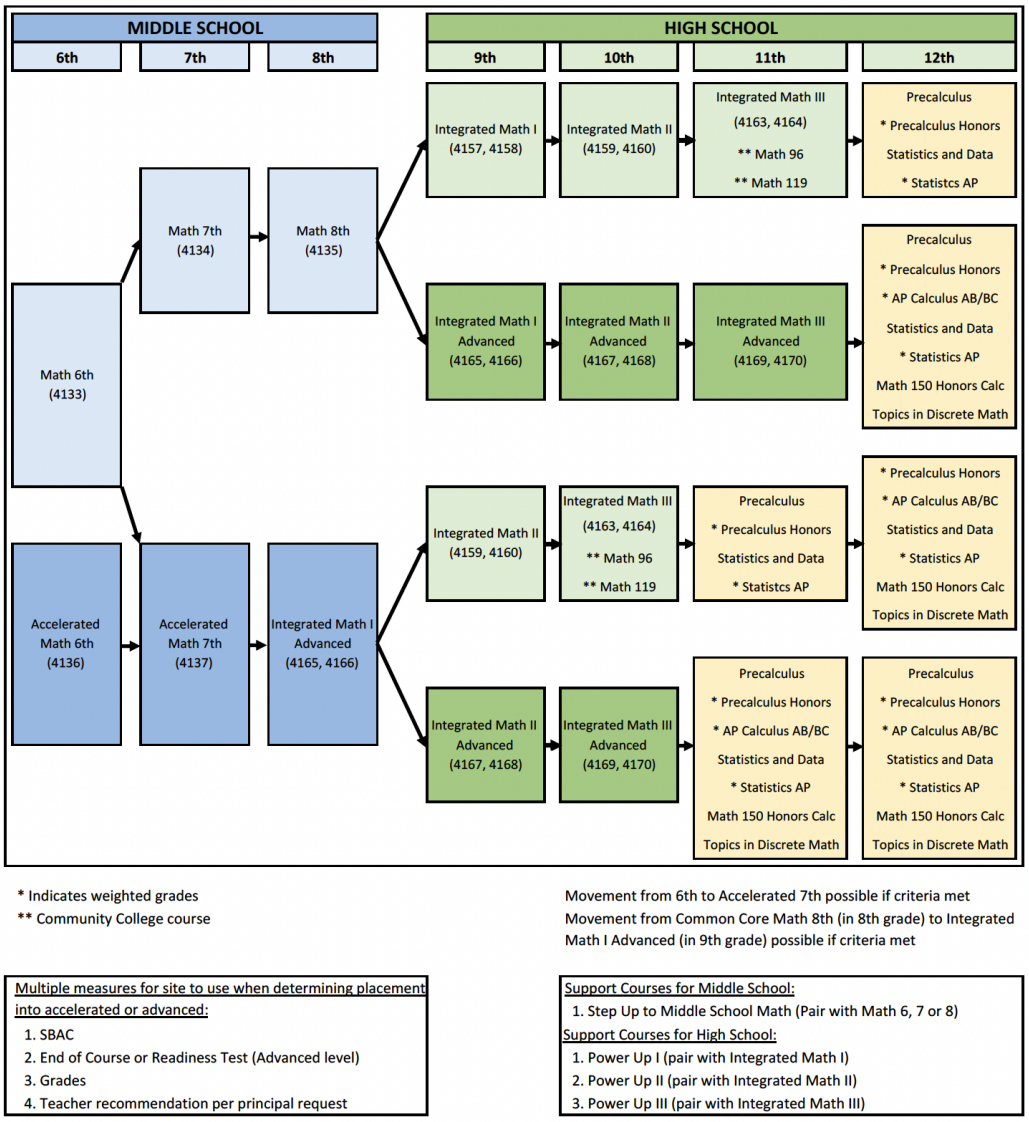


Figure 3.2. Secondary Mathematics Course Sequences in The District

The qualitative data were collected in partnership with The Center for Research on Educational Equity, Assessment & Teaching Excellence (CREATE) at UC San Diego. This dissertation is part of a larger study related to Black students and math course-taking in which I am Co-Principal Investigator (Co-PI), along with Dr. Ovie Soto. Dr. Soto was instrumental in helping me to make initial connections with school administrators due to his prior working relationship with The District. Using CREATE resources and administrators, I was able to access the transcript data set from The District. I was the sole researcher who constructed the qualitative

project and gathered the qualitative data. The qualitative data were collected from two school sites within The District, schools that I will call, Sunset High School and Rose High School.

Sunset High School enrolled 1,744 students in the 2019-2020 academic school year (California Department of Education, 2020a). In addition, roughly 78% of students (1,361) were classified as "socioeconomically disadvantaged[8]" about 20% of students were classified as "homeless[9]" (345), and about 12% of students (204) were categorized as "English-Language Learners" (California Department of Education, 2020a). Additionally, Sunset is a relatively diverse school in terms of race and ethnicity. In the 2019-2020 school year the majority of the students within the student body were either Latinx (38%) or Filipinx (33%), with 12% Black students (California Department of Education, 2020b). Considering the percentages of Black students in the state (%), county (%), and district (%), Sunset enrolls a relatively high percentage of Black students, for the area where this study took place.

Rose High School enrolled 2,554 students in the 2019-2020 academic school year (California Department of Education, 2020a). In addition, roughly 39% of students (992) were classified as "socioeconomically disadvantaged," about 1% of students were classified as "homeless" (36), and about 2% of students (60) were categorized as "English-Language Learners" (California Department of Education, 2020a). Additionally, in the 2019-2020 school year the majority of the students within the student body were either Latinx (31%) or White (38.6%), with 5.9% Black students (California Department of Education, 2020b).

[8] According to the California Department of Education (CDE), students are classified as SED if: 1) they were migrant, foster, homeless at any time during the academic year, 2) they were eligible for Free or Reduced-Priced Meal (FRPM) Program at any time during the academic year, or 3) their parent education level was marked as "both parents did not receive a high school diploma" at the time of standardized testing.

[9] According to the CDE, students are classified as homeless if they were marked as homeless at any time during the school year at the school where they took the statewide standardized test.

Rose and Sunset provided unique opportunities for examining the nuances of the schooling experiences of Black students because of the differences in the student demographics at each school.

Data Collection

This convergent mixed methods design (Creswell & Plano Clark, 2018) incorporated both qualitative and quantitative data collected at multiple levels. As indicated in Table 3.1, each component of this convergent mixed methods study aligns with one or more aspects of Martin's (2000) Framework. Table 3.1 displays how the quantitative and qualitative data were collected in line with the FAMSI framework. The qualitative student interview and focus group protocols were color coded to align with the levels of the FAMSI framework (See Appendix A). Each interview question was directly connected to a research question, and/or level of the FAMSI framework. Each section of the protocol was coded, and the levels of the FAMSI framework are represented throughout as detailed in Appendix A.

The quantitative variables within the student transcript data and publicly available datasets were created with each level of the FAMSI framework in mind. For example, variables related to gender, ELL status, homelessness, foster youth status, and acceleration in eighth grade math were used to represent the individual level of the FAMSI framework. At the school level, I created variables related to student body demographics, overall student achievement, and teacher demographics and courses taught. At the community level, I used a Free and Reduced Priced meal (FRPM) variable as a proxy for socioeconomic status. At the sociohistorical level, to indicate a sociohistorical relationship, I looked at the overarching trends in the data during the analysis phase.

Table 3.1. Data Collection using FAMSI Framework

Sociohistorical	Community	School	Individual
Qual - Student focus group and individual interview protocol sections: - Section I: Background. - Section II: Experiences in math courses. - Section III: Math Placement and course taking.	**Qual -** Student focus group and individual interview protocol sections: - Section I: Background. - Section II: Experiences in math courses. - Section III: Math Placement and course taking.	**Qual -** Student focus group and individual interview protocol sections: - Section I: Background. - Section II: Experiences in math courses. - Section III: Math Placement and course taking.	**Qual -** Student focus group and individual interview protocol sections: - Section I: Background. - Section II: Experiences in math courses. - Section III: Math Placement and courses. - Section IV: Future/STEM Interest.
Quant - Trends in student transcript data. **Quant -** Trends in publicly available dataset.	**Quant -** Quantitative Variables: - Number of Students Receiving Free and/or Reduced Price Meals.	**Quant -** Quantitative Variables: - Student Body Demographics and Enrollment. - Overall Student Achievement. - Teacher Demographics and Courses Taught.	**Quant -** Quantitative Variables: - Gender. - English Language Learner (ELL)/Multilingual Student. - Student Experiencing Homelessness. - Foster Youth. - Student Took an Accelerated Math Course in 8th Grade. - Student Earned an "A" in an Accelerated Math Course in 8th Grade.
A, B, C	**A, B, C**	**A, B, C, D**	**A, B, C, D**

Quantitative Data

Ultimately, the quantitative component of this project sought to determine the variables that contributed to a greater likelihood that a Black student would enroll in a course Beyond IM3

by their senior year of high school. To accomplish this goal, I ran logistic regression analyses using STATA. The following research sub-questions were the primary focus of the quantitative component of this mixed methods dissertation:

> ***C:*** *To what extent do institutional and structural factors influence the likelihood that a Black student will enroll in a Beyond IM3 math course by their senior year of high school?*
>
> ***D****: How does the concentration of Black math teachers in a school impact the likelihood that a Black student will enroll in a Beyond IM3 math course by their senior year of high school?*

For the purposes of this dissertation study, I used a combined dataset of student transcript data and school-specific publicly available California Department of Education (CDE) data to highlight statistical patterns across school contexts. Essentially, each student in the student transcript dataset was linked to their school and its variables (student enrollment, number of teachers, demographics of teachers, etc.). I did this by merging the two distinct datasets for analysis (using the "merge" function in STATA) and connecting each student to the school they attended in their senior year of HS. This was done by adding the County-District-School (CDS) code for each high school in The District as an identifier variable in the student transcript dataset. I then used that number to link each student to a school and its publicly available data. According to the CDE, "this 14-digit [CDS] code is the official, unique identification of a school within California. The first two digits identify the county, the next five digits identify the school district, and the last seven digits identify the school." The two original datasets and their components are described in detail below.

Student Transcript Data. The transcript data utilized for this project include the math transcript data from 1,561 Black seniors in The District between 2017-2020. This dataset includes the math transcripts for the students from their 6th-grade year (if available) until their

senior year of high school. The student transcript dataset also provides contextual information about each student, such as their demographics, course enrollment, and math achievement.

Publicly Available School Specific Dataset. In addition to the student transcript data, I compiled a second dataset consisting of publicly available CDE data from the 2017-18 academic school year. The data set includes the student enrollment, teacher demographics, adjusted cohort graduation rates, and an indicator of overall socioeconomic status for each of the 30 secondary schools that also appeared in the student transcript dataset. The components of this dataset represent one or more aspect(s) from Martin's (2000) FAMSI Framework and provide useful multilevel contextual information about each school. Specifically, this dataset included information about teacher demographics and experience, and student body demographics and the socioeconomic status for each school in The District.

The 2017-18 academic school year is important because the 2017-18 school year is the only school year that encompasses every student represented in the student transcript dataset. In other words, for the graduating classes of 2018, 2019, and 2020 the 2017-18 academic school year is the only year that all three classes were theoretically in attendance at the same school.

Quantitative Variables

Dependent Variable -- Beyond IM3. The long-term gains attributed to taking four years of math (including a course Beyond IM3) in high school are too explicit to ignore. As mentioned in the literature review, enrolling in a secondary course Beyond IM3 has been linked to overall student success at the undergraduate level, including decreased time to degree (ACT, 2007; Adelman, 1999; 2006; Hoyt & Sorensen, 2001). Therefore, my focal dependent variable is a binary variable created to indicate whether or not a student took a course Beyond IM3 by the time they completed high school. As mentioned earlier, I define a course as Beyond IM3 if the

prerequisite for enrollment in the course was Integrated Math III (IM3) or Algebra 2. These courses include Pre-Calculus, Statistics, Calculus, and several other courses as described by the math course sequence guidelines from the district. See Table 3.2 for a full list of the courses included in this classification.

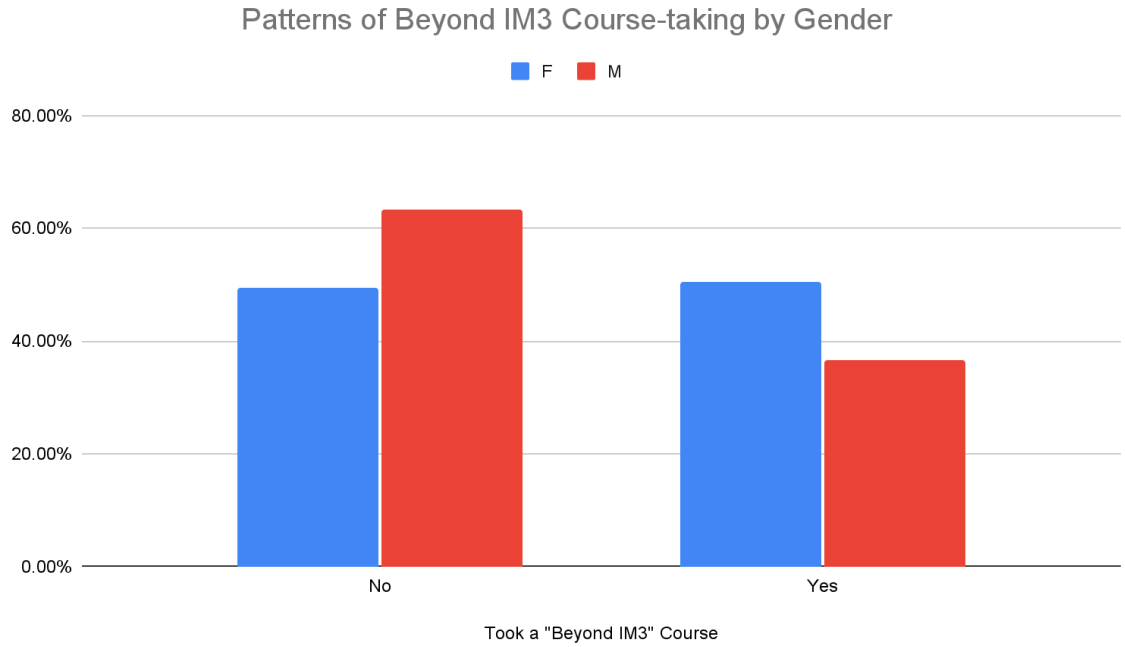
Table 3.2. List of Beyond IM3 Courses

Courses that count as a Beyond IM3 course: Prerequisite = IM3/Alg 2 (Intermediate Alg)	Courses that do not count as a Beyond IM3 course:
Precalculus (including Honors)	Algebra I
Calculus (AP or not)	Algebra II
Statistics (AP or not)	Geometry
Topics in Discrete Math	Edgenuity (EDG) Mathematics
	Integrated I
	Integrated II
	Integrated III
	Mathematical Studies

Descriptive patterns for my dependent variable indicated that about 43% of Black students had enrolled in a Beyond IM3 course by the time they graduated high school. Descriptive patterns by gender indicate that a disproportionate number of Black female students enrolled in Beyond IM3 courses in high school. Alternatively, Black male students appear to be grossly underrepresented in Beyond IM3 courses in high school. Descriptive patterns by gender for the Beyond IM3 dependent variable are displayed in Figure 3.2.

As you can see, more Black males than Black females did not enroll in a course Beyond IM3 in high school. As the quantitative analysis will indicate, this is a statically significant finding, and as the literature suggests, Black males have often been placed in lower-level math courses not because of academic ability but due to behavior or other non-academic institutional factors like placement policies (Gao & Johnson, 2017; Riegle-Crumb, 2006).

Graph 3.1. Descriptive Statistics: Beyond IM3 Course Taking Patterns by Gender



Independent Variables -- Individual Student Level Categorical Variables. From the student transcript dataset, the first set of variables were binary categorical variables connected to individual student-level demographics or achievement characteristics. Dummy variables were created for each of these variables (0 = no; 1 = yes). Table 3.3 displays descriptive statistics for my individual level categorical variables.

Gender. The Gender variable is a binary variable indicating the gender of each student, as specified by their school transcript. Transcript data defines gender as male and female, so this study uses aligned descriptors. Students categorized as female on their school-record were coded as a 1 on the dummy variable named "Female." Otherwise, the dummy variable was set to 0 to indicate male. Gender is a relevant variable due to the interesting statistics at the intersection of race and gender in the STEM pathway and within STEM careers. Specifically, in comparison to Black males, Black women tend to excel in academic settings, despite the anti-Black nature of education spaces (Ireland et al., 2018; Joseph et al., 2017). However, in STEM spaces, high

achieving Black boys are more likely to be guided towards and to choose a STEM major or STEM career (National Science Foundation, 2017; NCES, 2020) compared to Black girls who are less represented in the STEM field due to gender bias and exclusion (Collins et al., 2020; Farinde & Lewis, 2012; National Science Foundation, 2017; NCES, 2020). Thus, the intersectional nature of race, gender, and STEM provides nuanced implications for this study.

English Language Learner Status. The English Language Learner (ELL)/Multilingual Student variable began as a categorical variable with six categories: English Only, English Learner, Initially Fluent English Proficient (I-FEP), Redesignated Fluent English Proficient, To Be Determined, and Not Assessed/Special Education. Students who were classified as "English Only" on their student transcript were coded as a 0 on a dummy variable named "English Language Learner/Multilingual Student." Otherwise, the dummy variable was set to 1. This variable is important given the large ELL/Multilingual student population in Sunset HS as well as in the California context overall. This variable is also relevant given the intersection of race and ELL status. To be classified as a Black multilingual student means there is a possibility this student comes from an immigrant background or identifies as multi-racial. Therefore, ELL status is a way to potentially differentiate between African American students who have historical and familial ties to the Transatlantic Slave Trade in the US context and those who do not and are recent immigrants to the US. The distinction between monolingual and multilingual Black students is important to parse out, especially given recent scholarship that indicates that Black students from immigrant backgrounds are faring better in the STEM pipeline than African American students (King-Miller, 2017; Leggett-Robinson, 2017; Mwangi & Fries-Britt, 2015; Pinder, 2014; Sparks, 2018).

Table 3.3. Individual Student Level Categorical Variables Frequency Distribution

Variable	Value	%	N
Gender	Male	52.40	818
	Female	47.60	743
Total		100.00	1561
English Language Learner (ELL)/Multilingual Student	English Learner	8.14	127
	English Only	72.97	1139
	Initially Fluent English Proficient (I-FEP)	3.59	56
	Not Assessed/Special Education	0.06	1
	Redesignated Fluent English Proficient	15.12	236
	To Be Determined	0.13	2
Total		100.00	1561
Student Experiencing Homelessness	No	87.96	1373
	Yes	12.04	188
Total		100.00	1561
Foster Youth	No	98.21	1533
	Yes	1.79	28
Total		100.00	1561
Student Took an Accelerated Math Course in 8th Grade	No	74.25	1159
	Yes	25.75	402
Total		100.00	1561
Student Earned an "A" in an Accelerated Math Course in 8th Grade	No	91.22	1424
	Yes	8.78	137
Total		100.00	1561

Student Experiencing Homelessness. The Student Experiencing Homelessness variable is a binary variable that indicates whether or not a student was experiencing homelessness in their senior year of high school. Students whose transcript indicated they were experiencing homelessness during their senior year of high school were coded as a 1 on a dummy variable named "Student Experiencing Homelessness." Otherwise, the dummy variable was set to 0. The Experiencing Homelessness variable is important to this analysis because of the large number of students experiencing homelessness at Sunset HS as well as the overwhelmingly large population of adults experiencing homelessness within the larger California context. This variable is also important given recent scholarship related to homelessness and student academic outcomes (Burns et al., 2021; da Costa Nunez et al., 2016; De Gregorio et al., 2020, 2022; Fantuzzo et al., 2012; Rose et al., 2021). Finally, since homelessness is often connected to poverty, this variable provides an additional socioeconomic context for students in this study who were experiencing homelessness. By using this variable, I hoped to highlight the ways that sociohistorical elements such as poverty and homelessness impact Black students' math trajectories and Beyond IM3 course taking.

Foster Youth. The Foster Youth variable is a binary variable that indicates whether or not a student was living in a foster home in their senior year of high school. Students whose transcript identified them as foster youth during their senior year of high school were coded as a 1 on the dummy variable named "Foster Youth." Otherwise, the dummy variable was set to 0. This variable was included because it speaks to the unique experiences that some students may bring to their school. This variable was included in the quantitative data request from The District and provided unique familial and community level context for the students included in the sample. Research indicates that students in foster care are often disadvantaged in academic

settings, specifically in California (Barrat & Berliner, 2013; Wiegmann et al., 2014). By using this variable, I intended to explore the impact of foster care on Beyond IM3 course taking.

Student Took an Accelerated Math Course in 8th Grade. The Student Took an Accelerated Math Course in 8th Grade variable began as a categorical variable with several math course options for eighth grade math, including Algebra I, Geometry, Integrated Math I, Integrated Math II, Math 8, Math 7, Algebra Readiness, or Step-Up Math 8. Students who took any class considered above grade level, or "Accelerated" were coded as a 1 on a dummy variable named "Accelerated Math Course in 8th Grade." Otherwise, the dummy variable was set to 0. Algebra I, Geometry, Integrated Math I, and Integrated Math II are considered "accelerated" math courses. Acceleration in math is an interesting concept with mixed results, but overall studies have shown that middle school acceleration increases the likelihood that a student enrolls in upper-level courses Beyond IM3 before graduating from high school (Allensworth et al., 2009; Clotfelter et al., 2012; Finkelstein et al., 2012; Rogers, 2020; Spielhagen, 2006; Smith, 1996). For Black students in particular, Walston and McCarroll (2010) found that Black students who took accelerated Algebra in the eighth grade fared better in math overall, enjoyed math more, and held higher academic expectations of themselves. Therefore, this variable is an important addition to my model.

Student Earned an "A" in an Accelerated Math Course in 8th Grade. Similarly, the Student Earned an "A" in an Accelerated Math Course in 8th Grade variable was coded to represent any student whose transcript indicated that they had both taken an accelerated math course in 8th grade (as defined above) *and* earned an "A" in that course. Students who met these qualifications were coded as a 1 on the dummy variable named "Earned an 'A' in an Accelerated Math Course in 8th Grade." Otherwise, the dummy variable was set to 0. As the literature details,

performing well in eighth grade has implications for future math success (Allensworth et al., 2009; Archbald & Farley-Ripple, 2012; Bozick & Ingels, 2008; Brown et al., 2013; College Board, 2011; Ma, 2000; Paul, 2005; Wang & Goldschmidt, 2003). In addition, studies have shown that students who performed well in middle school math were more likely to enroll in upper-level math course work in high school (Rogers, 2020; Walston & McCarroll, 2010). Therefore, this variable is an important addition to my model.

Independent Variables -- School Level Continuous Variables. The school-level variables in my analysis were created by pulling school-specific publicly available data from the CDE website and merging the school-level data to the individual student transcript dataset. See Table 3.4 for descriptive statistics of all school-level continuous variables. Please note that the data in Table 3.4 is reported at the student level. If we use the Total Student Enrollment variable as an example, a mean of 1437.46 means that the average Black student in the sample went to a school with about 1,437 students enrolled.

Student Enrollment. The first of these variables represents the total enrollment for all students regardless of race/ethnicity or gender at the high school attended by the reference student. This variable originated from the California Department of Education (CDE). The second of these variables represents only the total number of Black students at each school. The student enrollment variable was important to include given scholarship that indicates that Black students who attend schools with a critical mass of same-race peers develop an increased sense of belonging (Garces & Jayakumar, 2014; Jayakumar, 2015), which contributes to better academic achievement outcomes (Boston, 2017; Faircloth & Hamm, 2005; Jayakumar et al., 2018; Miller et al., 2005; Murphy & Zirkle, 2016; Smalls et al., 2007). Research also indicates negative relationships between academic achievement and attending larger schools (Egalite &

Kisida, 2016) and with larger class sizes (Whitehurst & Chingos, 2011). Moreover, scholars have noted differences in course placement patterns based on the racial composition of a school, indicating a positive relationship between Black student enrollment, and placement into upper-level math coursework (Diette, 2011; Kelly, 2009). This student enrollment variable thus serves as a means for measuring the impact of attending a school with large enrollment, and the impact of attending a school with a critical mass of Black students on the Beyond IM3 course taking patterns of Black students.

Number of Students Receiving Free and/or Reduced Price Meals. The data for this variable were compiled using a dataset from the CDE that provided the unduplicated counts and percentages of students at each school who were eligible to receive Free or Reduced Price Meals (FRPM) under the National School Lunch Program (NSLP). This variable acts as a community level variable to provide pertinent socioeconomic context for each school. Scholarship has showcased the academic impacts of attending poorly resourced, underfunded schools (Betts et al., 2000; Duncombe, 2017; Semuels, 2016). By using this variable, I hoped to highlight the ways that sociohistorical elements such as poverty, limited school resources, and funding might impact Black students' math trajectories and Beyond IM3 course taking.

Overall Student Achievement. This set of variables includes the number of students who dropped out and the number of students who met each school's UC/CSU requirements. According to the CDE, the number of dropouts variable indicates the total number of cohort students who did not graduate with a regular high school diploma, did not complete high school, and were not still enrolled as a "fifth year senior" by the end of the academic school year.

Table 3.4. Descriptive Statistics – Continuous School Level Independent Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Student Enrollment					
Total Student Enrollment	1561	1437.46	629.73	33	2397
Black Student Enrollment	1561	168.60	105.42	0	322
Overall Student Achievement					
Number of Dropouts	1556	14.30	12.63	0	38
Number of Students who met UC and/or CSU Standards	1556	182.33	101.32	9	446
Socioeconomic Status					
Students Receiving Free and/or Reduced Price Meals	1561	932.34	458.57	14	1935
Teacher Demographics and Courses Taught					
Total Number of Teachers	1561	76.43	27.26	12	117
Number of Math Teachers	1561	11.69	4.59	2	19
Number of Black Teachers	1561	7.06	4.88	0	14
Number of Male Teachers	1561	36.05	13.52	4	66
Number of Black Math Teachers	1561	0.97	1.09	0	3
Average Teacher Age	1561	44.91	2.19	38.57	50.50
Average Teacher Years of Teaching Experience	1561	15.04	2.13	10.13	20.59

Meanwhile, according to the CDE, the number of students who met the UC/CSU requirements variable indicates the total number of cohort graduates who met all a-g requirements for admission into a University of California (UC) or California State University (CSU) school. This set of student achievement variables is important because the two variables give pertinent school-level student achievement context for all students who attended a specific

school. This context provides a point of comparison between the individual students in the student transcript data and a more global school-specific context. This variable not only gives context about how the students are faring overall, but also how well their school(s) are educating them. In addition, this set of variables speak to the community level factors that may influence Black students' persistence in math. As mentioned in the literature review, peers significantly impact academic achievement in classrooms (Darensbourg & Blake, 2014; Kunjufu, 1988; Ryan, 2001). For Black students, peers play a major role in their mathematics persistence and academic resilience, especially in upper-level math coursework (Datnow & Cooper, 1997; Thompson & Davis, 2013; Walker, 2006; Yonezawa et al., 2002). This variable acts as a proxy for peer achievement as a means to assess the relationship between peer achievement and Beyond IM3 course enrollment. In theory, this variable could act as a proxy for investigating the academic culture of the school itself. Using the overall student achievement variable allows for an analysis of how well the school is educating its pupils. If the school has a high number of dropouts and a low number of students who met the UC/CSU requirements, then it's possible that there are school-related factors that might be inhibiting Black students' Beyond IM3 course taking patterns.

Teacher Demographics and Courses Taught. This set of variables is a combination of several de-identified datasets from the CDE. I combined the staff demographics (which includes teacher gender, age, race/ethnicity, education level, and years of experience) with the staff credential dataset (which includes the credential type and subject area for each teacher) and the staff assignment dataset (which includes the assigned school(s) and course(s) taught for each teacher). Once combined, this dataset was reduced to only include secondary teachers in The District. This set of variables provides demographic information of the secondary teachers at

each school during the 2017-18 school year. This dataset specifically helped me identify the total number of teachers, male and female teachers, Black teachers, math teachers, and Black math teachers at each school—variables that are used in my logistic regression analysis. Each of these variables provides specific context about the demographics of the practitioners at each secondary school and the courses they taught. The number of Black teachers is especially pertinent as it directly aligns with RQ4 of my dissertation study. Given what we know about the impact of Black teachers on Black student's academic trajectories (Gershenson et al., 2017; Klopfenstein, 2005; McGrady & Reynolds, 2012) this variable was included to provide further quantitative proof of Black teachers' impact on Black students' math course taking patterns.

Average Teacher Age and Years of Teaching Experience. Using the dataset mentioned above, I calculated both the average age of the teachers at each school as well as their average years of experience teaching in the district. The average teacher age variable represents the mean age of teachers at the school attended by the reference student. The average years of teaching experience variable represents the mean number of years of teaching experience of the teachers at the school attended by the reference student. This set of variables is important given findings correlating less teaching experience with teacher ineffectiveness (Rice, 2010).

Independent Variables -- Control Variables. The two control variables for my quantitative analysis are dummy variables that differentiate between each of the three graduating classes included in this study. For example, the class of 2018 is represented in the 2017-18 student transcript dataset, the class of 2019 is represented in the 2018-19 student transcript dataset, and the class of 2020 is represented in the 2019-20 student transcript dataset. The final student-level dataset (n=1561) is a combination of the transcripts from each of the three graduating classes.

The 2017-18 school year was intentionally left out to create a reference category to compare against, thus controlling for "time" in the regression analysis.

Qualitative Data

To begin to dismantle the current barriers that exist along the STEM pipeline for Black students, there is a need to shift the focus of education research towards amplifying Black students' voices and experiences in order to understand the impacts that race and racism have on their academic trajectories. The following research sub-questions were the primary focus of the qualitative component of this mixed methods dissertation:

> ***A:*** *How do the schooling experiences of Black students shape their dispositions towards math?*
>
> ***B.*** *How do the schooling experiences of Black students shape their decisions to (dis)continue an academic trajectory in high school math?*

To address A & B, the qualitative data for this study included focus groups and individual interviews with 21 Black high school seniors and juniors. See Table 3.5 for more information about the participants. Pseudonyms were used to protect the anonymity of the student participants and were based on characters from three of my favorite Black 1990's sitcoms: *The Fresh Prince of Bel-Air*, *Sister Sister*, and *Family Matters*.

The interviews were semi-structured. The focus group interviews at Sunset High took place prior to the onset of the Covid-19 lockdown in the Spring Semester of 2020. The interviews at Rose High School were conducted via ZOOM in the Fall Semester of 2020. All interviews were audio recorded and transcribed verbatim (with participants' consent) and were checked for accuracy before proceeding with data analysis. In addition, following each interview and focus group, post-interview field notes were drafted with the major points, themes, or lingering questions (Merriam & Tisdell, 2016).

In the qualitative interviews, students were asked questions about their choices surrounding their math course selections, counseling at their schools, their feelings about (dispositions towards) math, and their future post-secondary goals in relation to math. The senior interviews offered a retrospective look at why these students chose to take or not take four years of math. Their stories provided necessary context for my dissertation about the factors that influenced their decision to take (or not take) four years of math in high school. The junior interviews provided an understanding of the conflicting emotions students were experiencing while determining the math courses they would take (or not take) in their senior year.

Student Participants. In March 2020 (prior to the Covid-19 school closures), I was able to hold two in-person focus group sessions with 12 juniors and seniors at Sunset High School. A total of six Black seniors and six Black juniors were invited to participate in the study. All 12 student recruits agreed to participate and were interviewed in two focus group sessions, one focus group with seniors and one focus group with juniors. Three of the seniors were enrolled in or had previously taken a course beyond Integrated Math III. Three of the seniors chose not to take a course beyond Integrated Math III. Four of the juniors chose not to enroll in a course beyond Integrated Math III or were undecided about doing so in their senior year. Two of the juniors were currently enrolled in, had previously taken, or intended to take a course beyond Integrated Math III.

At Rose High, 14 juniors and seniors were recruited for virtual interviews. Because of school closures due to the ongoing Covid-19 pandemic, the interviews at Rose High took place via Zoom, and were individual interviews using the same protocol as the focus group interviews at Sunset HS.

Table 3.5. Student Participants

	Pseudonym	Gender	High School	Year	Current Math Course	Previous Math Course	Beyond IM3 Course
1	Jordan	M	Sunset HS	Junior	None	IM3	Y
2	Richie	M	Sunset HS	Junior	Pre-Calculus	IM3	Y
3	Rachel	F	Sunset HS	Junior	IM3	IM2	Y
4	Will	M	Sunset HS	Junior	IM3	IM2	N
5	Nicky	F	Sunset HS	Junior	IM3	IM2	N
6	Myra	F	Sunset HS	Junior	IM3	IM2	Y
7	Lisa	F	Sunset HS	Senior	Statistics	IM3	Y
8	Ashley	F	Sunset HS	Senior	None	IM3	N
9	Hillary	F	Sunset HS	Senior	Pre-Calculus	IM3	Y
10	Geoffrey	M	Sunset HS	Senior	Pre-Calculus	IM3	Y
11	Vivian	F	Sunset HS	Senior	Pre-Calculus	IM3	Y
12	Diavian	F	Sunset HS	Senior	None	IM3	N
13	Roger	M	Rose HS	Junior	Pre-Calculus	IM3	Y
14	Ray	M	Rose HS	Junior	IM3	IM2	Y
15	Tia	F	Rose HS	Junior	IM3	IM2	Y
16	Tamera	F	Rose HS	Junior	IM3	IM2	Y
17	Tyreke	M	Rose HS	Senior	None	Pre-Calculus	Y
18	Carlton	M	Rose HS	Senior	Pre-Calculus	IM3	Y
19	Laura	F	Rose HS	Senior	None	IM3	N
20	Steve	M	Rose HS	Senior	None	IM3	N
21	Eddie	M	Rose HS	Senior	None	IM3	N

Only nine students at Rose High ended up participating in the study. Four students were juniors, and five students were seniors at the time of the interview. All four of the juniors were enrolled or were planning to enroll in a fourth year of math beyond IM3 in their senior year of

high school. Two of the five seniors were enrolled in a fourth year of math beyond IM3 at the time of the study.

Recruitment of Participants. Recruitment of potential student participants began in the Winter Quarter of 2020 when the IRBs was approved by both The District and UCSD. Recruitment began with initial meetings with the principals at each school site. Once the principals agreed to participate in the study, they assigned a contact person, the head counselor, who helped determine which students met my criteria for participation in the qualitative interviews. Essentially my targeted population was Black juniors and seniors who had taken Integrated Math 3 (IM3) and had taken or were eligible to take a Beyond IM3 math course. I wanted an equal population of juniors and seniors, and male and female students. The head counselors at each school site provided a list of students who met our criteria.

Sunset HS Recruitment (Early 2020, pre-pandemic shutdown). Sunset HS recruitment was handled by the brilliant, strong, and insanely supportive Black female principal, Harriette. After an initial meeting, Harriette worked with the head counselor to select students that not only met my requirements but would also be vocal qualitative participants. Harriette was instrumental in getting the students to agree to participate and even met with them about the study ahead of time so that they (and their parents) understood what I was interested in hearing from them. She also spent time tracking students down and getting them to return their consent/assent forms before the interview. She gave me a room to conduct the focus groups and made sure the students knew the room number and the time of the interview. The focus group interviews at Sunset HS would not have happened if not for Harriette. I cannot stress enough about how supportive and gracious she has been throughout this process despite being the head of a major secondary institution with an overpacked schedule.

Initial Rose HS Recruitment (Early 2020, pre-pandemic shutdown). Following the Sunset HS focus groups, I met with the principal at Rose HS and told her about our study. We were in the process of setting up a student information session and student focus groups in March 2020, but the Covid-19 surge shut down schools that month. So, we decided to regroup after the school year was over. In the meantime, the former principal retired. Luckily, the new principal was eager to be involved with our study when we reached out to her in August of 2020.

Rose HS Recruitment (Late 2020 - Early 2021). In August of 2020 I met with the new Principal at Rose HS, Madeline, who was eager to make equitable and systemic changes at her school. Madeline became my direct contact for this study. I gave her the counselor-created list of students from the previous school year, and we decided to recruit some of the same juniors (now seniors) and added new juniors (formerly sophomores) to our list of potential recruits. Madeline's eagerness to make changes at her school gave me more access to her than I was expecting, and I appreciate her help with this study. She was instrumental in facilitating my communications to potential participants and their parents and was one of my biggest advocates and supporters throughout the recruitment and writing processes.

The initial plan was to have Madeline contact them and get them to come to a virtual parent information session. However, only one parent attended, Tia's mother, Mrs. Landry. Mrs. Landry had strong feelings about math at Rose HS because her daughter was having really negative experiences in her math class at the time. Tia ended up being my very first student interview, with her mother's encouragement[10]. I shifted to individual interviews over focus

[10] Several student participants at Rose HS were recruited by their parents. This will be discussed further in Chapter 5 (Qualitative Findings) and Chapter 6 (Implications and Conclusions).

groups because I only had one interested student at the time and wanted to make sure I captured her voice and experiences while she was willing to participate in the study.

My next recruitment attempt was to craft an email to be sent by Madeline to parents (from the counselor created list). The email included a flyer, my image, links to my UCSD student and professional profiles, a link to a digital student interest form, and the consent/assent documents. Only one student signed up using the interest link and I was unable to lock down an interview with that student.

Following the initial recruitment attempts, I decided to shift my recruitment strategy. In February 2021 I requested parent emails from Madeline and sent out a similar series of emails that were more personalized and addressed to each parent. I also increased the gift card amount from $20 to $40 and set up a Calendly account for easy meeting time scheduling. After no initial responses, I sent out a second more abbreviated set of emails, with the flyer attached and Calendly link. I received 3 recruits in this manner (the parents of: Tamera, Roger, and Lisa).

My final attempt to recruit participants came in the form of phone calls and text messages to parents. I received contact information for parents from Madeline. I left a voicemail and sent a detailed text message to each parent who had not already responded to my previous attempts to contact them. The parents of Raymond, Carl, Eddie, and Steve each called me back, and after a lengthy conversation explaining who I was and why I was doing the study, they agreed to allow their student to participate and provided me with the student's contact information. I set up my final four interviews via text message with the students themselves.

Data Analysis

According to Merriam and Tisdell (2016), data analysis is a meaning making process, therefore the data analysis plan included making meaningful connections between the data and

the research questions posed for this study. The data for this convergent mixed methods study was analyzed inductively to further explore how contextual factors shaped Black students' choice to include a fourth year of secondary math. The data were analyzed using a theoretical lens that centers race and racism as central to the experiences of Black students in math classrooms. Using the FAMSI framework as a theoretical guide provided additional tools for unpacking the multi-level factors that allow for and prohibit Black students' successful progression along the math pathway. The quantitative data were analyzed using a logistic regression model. The qualitative data were analyzed inductively by theme.

Quantitative Data Analysis

The purpose of this dissertation study was to explore the multi-level factors that increased or decreased the odds that a Black student in The District would take a course Beyond IM3 before graduation. For the quantitative portion of this study, I focused on specific variables to build a logistic regression model that included school and individual student level variables to determine the odds that a student would have taken a course Beyond IM3 by the end of high school. In addition, I linked specific student-level characteristics to school-level patterns in my dataset prior to running the analyses. Logistic regression is appropriate for this study because the dependent variable for this study was a binary variable that indicated whether a student took a course Beyond IM3 by the time they completed high school.

In the logistic regression models presented in this chapter, standard errors are cluster robust, where unique clusters were defined as the school attended by the student. In other words, two individuals are considered members of the same cluster, and therefore there may be cross-observation correlation in the error term, if and only if they each attended the same school. This

method acknowledges that the students in my dataset do not represent independent observations, and that students in the same school might influence one another.

Qualitative Data Analysis

The questions from each interview protocol were pre-coded (see Appendix A) to match with one or more aspects of my theoretical framework. In addition, the data were analyzed inductively through open coding (Merriam & Tisdell, 2016) to identify emerging themes and search for critical moments from the interviews. I also created a data matrix (see Appendix B) to ensure that the evidence was attended to and connected to an emerging theme, research question or component of the theoretical framework (Yin, 2018). My purpose throughout the data analysis process was to keep the individuality and integrity of each participant's story intact (Merriam & Tisdell, 2016). Each of the students' stories cultivated through this research process was of paramount importance, and my goal was to keep their voices and experiences untouched, while searching for patterns across student stories and school contexts.

Before beginning analysis, each interview transcript, and my post-interview field notes (Merriam & Tisdell, 2016) were reviewed for emerging themes. Once the interviews were reviewed, I coded inductively using a data matrix (see Appendix B) where each students' response to an interview question was coded openly for possible reasons for taking or not taking a Beyond IM3 course in high school. Several initial codes emerged based on student responses, including: 1) dispositions towards math, 2) future college and career goals, 3) content/curriculum as fun, relevant, or boring, 4) math identity (or feeling like a "math person," 5) perceived math ability, 6) acceleration in eighth grade math, 7) teachers as influencers, 8) parents as influencers, and 9) counselors as influencers. If any of these concepts were brought up in an interview or focus group, the matching section was coded as such within the data matrix. These codes were

then grouped together into categories after deeper interpretation of their underlying meanings (Merriam & Tisdell, 2016) and how the emerging themes aligned with my theoretical frameworks and research questions. Once the categories were created using the interview transcripts, I coded my fieldnotes keeping in mind the emerging themes (Merriam & Tisdell, 2016). The themes will be discussed at length in the qualitative findings chapter, but they include: 1) racialized experiences with teachers and peers, 2) student relationships with math, 3) influence of educators (including counselors and teachers), 4) influence of parents, and 5) curriculum.

Validity, Reliability, and Trustworthiness of Data

Validity and Reliability

Mixed methodology is useful for increasing the validity of and to triangulate the data collected within this study (Merriam & Tisdell, 2016). Triangulation involves using multiple sources of data, multiple methods of data collection, and/or multiple theories to confirm emerging findings (Merriam & Tisdell, 2016). The initial qualitative data and quantitative data were analyzed simultaneously, and preliminary analyses demonstrated overlap. Using both quantitative and qualitative data allows the researcher to provide richer, more robust findings and is a key method for building reliability and consistency within a research study (Merriam & Tisdell, 2016). Specifically, as I began analyzing my quantitative data, I included variables in my quantitative models that were linked to some of the emerging themes within my qualitative data matrix, including the concept of eighth grade math acceleration as important to students' dispositions towards math and feelings of math ability.

Trustworthiness

At the start of this chapter, I provided information regarding my own positionality as an additional method for ensuring trustworthiness and internal validity (Merriam & Tisdell, 2016). In this way, I offer full transparency that my research and analysis has been guided by my own expertise and lived experiences. I used my own experiential knowledge and lens as a Black male, former STEM student who felt pushed out of the STEM pipeline, and STEM educator who witnessed inequitable treatment of Black and Brown students, to provide a richer and more robust analysis that centers equity for Black students in STEM.

In addition, to establish further trustworthiness, I engaged in member checks, allowing each principal to review my findings (Merriam & Tisdell, 2016). I scheduled individual meetings with the principals of Sunset and Rose high schools and presented the emerging themes and preliminary quantitative and qualitative analyses. After having a conversation about what they noticed, wondered, and/or were excited about, the principals provided me with current context and the ways in which my findings overlapped with their day-to-day experiences. They also offered suggestions and additional insight into what some of the data might be indicating. For example, Madeline, the principal at Rose HS, resonated with the findings related to teachers and their impact on student course taking patterns, adding that some teachers need to be more open-minded and growth-oriented and that the teachers who are doing well with Black students are often excited about the material and demonstrate that they *want* to be teaching at Rose HS.

Summary

This chapter discussed the methodology used to answer the question: "What informs Black students' decision-making processes as they choose to take, or not take, a fourth year of math, beyond IM3, in high school?" A mixed methodology approach was used to provide

triangulation and a more robust analysis of the quantitative and qualitative data. Logistical regression was the quantitative method used to analyze student transcript and district level data. Semi-structured interviews were conducted, transcribed, and analyzed from 21 Black high school juniors and seniors from two high schools within the same district: Rose HS and Sunset HS. Validity, reliability, and trustworthiness of this dissertation study were strengthened with the use of triangulation and member checks. The findings from the quantitative analysis will be presented in chapter four of this dissertation study. Chapter five presents the findings of the qualitative data analysis.

Chapter 4: Quantitative Results
The Multilevel Factors that Increase the Odds of Black Student Enrollment in Beyond IM3 Coursework

This chapter reports the findings of the quantitative phase of this mixed methods dissertation. Because I was seeking to understand how school and community-related variables such as the number of Black teachers, the achievement patterns of the schools, and the socioeconomics of the student body impacted Black student math course taking patterns, I decided to use the FAMSI Framework as a guide for building my logistic regression models. Each logistic regression model described in the sections below was derived by combining variables that mirrored components of the FAMSI framework. Model 1 and Model 2 include variables related to individual student demographic and achievement variables. Model 3 and Model 4 include school level and teacher demographic variables. Model 5 includes all variables, which allowed me to compare statistical significance between and across all models.

Model 1 - Logistic Regression Analysis of Individual-Level Demographic Characteristics

Results of the logistic regression analysis for individual student-level demographic characteristics are presented in Model 1 of Table 4.1. For each model in Table 4.1, the results are measured in terms of the odds ratio of the event occurring, contingent on a variety of factors. Coefficients with values greater than one indicate that the given factor *increases* the odds of taking a Beyond IM3 course; coefficients less than one indicate that the given factor *decreases* the odds of taking a Beyond IM3 course.

Of the four non-control variables used within this first model, all four of them have a statistically significant relationship to the Beyond IM3 dependent variable. Gender was the first variable used in this model, by way of the Female dummy variable. The coefficient for this variable was 1.670, which indicates that Black female students were significantly more likely to

have taken a course Beyond IM3 at some point in high school compared to Black male students ($p<.001$). Moreover, the coefficient of 1.670 tells us that the odds of a Black female student taking a course Beyond IM3 in high school are 67% higher than the odds of a Black male student taking a course Beyond IM3 in high school. The ELL status of a student was another variable that contributed to the likelihood that a student would take a course Beyond IM3 in high school. Students who were classified as both Black and an English Language Learner/Multilingual Student were more likely than Non-ELL/Monolingual Black students to take a course Beyond IM3 in high school. The coefficient of 1.879 suggests that this factor was slightly more impactful than gender on math course taking. The odds of a Black ELL/Multilingual student taking a Beyond IM3 course were 87.9% higher than the odds of a Black Non-ELL/Monolingual student taking a Beyond IM3 course ($p<.001$). Homelessness also impacted the odds of a Black student enrolling in a course Beyond IM3 in high school. For students who were classified as Black and experiencing homelessness on their transcript, the odds of taking a course Beyond IM3 were significantly lower than for students who were classified as Black and not experiencing homelessness on their high school transcript ($p<.001$). The coefficient of 0.388 suggests that homelessness had a negative effect on math course taking. Essentially for students experiencing homelessness, the odds of taking a course Beyond IM3 decreased by 61.2%. Similarly, for students who were classified as both Black and foster youth, the coefficient of 0.174 indicates a statistically significant negative relationship between being a Black foster youth and taking a course Beyond IM3 in high school ($p<.001$). Specifically, the odds that a Black student who was also classified as a foster youth would take a course Beyond IM3 was 82.6% less than a Black student who was not a foster youth.

Table 4.1 Linear Regression Model of the Factors that Increase the Odds of Taking Beyond IM3 Coursework for Black Students

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Controls										
2018-19 School Year	.818	.133	1.629*	.392	.843	.147	.801	.135	1.482	.321
2019-20 School Year	.740	.134	1.627**	.262	.737	.138	.749	.136	1.427	.262
Individual Level -- Demographic Characteristics										
Gender										
(Male)										
Female	1.660***	.179							1.615***	.162
English Language Learner Status										
(Monolingual English Speaker)										
English Language Learner/Multilingual Student	1.879***	.242							1.564**	.247
Experiencing Homelessness										
(No)										
Yes	.388***	.068							.477***	.085
Foster Youth										
(No)										
Yes	.174**	.108							.204*	.137
Individual Level -- Middle School Achievement										
Accelerated Math Course in 8th Grade										
(No)										
Yes			2.892***	.686					2.639***	.594
Earned an "A" in an Accelerated Math Couse in 8th Grade										
(No)										
Yes			6.108***	2.023					5.720***	1.948
School Level -- Student Body Characteristics										
Student Enrollment					.997***	.001			.996**	.001
Black Student Enrollment					1.004***	.001			1.001	.003
Number of Students Receiving Free and/or Reduced Price Meals					1.002***	.000			1.001	.001
Number of Dropouts					0.946***	.009			.900***	.021
Number of Students who met UC and/or CSU Requirements					1.015***	.003			1.011**	.004
School Level -- Teacher Characteristics										
Number of Teachers							1.008	.039	1.024	.038
Number of Male Teachers							1.018	.048	1.050*	.023
Number of Black Teachers							.949	.039	1.103	.068
Number of Math Teachers							.968	.138	1.069	.085
Number of Black Math Teachers							.925	.188	1.410	.285
Average Teacher Age							1.207	.170	1.146	.112
Average Years of Teaching Experience							.771*	.088	.892	.082
Constant										
	.669**	.103	.370***	.089	.591	.245	.006	.029	.002	.006
N	1,561		1,561		1,556		1,561		1,556	

Note: Logistic Regression coefficients (presented as odds ratios). For categorical variables, reference category in parentheses

*p<.05; **p<.01; ***p<.001

Model 2 - Logistic Regression Analysis of Individual-Level Middle School Achievement

Results of the logistic regression analysis for individual student-level middle school achievement are presented in Model 2 in Table 4.1. Both variables included in this model were statistically significant ($p<.001$)–and unusually large in magnitude, suggesting that middle school math achievement is an especially important predictor of students' subsequent likelihood of taking a Beyond IM3 course in high school. The first variable highlighted the type of math taken by an individual student in eighth grade. Black students who took an "accelerated" math course in eighth grade were more likely to enroll in a Beyond IM3 math course by the end of high school, as indicated by a coefficient of 2.892. This means that the odds that a Black student took a course Beyond IM3 in high school increased by 189.2% if they took an accelerated math course in eighth grade. As mentioned earlier, for the purposes of this study an accelerated math course is a course that would be considered of a higher rigor than eighth grade math and/or required eighth grade math as a prerequisite. Moreover, Black students who earned an "A" in their accelerated eighth grade math courses were even more likely to take a course Beyond IM3 in high school. The coefficient of 6.108 indicates the odds of a student taking a Beyond IM3 course increases by an *additional* 510.8% if they took an accelerated math course in eighth grade *and* received an A in the course.

Model 3 - Logistic Regression Analysis of School Level Student Body Characteristics

Results of the logistic regression analysis for school level student body characteristics are presented in Model 3 in Table 4.1. Student enrollment was statistically significant with a coefficient of .997 ($p<.001$). The coefficient of .997 indicates a negative relationship between the number of students enrolled in a school and the odds that a Black student would take a course Beyond IM3 in high school. Schools with larger overall enrollment typically had lower Black

student enrollment in courses “Beyond IM3." Alternatively, Black student enrollment was statistically significant (p<.001) with a coefficient above one (1.004). This coefficient indicates a positive relationship between Black student enrollment and the odds that a Black student enrolled in a course Beyond IM3 in high school. This data point means that for students who attended a school with a relatively high number of Black students enrolled–controlling for the *overall* enrollment of that school–the odds that they were enrolled in a Beyond IM3 course in high school increased. Interestingly, the number of students receiving free and/or reduced-price meals (FRPM) had a slightly positive impact on the odds that a student would take a course beyond IM3. For this variable, the coefficient was 1.002 and was statistically significant (p<.001). In this model, the number of student dropouts and the number of students who met UC and/or CSU standards acted as expected in relation to the Beyond IM3 dependent variable and were also both statistically significant (p<.001). A coefficient of .946 means that Black students who attended a school with a relatively high number of student dropouts were less likely to have enrolled in a Beyond IM3 course in high school. Meanwhile, Black students who attended a school with a relatively high number of students who met the UC/CSU a-g requirements were more likely to have enrolled in a math course Beyond IM3 in high school.

Model 4 - Logistic Regression Analysis of School Level Teacher Characteristics

Of the seven independent variables included in this model, only one of them, the average years of teaching experience, was statistically significant. The coefficient of .771 for the average years of teaching experience of the teachers at a given school indicates lower odds of students having enrolled in Beyond IM3 if teachers have more years of teaching experience on average. This result indicates a possible connection to the amount of classroom experience of the teachers in a school, and the math trajectories of their Black students. In other words, the more years of

experience teachers had at a school on average, the less likely students were to take a Beyond IM3 course. This finding is in contradiction to much of the literature about the importance of teaching experience and student achievement (Rice, 2010). In addition, because I controlled for average teacher age in this model, I was able to showcase that this finding is not merely related to teacher age, but this finding specifically centers years of teaching experience as significant for Black student Beyond IM3 course taking.

Model 5 - Logistic Regression Analysis of School Level and Individual Student Level Characteristics

The full model held similar findings as many of the previously discussed, meaning that the results of the other models were robust, and not simply artifacts of other variables that were omitted. Basically, the results of each model were independent of one another. In this model (unlike in Model 4), the number of male teachers was statistically significant at the .05 level. The coefficient of 1.05 indicates that having more male teachers in a school plays a role in increasing the odds of Black student enrollment in courses Beyond IM3. Additionally, there were two variables that were no longer statistically significant within this final model, once effects from all models were included. First, this model no longer indicates a statistically significant relationship between Beyond IM3 course taking and the number of students receiving FRPM at a given school. Second, there is no longer a statistically significant relationship between the number of Black students enrolled in a given school and the odds that a Black student would have enrolled in a course beyond IM3 in high school.

Discussion

My quantitative findings are my first attempt to answer the question: *What informs Black students' decision-making processes as they choose to take, or not take, a fourth year of math in*

high school? My analysis suggests that Black students' Beyond IM3 course taking patterns are impacted by a multitude of systemic factors. As informed by Martin's FAMSI framework, analyses were conducted to consider how sociohistorical, community, school, and individual factors impacted Beyond IM3 course taking for Black students. The articulated results help to explain the barriers and systems of support that (dis)allow Black students to foster positive math identities, which increase the odds that a Black student would take a Beyond IM3 course prior to graduating from high school. My quantitative findings demonstrate that several factors including enrollment in accelerated math courses in eighth grade, racial-ethnic and gender identities, ethno-racial context, and teacher characteristics also held significance in the course taking patterns of the students included in my quantitative analyses. At the individual student level, every student characteristic variable and achievement variable included in the logistic regressions were statistically significant. While the relationships among variables may vary, they all matter for students' experiences with math and their decisions to (dis)continue their math trajectories beyond IM3. Ultimately, the quantitative findings can be broken into two major categories: barriers to students taking courses beyond IM3 and systems of support for students taking coursework beyond IM3.

Barriers to Students Taking Courses Beyond IM3

Homelessness, Foster Youth Status, and Indicators of Poverty. The Students Experiencing Homelessness variable, the Foster Youth variable, and the Number of Students Receiving Free and Reduced Priced Meals variable were all statistically significant in my logistic regression analyses. The inverse relationship between these variables and positive student outcomes shows that homelessness, foster youth status, and socioeconomic status negatively impact student achievement outcomes. Poverty is a component of the sociohistorical level and

can be attributed to structural and systemically racist policies and practices such as colonialism, slavery, redlining, and mass-incarceration that have strategically disadvantaged descendants of enslaved people, further contributing to generational poverty within the Black community (Alexander, 2010; Davis, 2017; Ladson-Billings, 2006; Kendi, 2016; Rothstein, 2017). Poverty works at the sociohistorical level, and it underscores most inequitable school outcomes occurring at the structural and institutional levels. Schools in higher socioeconomic communities often have more resources, newer textbooks, better technology, more teachers, smaller class sizes, and more rigorous course offerings. Given the relationship between economic capital and quality schools in majority Black communities, the resounding education benefits for economically secure families and affluent communities contribute to resource gaps (Ladson-Billings, 2006) and exacerbate racial inequities for historically marginalized groups, particularly those who are living in urban areas with high indicators of poverty (Martin & Larnell, 2013). In this study, I found that several indicators of poverty held statistically significant results related to Beyond IM3 course taking for Black students.

Homelessness. Homelessness is an ever present and unfortunate condition for many families in the United States who struggle with poverty. Tragically, children comprise nearly one-fourth of the homeless population in the United States (Henry et al., 2017). The Student Experiencing Homelessness variable was pertinent to this study specifically because of the overwhelmingly large population of people experiencing homelessness within the larger California context and urban areas such as the district where I collected the data. As mentioned in the findings, students who were classified as Black and experiencing homelessness on their high school transcript, had significantly lower odds of enrolling in a course beyond IM3. Thus, the results indicate that homelessness plays a factor in Beyond IM3 course taking for Black

students. This finding tracks with recent scholarship related to the negative relationship between homelessness and student academic outcomes (Burns et al., 2021; da Costa Nunez et al., 2016; De Gregorio et al., 2020, 2022; Fantuzzo et al., 2012; Rose et al., 2021).

Foster Youth. For students who were classified as both Black and foster youth, there was a statistically significant negative relationship between being a Black foster youth and taking a course Beyond IM3 in high school ($p<.001$). This finding is echoed in research about students in foster care being disadvantaged in academic settings, specifically in California (Barrat & Berliner, 2013; Wiegmann et al., 2014). Whitman states,

> In 2013, there were an estimated 402,000 youth in foster care (U.S. Health and Human Services, 2013). Black/African Americans are overrepresented among the foster youth population. As of 2013, 24% of children in foster care were Black/African American, yet this racial/ethnic group only accounts for 13.3% of the U.S. population. (2016, p.49)

While foster care youth were not represented in my qualitative data collection, the relationship between Black student outcomes and foster care helps to explain the structural, institutional, community, and individual factors impacting Black student achievement in math.

Free and Reduced Priced Meals. Scholarship has showcased the academic impacts of attending poorly resourced, underfunded schools (Betts et al., 2000; Duncombe, 2017; Semuels, 2016). By using the students receiving free and/or reduced-price meals (FRPM) variable, I hoped to highlight the ways that sociohistorical elements such as poverty might impact Black students' math trajectories and Beyond IM3 course taking. However, in the realm of quantitative data, more nuanced data and tools of analysis beyond my dissertation are needed to unpack the complex interactions between FRPM and Black students' experiences. Interestingly, in model 3 the number of students receiving free and/or reduced-price meals (FRPM) had a slightly positive impact on the odds that a student would take a course "Beyond IM3." In model 5, the

relationship between Beyond IM3 course taking and the number of students receiving FRPM at a given school was no longer statistically significant. These findings speak to the need to incorporate other variables for addressing the relationships between poverty and school level factors in quantitative research. Taken together however, the homeless, foster youth, and FRPM findings indicate that poverty negatively impacts Black students' Beyond IM3 course taking patterns at statistically significant levels.

Student Enrollment. My logistic regression analyses indicated a negative relationship between the number of students enrolled in a school and the odds that a Black student would take a course Beyond IM3 in high school. In other words, schools with larger overall enrollments typically had lower Black student enrollment in courses Beyond IM3. This finding tracks with research that also indicates negative relationships between academic achievement and attending larger schools (Egalite & Kisida, 2016) and having larger class sizes (Whitehurst & Chingos, 2011). This finding may relate to the resource gap. The negative relationship between larger student enrollment and Beyond IM3 course taking possibly connects to limited resources and less counselors available to students who attend largely enrolled schools. As my qualitative findings suggest, limited counselor availability was also one of the barriers to students' math course taking patterns.

Black Student Enrollment. Alternatively, my logistic regression analyses indicated a complicated relationship between Black student enrollment and the Beyond IM3 course taking patterns of Black students. In model 3, Black student enrollment was statistically significant ($p<.001$) with a coefficient above one (1.004). This coefficient indicates a positive relationship between high numbers of Black student enrollment and the possibility that a Black student enrolled in a course Beyond IM3 in high school. However, in model 5 there was no longer a

statistically significant relationship between the number of Black students enrolled in a given school and the possibility that a Black student would have enrolled in a course Beyond IM3 in high school. These findings complicate scholarship that indicates that Black students who attend schools with a critical mass of same-race peers develop an increased sense of belonging that contributes to better academic achievement outcomes (Boston, 2017; Faircloth & Hamm, 2005; Garces & Jayakumar, 2014; Jayakumar, 2015; Jayakumar et al., 2018; Miller et al., 2005; Murphy & Zirkle, 2016; Smalls et al., 2007). Rather these findings nod to other indicators of quality school experiences and the impacts of school, community, and individual factors on Black students' decision-making processes. My qualitative findings expound on the experiences of the Black students in my study and their feelings about having more Black students and their own sense of belonging in math classrooms.

Systems of Support for Students Taking Courses Beyond IM3

Beyond IM3 Course Taking and Eighth Grade Math. As mentioned in the previous chapters, the literature suggests a positive relationship between eighth grade math and future levels of math attainment (Brown et al., 2013; Kurleander et al., 2008; Neild & Balfanz, 2006; Paul, 2005; Smith, 1996; Spielhagen, 2006; Walston & McCarroll, 2010; Wang & Goldschmidt, 2003). The importance of eighth grade math is underscored by the results in my logistic regression models. Black students who took an accelerated math course in the eighth grade[11] were significantly more likely to be enrolled in a course Beyond IM3 in high school. This is important to consider because according to the US Department of Education (2018) only 24% of eighth graders take accelerated math courses, and Black students are even less likely than their

[11] As mentioned earlier, an accelerated eighth grade math course is a course that is above grade level and typically taken in high school, such as Algebra 1, Geometry, Integrate Math 1, or Integrate Math 2.

peers to be enrolled in these courses (Faulkner et al., 2014; Francis, 2012; US Department of Education, 2018).

In addition, if a student took an accelerated math class in eighth grade *and* received an A in that class, the odds that they would take a Beyond IM3 course increased by an additional 510 percent. So as the literature suggests (Joseph et al., 2019), early math experiences are significant for high school math trajectories. Based on my findings, eighth grade math is a crucial turning point for many Black students. These findings suggest that for many Black students taking coursework beyond IM3 in high school might be nearly impossible without acceleration in the eighth grade. These findings illuminate how placement policies act as institutional barriers to courses beyond IM3. Hence, the secondary math trajectories of the Black students in my quantitative dataset were diminished before even reaching high school.

Clearly, not taking an accelerated math course by the eighth grade has unfortunate effects on the academic trajectories of Black students, which appears to limit their ability to reach courses beyond IM3 by their senior year of high school (Ngo & Velasquez, 2020; Wells, 2018). Thus, in order for Black students to increase their likelihood of making it to a Beyond IM3 course by senior year, they must be enrolled in the highest math tracks by the eighth grade, if not before. Although this finding speaks to the importance of accelerated math coursework in middle school and before, I will present a more nuanced assessment of this finding through the qualitative data. In the next chapter my qualitative data analysis speaks to the need for culturally relevant teachers that foster STEM interest, identities, and persistence among Black students in order to support the students' trajectories into accelerated math courses. Without teachers who are both strong in their math and culturally relevant teaching pedagogies students are still being

forced into classroom spaces that may feel exclusionary and harmful spaces. My qualitative findings in the next chapter will speak to these musings.

Intersections of Racial-Ethnic Identities, Gender, and Multilingualism. Gender and ELL status were statistically significant in all of my models. However, the results point to being Black and female as a significant factor in upper math placements beyond IM3. Black female students had 67% higher odds than Black male students of taking a Beyond IM3 course in high school. The findings about Black males echo the literature about their limited enrollment in upper-level math course work for various institutional and structural reasons that are steeped in systemic racism such as tracking, exclusionary discipline practices, and lowered expectations from teachers (Berry & McClain, 2009; Oakes, 1990, 2005; Riegle-Crumb, 2006; Wood et al., 2018).

Gender. Alternatively, the findings demonstrated that Black girls were overrepresented in Beyond IM3 coursework. Scholars have long studied the invisibility of Black girls in STEM classrooms (Chavous & Cogburn, 2007; Farinde & Lewis, 2012; Neal-Jackson, 2018; Ricks, 2014). This finding does not mean that Black girls are having better experiences than Black boys necessarily. As previous scholarship has indicated, Black girls are grossly underrepresented in STEM degrees and careers (Collins et al., 2020; Farinde & Lewis, 2012; NCES, 2020) and often have negative experiences in STEM spaces that are multiplied due to the intersections of their race and their gender (Ireland et al., 2018). Black girls are being enrolled in these courses at much higher rates than Black boys, which poses a host of interesting questions about where and how Black girls are getting lost or being removed from STEM pipelines. However, the quantitative analysis highlights the underrepresentation of Black boys in Beyond IM3 coursework. Black boys are also experiencing the math classroom in racialized and gendered

ways (Jett et al., 2015; Jett & Davis, 2020) and their underrepresentation speaks to the overarching structural and institutional barriers that impact Black boys' math course taking. Regrettably, my qualitative findings also are unclear as to the underlying reality of Black students' specific experiences with gender and racism in math classrooms.

Black Multilingual Students. As it relates to multilingualism, students who were Black and multilingual had 87.9% higher odds of taking a Beyond IM3 course than Black monolingual students. This finding challenges how research has historically depicted multilingual/ELL students and their mathematical ability levels in comparison to their monolingual/non-ELL peers (Fry, 2007; Garcia, et al., 2010; Goodrich et al., 2021; Hemphill et al., 2011). One underlying factor could be the differences in the experiences of African American and Black immigrant populations in the U.S. context, and their cultural orientations to schools and schooling (King-Miller, 2017; Mwangi & Fries-Britt, 2015; Sparks, 2018). My qualitative data collection did not speak to the issue of students' Black immigrant status. Further research is needed to understand the underlying factors contributing to this result.

Beyond IM3 Course Taking and Teachers. Teacher characteristic variables allowed for an analysis of the impacts of teacher characteristics on Beyond IM3 course taking patterns. Race/ethnicity, gender, average teacher's age, average teachers' years of teaching experience, and the average level of education of teachers at each school in The District were all variables that I included in my initial quantitative analyses before finalizing my logistic regression model. As mentioned in chapter three, the teacher characteristics that remained in my final logistic regression analysis were variables for gender (the number of male teachers), race (the number of Black teachers), subject area (the number of math teachers and the number of Black math teachers), average teacher age, and average years of teaching experience. Teacher race, gender,

and years of teaching experience will be discussed further as potential solutions for increasing Black student Beyond IM3 course taking.

Black Teachers. In my logistic regression analysis, I specifically wanted to understand the implications of my fourth research question which centers teachers, specifically Black teachers, as a potential solution for increasing Black student Beyond IM3 course enrollment. In fact, having more Black teachers and more Black math teachers were each *very* close to being statistically significant ($p = .09$ and $p = .10$ in the final model, respectively). With a larger sample (and therefore more statistical power) the models may have demonstrated statistically significant results. My findings about the relationship between Black teachers and student enrollment support a push for recruiting and retaining more Black teachers in districts with larger percentages of Black students. As mentioned in chapter two, teacher-match scholarship explicitly links Black teachers to better academic outcomes for Black students (Gershenson et al., 2017; Klopfenstein, 2005; McGrady & Reynolds, 2012). Specifically, Gershenson et al. (2017) found that for Black males the likelihood that he would graduate high school significantly increased if the young man was exposed to one or more Black teachers in elementary school.

Male Teachers. The results suggested that having more male teachers was significant for increasing the odds that more Black students enrolled in Beyond IM3 coursework. In model 5 (unlike in Model 4), the number of male teachers was statistically significant at the .05 level. Using male teachers as a reference category I created a binary variable for teachers' gender. This information was relevant based on my findings related to Black boys' underrepresentation in Beyond IM3 coursework. Teacher-match literature holds conflicting opinions regarding the impact of same race, same gender, teacher-student pairings (Dee 2006; Klopfenstein, 2005). However, as mentioned in chapter two, Dee (2006) found that same gender teachers significantly

improved the achievement of both boys and girls. Dee (2006) also found that teachers perceived students of the same gender as having a better attitude, better motivation, and a better ability to succeed. Dee's (2006) findings further expose the potential biases in education based solely on gender. Given that most teachers are both white and female, these findings provide strong implications for my statistically significant finding related to underrepresentation of Black boys in Beyond IM3 coursework.

In contrast, Klopfenstein (2005) found that having more Black teachers in a school had a positive statistically significant impact on the likelihood that a Black student enrolled in a secondary math course beyond Geometry, but only if the teacher was of the opposite gender. In this study, the significance of having a same-sex, same-race student-teacher match was indiscernible, having a minimal effect on the course taking decisions of Black students. Thus, according to Klopfenstein's (2005) findings, in regard to Black girls, having more male math teachers, specifically Black male math teachers might bode well for increasing Black girls' enrollment in Beyond IM3 coursework. Taken together the implication regarding male teachers leaves room for thinking about the role of teacher gender on Black students' math course taking patterns and their academic outcomes.

Newer Teachers as Possible Game Changers. Another factor illuminated by the results was the statistical significance of average teacher years of experience on the Beyond IM3 course taking of Black students at a given school. This result is interesting given previous research demonstrating how less teaching experience is significantly associated with teacher ineffectiveness (Rice, 2010). Additional data would be needed to understand why the findings indicated statistical significance regarding teacher years of experience, perhaps both quantitative and qualitative in nature. One potential explanation might be that as teachers spend more time in

a school system, they may be more likely to work in alignment with potential gatekeeping mechanisms functioning at their school site. Perhaps as teachers earn more years of teaching experience, they ultimately begin to ascribe to the anti-Black foundations of the public education system and begin to assimilate into the deficit-oriented lenses of many educational institutions, often reifying the structures that make it difficult for Black students to succeed in math classrooms. Moreover, though subject area and pedagogical expertise might grow over time, it is possible that socializing structures make teachers less likely to consider equity-oriented approaches and asset-based framing of student outcomes.

While the reasons behind these statistical outcomes related to race, gender, and average years of teaching experience are unclear, taken together, the results reiterate the role of teachers as crucial to Black students' progression through the math pipeline to courses "Beyond IM3." Using the experiential knowledge of my student participants, my qualitative findings further explore the need for Black teachers in math classrooms.

Summary

The purpose of this chapter was to investigate the extent to which institutional, structural, and individual factors influenced the likelihood that a Black student would enroll in a math course Beyond IM3 by their senior year of high school. This chapter presented the results of logistic regression models using a binary dependent variable indicating whether or not a student took a course Beyond IM3 in high school. Ultimately, the quantitative findings suggest that there is a relationship between whether or not a Black student is enrolled in a course Beyond IM3 their gender, the math courses taken and achievement in eighth grade, as well as some school level variables such as the average years of teaching experience of the teachers working there.

The discussion section broke the findings into two major categories: barriers to students taking courses beyond IM3, and systems of support for students taking coursework beyond IM3. The barriers to students taking Beyond IM3 coursework were at the sociohistorical and school levels. At the sociohistorical level, the barriers included indicators of poverty such as homelessness or if a student was classified as a foster youth on their transcript. At the school level, the barriers included overall school achievement factors such as high school dropout rates, as well as student enrollment. The systems of support to students taking Beyond IM3 coursework were at the sociohistorical, school, and individual levels. Eighth grade math stood out as a major statistically significant finding that could speak to the sociohistorical element of academic tracking that disproportionately impacts Black students. At the school level, teacher gender and years of teaching experience held statistically significant results for Beyond IM3 course taking. At the individual level, student gender and ELL status played a statistically significant role in beyond IM3 course taking. The gender and ELL findings can also be connected to the sociohistorical elements of the intersectionality of marginalized identities.

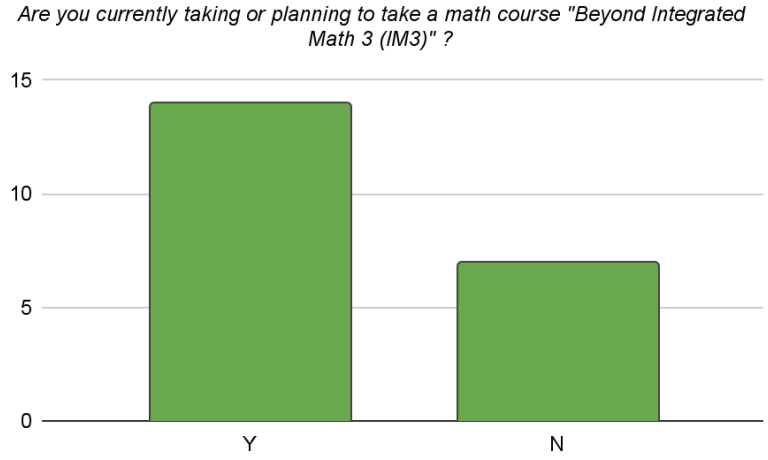
Quantitative findings are necessary for this study but are also somewhat limited in scope, leaving more questions than answers about how Black student experiences in math classrooms may impact their decision to persist in math to a course "Beyond IM3." The next chapter presents qualitative findings that will give voice to some of the lived experiences of the Black student participants in this study. It will provide room for deeper interpretation and analysis for investigating the overarching research question, "What informs Black students' decision-making processes as they choose to take, or not take, a fourth year of math, beyond IM3, in high school?"

Chapter 5: Qualitative Findings
Student Math Dispositions, Racialized Experiences, and the Multifaceted Nature of "Choice"

This chapter reports the findings of the qualitative phase of this mixed methods dissertation. To understand how Black students in The District made decisions to take, or not take, Beyond IM3 coursework in high school, I chose to do semi-structured interviews with 21 Black high school juniors and seniors. As mentioned earlier, the interviews at Sunset HS were in-person focus groups and the interviews at Rose HS were individual interviews via Zoom. Figure 5.1 displays the student participant responses from a brief pre-interview survey regarding their plans to take or not take a course Beyond IM3. The survey was given prior to the interview to gather additional contextual information from the student participants and to triangulate their interview responses about their math course taking decisions. As Figure 5.1 indicates, 14 students were currently taking, or planned to take, a course Beyond IM3. Seven students were not taking, or did not plan to take, a course Beyond IM3.

In addition, this chapter summarizes the findings at both schools with the FAMSI framework as a guide for categorizing the themes presented in the data. The qualitative findings discussed in this chapter were categorized into the four levels of Martin's FAMSI framework: sociohistorical, community, school, and individual. This chapter will explore the themes presented at each level. Each theme was an informing factor that influenced Black student participants' dispositions towards math and their Beyond IM3 math course taking patterns.

Graph 5.1. Student Participants' Beyond IM3 Course Taking Patterns



Sociohistorical -- Math Curriculum as a Structural Barrier or Facilitator to Beyond IM3 Coursework

The math curriculum serves as a sociohistorical level barrier that bleeds across students' math course decision-making patterns. Some students' beyond IM3 course taking was informed by the math curriculum and its relevance to their everyday lives, and their experiences with math in middle school. In addition, eighth grade math stood out as a tool for progressing to beyond IM3 coursework. I consider the influence of eighth grade math a product of academic tracking, a sociohistorical level barrier. The section that follows considers curriculum and eighth grade math as structural barriers that work at the sociohistorical level.

Relevance of the Math Curriculum to Everyday Lives and Postsecondary Goals

Relevance to Everyday Lives. A first theme that stood out across the qualitative data was students' feelings about the (ir)relevance of the secondary math curriculum. Several students opted out of Beyond IM3 coursework simply because they felt the math curriculum was irrelevant, boring, and disconnected from their everyday lives. For example, when asked about

whether or not he was planning to take a math course in his senior year, Will, a junior from Sunset HS, who opted to not take a Beyond IM3 math course stated:

> I'm most definitely not taking a math class next year. I don't like the subject. I go to tutoring for help with math, and see the same teachers, trying to teach us the same stuff, never in different ways. Eighth grade math was my favorite only because we did more word problems, that applied to real-life situations, so managing money, stuff like that. Stuff that I felt would actually help me in the future.

Will was very memorable in that he was the most outspoken about hating math because of the teachers and the curriculum. Will makes it clear that the irrelevance of the math curriculum has ultimately made him dislike the content and has influenced his decision to opt out of a fourth year of secondary math. Will's statements can be broken into two pieces. In the first part of his comments, Will alludes to the importance of what scholars refer to as culturally relevant pedagogy (Ladson-Billings, 1995) and culturally responsive teaching (Gay, 2000). Culturally responsive teaching situates teaching and learning in the contexts of BIPOC students' lived experiences and their cultural frames of reference (Gay, 2000). Culturally relevant teaching pedagogy is a social justice-oriented pedagogy with a focus on student empowerment and the development of students' critical consciousness, using students "culture as a vehicle for learning" (Ladson-Billings, 1995, p. 161). When Will refers to seeing "the same teachers, trying to teach us the same stuff, never in different ways" he seems to be making the point that his math teachers are not making the math content engaging and relevant to his lived experiences. In contrast, in the second part of Will's quote, he speaks about the eighth-grade math curriculum that felt relevant and connected to his daily life as well as his future. For Will, relevance meant word problems that dealt with real-world situations like managing money, and "stuff that…would actually help [him] in the future."

Jordan felt similarly about math, indicating that his love of math is conditional on it connecting to counting money, something more relevant to his everyday life. He commented that "Overall I like math, because counting money is like math. That's the only math I like. It's like life. Money is a good way for me to understand math." Jordan, a junior at Sunset HS, had already met his math requirements in his sophomore year, meaning he was most likely in an accelerated math course in the eighth grade. Jordan also was not enrolled in a math class at the time of the interview but planned to take an additional math course beyond IM3 in his senior year. Despite the difference in their math trajectories, Jordan and Will both shared similar impressions of what the math curriculum could and should look like for Black students. For students like Will, the irrelevance of the math curriculum serves as a major factor in the negative dispositions they hold towards math with implications for their Beyond IM3 course taking. For students like Jordan, exposure to Algebra in middle school seems to have affected his math trajectory, but not his disposition towards math. I will speak further about this concept later in this chapter.

Relevance to Postsecondary Goals. The students' opinions about the utility of the math pathway are important at the sociohistorical level because they highlight how curricular pathways and institutional policies act in structural ways to impede or facilitate students' math trajectories. Very few students mentioned taking a fourth year of math because of its relevance to everyday life. However, the students who identified math as important noted that they needed math as a prerequisite for their postsecondary plans. If a student mentioned college or career in their explanation of why they opted into or out of Beyond IM3 coursework, their comments are discussed in this section.

For example, Hillary, a senior at Sunset HS who was enrolled in a Beyond IM3 course at the time of her interview, spoke about her feelings about math as it related to her college and career aspirations and the transition into college. In Hillary's words:

> You know how you go to college, and everybody has to take math, English, history, all the basics... so it's like, why waste all that money, why waste all that time? Because college takes time. So why waste all that time doing something when it's not even in your major. Some folks just don't need math. They don't need to take it, so why do you have to? Why does it have to be in the curriculum? Why does it have to be in what they have to take? Because they can be taking other classes and get done faster, but no, they're too busy taking the core classes, like math, even when they don't need it.

Hillary's statements about coursework relates to scholarship about college time to degree (Adelman, 2006). Her strong protests demonstrate the lack of counseling and information students have concerning taking upper-level math. Advanced math courses in high school would actually reduce her time to degree because she would have the opportunity to test out of basic requirements and receive AP course credit. BIPOC students are already more likely to take longer to obtain their college because they are more likely to spend time in remedial math and English courses and bring in less college credits than white and Asian American students (Adelman, 2006; ACT, 2007). Because of the relationship between students' course taking patterns in high school and their college time to degree, the lack of knowledge and counseling around issues of college access and success remains a barrier.

Ashley, a senior at Sunset HS who chose to not take coursework Beyond IM3 also felt that Beyond IM3 math coursework was irrelevant for her future career. In Ashley's words:

> I feel like math won't fit into my future plans because I want to be a business owner, I want to be an entrepreneur, my own boss. So, I feel like, basic math, yes, it's needed, of course and you just need it in life, but all the extraness of math, it's too much. Like why does this matter to what I'm trying to do? Yes, it matters to some career fields, but not all, but we still have to take it and it's just like "why?"

Ashley speaks to her feelings of math not fitting into her future plans of becoming an entrepreneur when she talks about the "extraness of math" and its "mattering" to what she is "trying to do" career wise. Ashley's comments also speak to a larger conversation about students needing a better understanding of the relevance of the math curriculum. When she suggests that all students need "basic math" because "you need it in life," Ashley is expressing how little she understands about the ways in which math can and does impact her life. Because she is choosing a career with fewer math requirements, Ashley felt the math curriculum should be more tailored to her future career aspirations and that the math curriculum should be "less extra". I likened Ashley's use of "extraness" to the colloquial phrases "being extra" or "doing too much." Essentially, Ashley means that the curriculum should be more streamlined to meet her particular needs.

Other students felt similarly to Hillary and Ashley, connecting college and career aspirations to the curricular relevance of the math pathway. According to Tia, a junior at Rose HS who planned to take a Beyond IM3 course in her senior year, "I need four years of math depending on which path I take. In the medical field I will need math…I was thinking of becoming either a pathologist or a veterinarian." Tia's decision to take a course beyond IM3 is directly related to her future goals which compels her to continue taking advanced math courses.

Geoffrey, a senior at Sunset HS, who was enrolled in a Beyond IM3 course at the time of his interview, also cited college as a major reason for his decision. In Geoffrey's words, "I decided to take math this year because I knew that if I was going to college, it would help me so I could remember what I previously learned." In addition to thinking of beyond IM3 as important for his postsecondary plans, it seems that Geoffrey is thinking about math in his senior year as a means for avoiding summer learning loss as he transitions to college (Shafer, 2016; Turner et al.,

2020). Similarly, Lisa, a senior at Sunset HS also mentioned college goals and avoiding learning loss as her main reasoning for taking a Beyond IM3 course. Lisa shared that she, "chose to take Statistics because I just felt like it would give me the upper leg in college, seeing how I plan on going to a four-year college next year. I just felt like it would be really helpful and set me higher from the rest [of my peers]." Lisa reiterates this notion of using a fourth year of math beyond IM3 as a means to prepare herself for college and the potential difficulties of taking math at the undergraduate level. Lisa's comments reflected how beyond IM3 coursework could act as a potential shield from Black students feeling underprepared as they transition into college level STEM coursework.

Myra, a senior at Sunset HS also cited college in her reasoning for taking an additional math course beyond IM3. Myra emphasized that she decided to take math because, "I was going to apply to [a University of California School] and I needed that fourth year of math to stand out in the apps [applications]." Myra's comments speak to the nature of the UC system and that students must take Beyond IM3 math coursework to be competitive for UC admission. Her sentiments also demonstrate that taking a fourth year of math beyond IM3 was the only option if she wanted to meet her postsecondary goals of attending a top four-year institution.

The students' comments underscore an important point in the discussion about math pathways as they relate to college and career goals. These students all held similar views of math as a means to an end, but not an enjoyable academic pathway. Students' future goals and ambitions became the primary influence to continue Beyond IM3.

Eighth Grade Math

Many participants centered middle school as a pivotal time in their educational career. As mentioned in my quantitative findings in chapter 4 as well as the literature review in chapter two,

academic tracking is a sociohistorical tool that works structurally to impede Black students' math trajectories. Nicky, a junior at Sunset HS, who opted to not take a Beyond IM3 course in high school, recalled her best memory of math was in eighth grade. Nicky remarked, "my favorite math would be eighth grade year because that's when everything basically clicked for me." Nicky speaks to a few interesting connections in her comment about eighth grade math. First Nicky talks about eighth grade math as a space where "everything clicked" for her. This finding connects to scholarship about the importance of achievement in eighth grade math and future levels of math attainment (Allensworth et al., 2009; Archbald & Farley-Ripple, 2012; Bozick & Ingels, 2008; Brown et al., 2013; College Board, 2011; Paul, 2005; Wang & Goldschmidt, 2003). In addition, although I am unsure if Nicky was enrolled in an accelerated math course, her comments regarding "everything click[ing]" in the eighth grade connect to my quantitative findings related to student achievement in accelerated eighth grade math. As a reminder, a major statistically significant finding in my quantitative chapter was that if a student took an accelerated math course in the eighth grade and received an A in that course then their odds of taking courses beyond IM3 increased by 510 percent. Given the clear relationship between eighth grade math and students' math trajectories, it seems like a no brainer to shift the math curriculum and pathway in a way that removes the curricular barriers related to Beyond IM3 coursework.

Tamera, a junior at Rose HS who intended to take a Beyond IM3 course in her senior year, also mentioned eighth grade as she discussed when and why education became important to her. In Tamera's words:

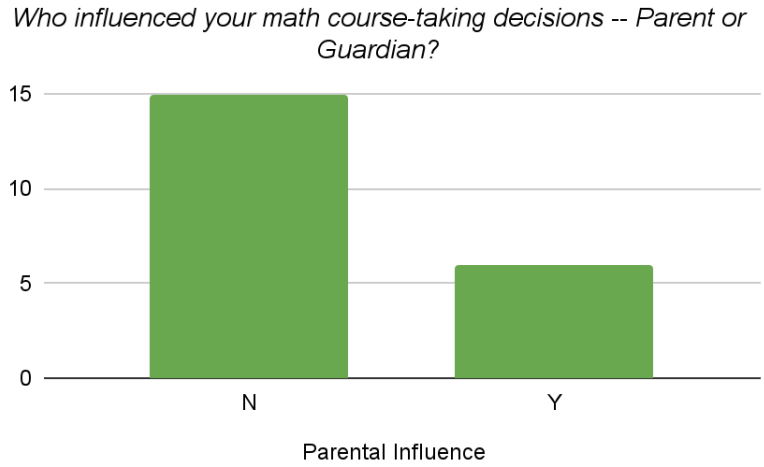
> It was probably in middle school [when education became important to me] because [I was placed into] a seminar class to help [me] get stronger in math for high school…so that's where I tried to work harder so I could eventually attempt to get into harder [math] classes when I went to high school.

Both Nicky and Tamera speak to the importance of eighth grade as a turning point in their math trajectory where students either solidify their math content knowledge in preparation for high school and Beyond IM3 coursework. In addition, many of the student participants had been in an accelerated math course in their eighth-grade year, making it that much more likely they would be eligible to take a Beyond IM3 course by the end of high school. Specifically, Richie, a junior at Sunset HS emphasized this point in his interview, "I'm already taking Pre-calculus this year. So basically, because I was already doing high school math as an eighth grader…I felt like I was already ahead of the game." Other students felt similarly. Like Roger, for example, who was also taking Pre-calculus in his junior year, shared that he "has always been in advanced math classes" as early as middle school. As echoed in the literature as well as in my quantitative results, acceleration in middle school is a very important mechanism for increasing Beyond IM3 course taking. Even though not all students' participants mentioned eighth grade as important in their math trajectory, it was a common thread mentioned periodically by many of the students -- especially the students who had already made it to a course Beyond IM3.

Community Level -- Beyond IM3 Course Taking and the Village of Support Surrounding Black Students

Beyond the school site, parents played a pivotal role in the students' math course taking decisions. According to the pre-interview survey, several students mentioned a parent or guardian as one of the people that influenced their math course taking decisions. As Figure 5.2 notes, six students indicated that a parent or guardian influenced their decisions about the math courses they would take in their senior and/or junior year(s) of high school. Of those six, all of the students stated that their parents positively influenced their decisions, meaning they encouraged them to take more math classes, particularly courses Beyond IM3.

Graph 5.2. Parent/Guardian Influence on Beyond IM3 Course Taking



As mentioned in Chapter 3, my methodology shifted when interviewing Rose HS students and I was able to interact with parents first before meeting the student participants. These interactions provided room for rich conversations about my study and math in general. I obtained much needed context for my study through these conversations. Specifically, when speaking with Carlton's father, Mr. Banks, I learned that Mr. Banks works as an engineer and was in the air force. He had high expectations of his son and encouraged him to do better and be better in general as a young adult. Mr. Banks also talked about the importance of young Black kids, particularly young Black boys, seeing Black success to understand the possible career opportunities that are out there for them. According to Mr. Banks, who is originally from Oakland, "a lot of [Black] folks haven't seen Black success and what that looks like." Carlton, a senior at Rose HS, spoke highly of his father, Mr. Banks. According to Carlton, "Dude, my dad is on me like practically every day about my schoolwork, and my mom really cares about [my success in school] too." Carlton opted into a fourth year of math (Pre-calculus) because his father encouraged him to take it. According to Carlton, "my dad was like 'oh you're gonna be taking Pre-calculus in college and it would be really beneficial to you if you did take it [as preparation for college]." Mr. Banks was a major source of support and encouragement for Carlton. Carlton

went on to share how instrumental his father and grandfather were in his life outside of school, "My dad, he's not a teacher, but he teaches me so much. My grandfather too. They all are my Black teachers at home. They're both always pushing me to do better and be better. I also have my mom and grandmother too, so it's like a lot of support." The pivotal role of a Black student's "village" of parents, grandparents, and other sources of community support has been documented in the research on Black male students' resilience and math (Jett & Davis, 2020). According to Jett and Davis (2020) Black males who thrive in STEM spaces typically have at least one individual supporting them at every step of the STEM pathway. Carlton was fortunate enough to have an entire village of support behind him. Carlton's village helped him develop the resilience needed to traverse the tumultuous math pathway outlined in the previous findings about sociohistorical level experiences.

Other students felt similarly to Carlton. Jordan, a junior from Sunset HS, also mentioned his father as an important factor in his decision to take an additional year of math in his senior year of high school. When asked who, other than himself, influenced his decision the most, Jordan shared:

> I feel like it's my dad because every time we're in the car, he comes for me. He's like, "Oh okay, you're a little mathematician?" And I say "yea, it's easy, just counting stuff." So, he's like, "You like math and stuff, so you better be taking math next year." And I'm like, "All right, I'm going to do Pre-cal." And he was like "That's a good fit for you, because you like math and stuff." That's cool to hear from my dad.

This recollection of a conversation he had with his dad seemed to have a tremendous impact on Jordan and illuminates the influence that Black parents, fathers in particular when speaking to their sons, have on the math course taking patterns of their children. Jett and Davis (2020) illuminate how family support is most salient to the support system of successful Black males in STEM. Berry (2008) also emphasizes that Black males who are successful in math are most

successful when their parents stress the importance of education and succeeding academically. Jordan's father letting Jordan know that he "better be taking math next year" is evidence of his high expectations for Jordan.

Roger, a junior from Rose HS, also mentioned his parents as major sources of encouragement to take a course Beyond IM3. In fact, as a junior, Roger was already taking a course Beyond IM3 (Pre-calculus) and was considering taking another math course in his senior year of high school. Roger attributed this to his parents' high expectations. According to Roger,

> my parents always told me that I would go to college. Ever since I was a kid, they've been talking about an account they had that they would put a little bit of money in and that would be my college tuition. They made it seem like there wasn't an option. [Going to college] is just a common thing.

Roger's parents normalized going to college and even spoke to Roger about the college tuition fund they were saving up for. In this way they gave Roger no choice but to aspire to go to college and even gave him a means for getting there without scholarships or student loan debt, making it even more likely that Roger would consider going to college after high school. This finding also coincides with scholarship about the role of Black parents on their high achieving Black students. Berry (2008) saw that for Black males who performed well in math, their parents instilled in them that doing well in school was expected. The findings from Chapman et al. (2018) also illuminate the instrumental role of Black parents who heavily stressed the importance of college. The normalization of college can be seen as a factor in the beyond IM3 decision making of several of my student participants.

Tyreke, a senior at Rose HS, took Pre-calculus in his senior year because it would help with his future career goals and with getting into college. Tyreke attributes this decision primarily to the example set by his mother, who instilled in him college-going values. According to Tyreke he chose to take four years of math and enter college after high school because:

> My mother always tried to instill the value of education in me because she herself was one of the first college goers in our family. My grandmother didn't go to college, she actually had to drop out, but my mom was the first one to successfully get into college and graduate from a very top tier college, all through scholarships. So, yea, when I think about it my family kind of instilled this idea of going to college, and that you always need that education to open yourself up to more opportunities as you go up the chain of command.

Tyreke's mother and grandmother played a major role in his decision to take a course Beyond IM3. Their college-going mentality allowed Tyreke to see no other option but going to college after high school. For Tyreke, and many other students, taking four years of math in high school was ultimately their best shot at being accepted into a four-year institution.

Despite having consistently negative experiences in math classrooms and feeling racialized at school, Tia, a junior at Rose HS, still intended to take four years of math in high school, including a course Beyond IM3. She attributes this decision primarily to her parents. When asked who influenced her decision to take an additional year of math, Tia referenced her mother:

> My mom told me [taking four years of math is] important for college. [She] is really on me about school and everything, even though I'm doing well you know she's still there and she told me about her college experience and how she took Pre-calculus her last year of high school and that it really helped her in college, so that kind of pushed my decision and she's also always been there for me for math because she also knows like math is not my strong point so she's always pushing me she's always giving me practices to do she's always just randomly quizzing me…so that pushed me [to take four years of math] my mom did.

Clearly Tia's mother had a major influence on her decision to take a math course Beyond IM3, despite the negative experiences she and her mother had previously mentioned. Tia's mother did several things to support her daughter's math resilience. First, Mrs. Landry held high expectations of Tia and made it clear that college was the only option. The impact of parental expectations on Black students' math outcomes is echoed in the literature (Berry, 2008; Carter Andrews, 2020). Specifically, Carter Andrews (2020) found that successful Black engineering

students cited their family as major motivation for their persistence within the STEM pathway. Second, Mrs. Landry's experience as a college graduate helped provide important institutional knowledge about the role of beyond IM3 math coursework and success in postsecondary math coursework. This point speaks to findings presented by Chapman et al. (2018) regarding the positive role of second and third generation Black parents on the college going and college choice processes of their children. Finally, Mrs. Landry was also extremely involved in Tia's academic career, helping her with homework and giving Tia quizzes at random to test her knowledge. This aspect of Mrs. Landry's parenting is reiterated in Strayhorn (2010) who found that Black students earned higher math achievement scores when their parents demonstrated high expectations and school involvement such as attending school meetings and checking over homework.

Similarly, Tamera, another junior at Rose HS did not see herself as a math person but her parents, who are both educators, pushed her to continue taking math classes. Her father, Mr. Campbell, is a principal and former STEM teacher and her mother is an elementary school teacher. When I met with Tamera and Mr. Campbell to discuss the goals of my study, he was really interested in my study and wanted to know more, asking several questions when we met. When asked how involved her parents are in her schooling, Tamera's response was that they are "pretty involved just because they're like teachers, that they want me to have the best education that I can." Later in the interview she shared that:

> I just don't really like math that much, and I know that I can… I can be good. I like to try but it's not my favorite subject…but like my parents told me, it was a good idea to take math next year to prepare me for college. I was going to take regular math classes, like just the normal ones, but they told me I should probably take advanced and that was definitely a good idea because I heard that the regular classes were really easy, and I want to challenge myself, like, I don't want to just cruise by school.

Ultimately for Tamera, her parents' opinion outweighed any worries she had about her abilities or negative school-related experiences she had about taking Beyond IM3 math coursework, because her parents had already instilled in her the importance of going to college. Again, aspects of Tamera's parenting echoes literature regarding the importance of Black parents' academic involvement and college going expectations on Black students' math trajectories (Berry, 2008; Carter Andrews 2020; Strayhorn, 2010; Walker, 2006).

Some students mentioned their parents as instrumental in their math course taking decisions overall, but when it came to taking a Beyond IM3 math course in their senior year, ultimately, they opted to not take the course despite their parents' urging. Specifically, Ashley, a senior at Sunset HS who opted to not take a Beyond IM3 course in her senior year stated,

> My mother is like, "You're smart, you do good in math. When I was in school, I failed math. Look at you, getting As and Bs. You'd better take math." I'm like, "Child, do you know how hard math is? I'm struggling."

While Ashley's mother encouraged her to take math in her senior year, Ashley ultimately opted out of beyond IM3 coursework anyway. Ashley's choice speaks to the overlapping levels of Martin's framework. Ashley's prior experiences at the school level, in which she developed a "love/hate relationship with math" and the sociohistorical level in which she felt that math was irrelevant to her future plans "to be a business owner" might have outweighed the community level effects. Ultimately, Ashley utilized her individual agency to make the choice she felt was best for herself and her future career as an entrepreneur.

Nicky, another junior at Sunset HS who also chose not to take a Beyond IM3 math course in her senior year, shared Hillary's experience. According to Nicky, "Same thing [as Ashley]. My mom was like, 'You're getting all As and Bs in math, so why don't you take another year?' 'Because I don't like it,' I said." Nicky's mother had a say in Nicky completing the math

coursework required for high school graduation, but ultimately Nicky's negative feelings about math superseded her mother's wishes and Nicky chose to not take a math course beyond IM3.

Many of the participants' parents were instrumental in their child's math course taking decisions. The students who opted into Beyond IM3 coursework seemed to overwhelmingly have parents who held high expectations and instilled in their children that academic success was expected, and that college was not optional. However, for some students their lived experiences might outweigh the influence of parents in students' decisions to take or not take Beyond IM3 coursework in high school.

School Level -- Beyond IM3 Course Taking and Racialized School Experiences

Many of the students in this study discussed the racialized experiences they encountered while navigating math courses as well as what it felt like to be Black while engaging with math in their high schools. For many of the students in my study, they experienced their schools in racially hostile ways. Some students emphasized the mistreatment they felt as one of a few Black students in accelerated math. Tia, a junior at Rose HS felt racialized by her math teacher. According to Tia:

> In that class there was actually three [Black students]. She always lost our homework, and she always didn't know where our assignments were. Then, if we raised our hand she would be like "Oh, you can wait until the end of class." I'd wait until the end of class to ask her a question, and she would be like "Oh, the bell is gonna ring in two minutes you can ask me tomorrow." I asked her tomorrow and she still didn't want to answer, like she basically just ignored us.

Tia's comments stand out for various reasons. Tia felt racially marginalized by her math teacher and ignored. Similar to Tia, Will also felt ignored by his teachers at Sunset HS and also attributed his feelings to teachers' selectivity with whom they interact and provide additional academic support to. Will, a junior, spoke about the teachers at Sunset HS. In Will's words:

> These inner-city teachers just don't care. They're selective about who their students are. You try to stay after class to try to talk to them, and they don't have time to talk to you, but the next day you see another student that's a different ethnicity than you, and they be talking to them and not you.

Will's statement illuminates the ways in which many Black students feel racialized within the math classroom. For Will, the experience of being ignored while asking for additional help in math class ultimately left him feeling dejected about math in general. Will's experience speaks to the findings of scholars indicating strong math teachers as crucial to Black students' success in math (Berry & McClain, 2009; Malloy, 2009; Martin, 2007, 2009a). An unfortunate reality is that many teachers are often ill-equipped to meet the needs of their Black students, and often unable to provide Black students with the curricular support that they are longing for.

Hillary, a junior at Sunset HS who was initially unsure about taking another year of math, but ultimately opted in, had similar experiences in her math classes. According to Hillary:

> I'm still indecisive about taking a math class…. But this year I hated [math]. Because when she would explain [topics], my teacher doesn't speak very good English, so I really [had to] rely on the pictures. But the way she [made them], the pictures were not clear. So, I would be afraid to ask her questions because I couldn't understand her in the first place. And it's like, sometimes I don't even ask her questions, because I'm the only Black person in there, and I hate it so much. I'm literally the only Black person in my math class. Well, it's been that way since eighth grade, but still. That's irritating, because I feel like the teacher looks at me different.

Not only is Hillary having to contend with being the only Black student in her math class (and many previous math classes), but she also *feels* like the only Black student when she shares that "the teacher looks at me different." She also feels afraid to ask questions in class which is a key part of the learning process.

Other students noted how being the only Black students motivated them to excel. For example, Richie, a junior at Sunset HS who opted to take a Beyond IM3 course, commented that the reason he chose to take math next year is because:

> I like competition. I basically like to have my own kind of pressure. In middle school, I was the only Black person in class, so I always felt there was competition. And then, people didn't like me because when I got [the questions] right, I would show off, like, "Let's get it." That's why I would do it, for competition. Other than that, if I felt like it was just for the grades, I wouldn't do it.

Richie details his experiences as the only Black student in his accelerated math classes. This made him want to disprove potential racialized narratives about Black students' math abilities by being the best in his class. Although it is unfortunate the Richie had to experience the math classroom as a racialized learning environment, Richie's competitive coping strategy seems to have provided the fuel for his successful navigation through the math pipeline, as he was already an accelerated math student who was enrolled in Pre-calculus, a Beyond IM3 course, at the time of the interview.

While for Richie being the only Black student inspired a competitive spirit, for Hillary it created seeds of doubt about taking additional math courses. Richie and Hillary's experiences speak to what scholars call stereotype threat (McGee, 2018; Steele, 2003) and imposter syndrome (Clance & Imes, 1978; Cokley et al., 2017). Richie and Hillary were forced to manage additional pressures as the "only Black person in class," pressures that are potentially associated with stereotype threat and imposter syndrome if they did not perform as well, or in this case better than, their peers.

For many of the students, especially those at Rose HS, racialized experiences were normalized at the school level. The experiences of my student participants echo the literature related to Black students experiencing classrooms in racialized and gendered ways (Jett, 2019; Joseph, et al., 2016; Martin, 2009b). For example, Tia shared her opinions about the overall experience of attending a school with predominantly white students. In Tia's view:

> There is a huge percentage of [Black students] that just feel like being at the school is just gross to them because there's so many Caucasian people which shouldn't matter, but at the same time it's like [a lot of Black students at Rose HS] just feel like they don't belong automatically because there's some Caucasian people who are chill but then there's the group of Caucasian kids who walk around with Trump flags tied around their necks...so it's kind of hard. Like those kids really walked around with Trump flags and said racial slurs they were just horrible. Some kids don't think about what they say, and they just say it out loud and it's mostly the Caucasian kids that do it all the time they'll say, like the N word…with the 'hard R' or they're trying to be cool and say it with the 'A' and stuff like that and they look at us and they start laughing and they like don't think anything of it.

Tia's recollection of an almost reenactment of the domestic terrorism of the January 6th United States Capitol attack being reverberated at the school level is terrifying. The fact that white students felt emboldened in Southern California to bring "Trump flags" and behave in racially hostile ways towards their Black peers connects directly to the sociohistorical elements of Martin's framework. Tia's statements speak to how the racialized nature of society trickles into schools. The sociohistorical events that led to a Trump presidency during the time of this study have important implications for how Black students experienced school in comparison to their white classmates.

Tamera echoed Tia's sentiments about attending a school with mostly white teachers and students. Tamera emphasized that:

> A lot of my classmates are, like, and all my teachers are mainly white, and I feel like there's not really a lot of People of Color. I would say I see maybe two People of Color in my entire [class] schedule.

When asked to elaborate about whether race was a factor at Rose HS, Tamera said:

> Kind of because, like, the whole school is basically just a lot of white people and there's not really a lot of People of Color and if there are, they kind of, like, group together. Sometimes it's kind of awkward being the only Black person in the class because I feel sometimes out of place.

Tamera reiterated that most of her teachers and peers were nice, but race still came up in seemingly subtle ways. Tamera shared her feelings about an incident that happened recently with one of her classmates:

> There was one time where a student made racial comments towards me. Someone turned the lights off in the classroom and they said, like "Oh, where did she go?" at the time I was like, "oh, that's kind of rude" but, like, as I thought about it, I realized it was a racial comment because at the time I was the only Black person in the room.

Tia and Tamera were forced to navigate racially hostile environments of which their white peers often have no understanding or were the perpetrators. Tamera's experience in which she is essentially called out by a white peer for being the only Black person in the class is an example of why there is a need for a critical mass of Black students in math coursework. As Boston & Warren (2017) state, "in order for Black students to feel the sense of belongingness, schools must cultivate a culture of acceptance of all racial groups and promote positive teacher-student relationships" (p. 30). As the findings of Boston & Warren (2017) indicate, a Black students' sense of belonging can be directly correlated to their academic achievement. Thus, successfully navigating the racially hostile environments of their schools is no small feat.

Tia and Tamera both ultimately decided to enroll in beyond IM3 coursework. Their resilience could be replicated and bolstered by increasing Black student enrollment in courses beyond IM3. Several students spoke about wanting more Black students in their classes to help with their sense of belonging at school. These findings echo the literature about the relationship between having a critical mass of Black students and Black students' academic achievement (Boston, 2017; Faircloth & Hamm, 2005; Jayakumar et al., 2018; Miller et al., 2005; Murphy & Zirkle, 2016; Smalls et al., 2007). These findings also relate to my statistically significant quant findings about higher Black student enrollment increasing the odds that a Black student would

enroll in coursework beyond IM3 in high school. For example, Tamera hypothesized about whether or not having more Black peers in her classes would make a difference. In Tamera's words:

> I feel like it would make me more comfortable if there were other people who looked like me in the classroom, especially if someone made racial comments, then maybe they could say something or stick up for me or something.

Tamera's feelings are reiterated by other students in this study, but Tamera's voice is particularly interesting as someone who felt racialized in her class and now longs for Black peers to help establish a sense of belonging in math class.

Vivian, a senior at Sunset HS, held similar thoughts about the need for more Black peers in her math classes. Vivian emphasized that, "Having more students that look like us [in math class] would help with just being comfortable with asking a question when you aren't understanding something. You'll have more people who are like you and who you just know they won't judge [you]." Vivian's comments circle back to Richie's earlier statements related to the fear of being wrong in front of peers. The concept of being Black while doing math stands out in Myra's comments about asking for help from non-Black peers in math class. According to Myra:

> I would say [having more Black students in my math class] would ultimately help because at the end of the day [working together] is how you learn and it's better to have more people of your color in the class because when I go ask another person [outside my race] for help, they act intimidated, hesitant to help me. They don't want to help me. So, I'm just like "I'm just not going to ask anybody [for help]."

Myra's feelings of isolation in the math classroom are disheartening. To be Black while doing math can be lonely for many students, especially when peers are not the same race and other peers have underlying biases about Black students. Myra's feelings of isolation are bolstered by the statements Hillary makes about STEM in general at Sunset HS. According to Hillary, a junior,

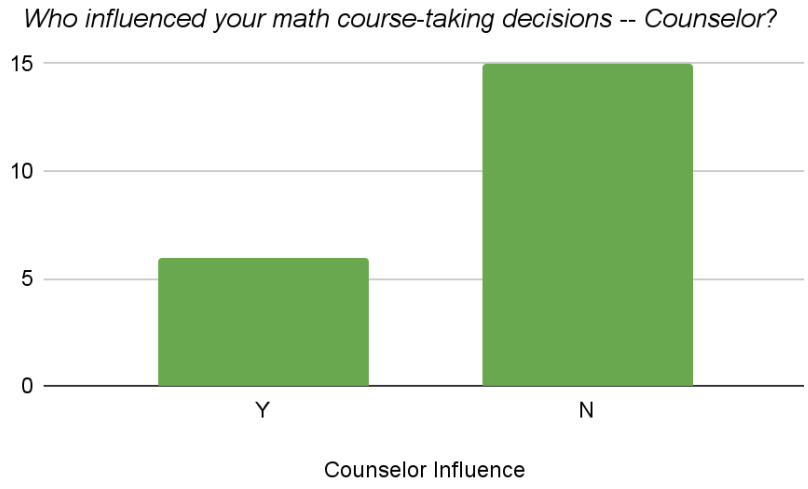
> I don't really like STEM like that. I like math but I don't like being in STEM because it's a lot of people that's not my color. So, I just don't mix. I mean, I'm not racist or anything. I want to feel comfortable, and when I'm in STEM I don't feel comfortable because they be looking at me weird.

The sentiments of these students echoed across schools seems to offer insight into the micro and macro aggressions (Jett, 2019; Sue et al., 2007; Solorzano et al., 2000) that Black students face at school in general while also highlighting the ways the math (and STEM) classroom continues to feel like a space not made for supporting Black students. Taken together, these findings showcase a delicate thread linking Black student dispositions towards math and their racialized experiences with math teachers and within math classrooms.

School Level -- Beyond IM3 Course Taking and Counselor and Teacher Influences

In addition to the negative influences from school climate and social contexts, students' decision-making was also informed to varying extents by the explicit roles of counselors and teachers at the school level. Very few students mentioned counselors as important in their math course decision making processes. In fact, only six students mentioned counselors at all in the pre-interview survey as shown in Figure 5.3.

Graph 5.3. Counselor Influence on Beyond IM3 Course Taking



Of the six students that mentioned counselors, only two of them enrolled in courses Beyond IM3. The other four students opted to not take a math course Beyond IM3. Two of the four that opted out of math chose the survey option that they were not taking Beyond IM3 math coursework because "the school counselor suggested [they] not take additional math coursework." For those students, counselors negatively influenced their decision to take additional math coursework.

Specifically, Tyreke, a senior, spoke about biases in counselors offering preferential treatment for certain students. As Tyreke puts it:

> There's a huge bias within counselors. They'll present you with more opportunities or give you more help or offer more help if they like you. But if they don't [like you], well you're kind of just stuck with a person who is only recommended and do things when mandatory, not necessarily because they want to.

The inequitable treatment Tyreke mentioned here was reiterated by students across both schools. Vivian, for example, a senior at Sunset HS who opted to take a course Beyond IM3, also felt there was inequitable treatment in the counseling department at her school. She shared her recollection of an incident with a counselor in which she was almost discouraged from taking advanced math courses. According to Vivian:

> Some counselors will just do anything, a shortcut, anything that's easy and convenient for them. I remember my first [counselor] my freshman year- I was trying to register for classes and both regular and advanced math classes were open, and he was like, "if you take regular classes and get As, you'll still get into [college]." I'm like "I do not want to take a regular math; I want advanced math."

Similarly, Diavian, a senior who opted to not take Beyond IM3 coursework, also talked about negative experiences with the counseling department at Sunset HS. According to Diavian:

> Personally, I don't think the counselors help. We'll ask, "Oh can we get moved to this class because we'll understand this teacher more, but we don't understand this teacher?" They'll say, "no because you can't pick the teacher you want, we pick the schedule for you." They're just not there for us when we need them to be there. They don't understand us or what we need or want.

Myra echoed Diavian and Vivian's sentiments in their focus group interview and added, "You have to have your parents come. If it's not your parents, they're not going to do anything. It's like we're just little kids but...they want us to act like adults. But they treat us like kids. It doesn't make sense." Myra's points speak to her wanting more agency in the choice-making process.

Reiterating and expounding upon Myra's comments, Vivian also spoke to the importance of having a parent to advocate for them to the counseling department at Sunset HS. In Vivian's words: "[the counselor] was arguing with me [about being placed in advanced math] so my mom had to come in and tell him to give me advanced classes." Geoffrey, a senior at Sunset also acknowledged that counselors "don't really help...unless you get your parents [involved]." Recent scholars emphasize the importance of school support, including counselors for the academic success of Black students in STEM (Jett & Davis, 2020). Geoffrey, Myra, Diavian, and Vivian all felt pushback from counselors as they were attempting to make their math course selections. While it is understandable for students to require parent permission to change classes, parent permission should not be used as an impediment to a student attempting to challenge and push themselves by enrolling in rigorous coursework. The notion that a counselor would potentially talk a student out of taking higher-level coursework feels in opposition to the general best-practices of school counseling that should emphasize the value of student voice and high expectations. This counselor opposition is yet another potential institutional mechanism that creates a barrier to Black students' math trajectories and Beyond IM3 course taking.

Fortunately, not all students felt they had negative experiences with counselors. Particularly, Hillary, a junior at Sunset HS mentioned having positive experiences with a counselor in previous years of high school. According to Hillary,

> I only like one counselor, and that's because he's been with me since ninth grade, and he always be calling me in his office, trying to get me into STEM and stuff. And sometimes I think I'm a little slow sometimes, but he encourages me.

Hillary's statement shows that while it might not be everyone, there are counselors who make attempts to build special relationships with students and try to encourage them to push themselves and pursue opportunities outside of their comfort zone. However, in contrast, Hillary further explained her disconnect with her current counselor. In Hillary's words, "my counselor now, she only checks up on me when there's, like, a field trip or something. But she doesn't check up on me like how [my old counselor] did, because [my old counselor] always called me in [to his office] and pushed me [academically]." Another junior, Roger from Rose HS, mentioned the positive role of counselors in his course taking decisions. According to Roger:

> Every year when we pick our classes, we talk to our counselors, and I visited my high school counselor more times after that. I'd say [my counselors] definitely advised me well and told me, "Well, you struggled here, so you'll probably struggle here. But you excelled over here, so you would excel in this class." I'd say they probably had a really good influence on me deciding where I went. And they encouraged me to also ask my math teachers if they thought I should go into the next [level of] math….so yeah, my counselors definitely helped [with my course decisions].

Roger's counselor seemed to have Roger's best interests at heart and encouraged Roger to reach out to his teachers for input into Roger's math course taking decisions. By providing Roger with guidance on how to make the best decision by pushing him to talk to his teachers, the counselor gave Roger the tools necessary to make an informed decision. Another student, Jordan, a junior at Sunset HS, felt similarly about his counselor being a support system. As Jordan puts it:

> I don't know about everybody else's counselor, but my counselor, he's the man. He helps me to think about after high school and stuff, and college and stuff, right? And he talks to me like, "I know you've got sports and stuff to worry about, so don't take it so hard, with all these AP classes and college classes and honors classes." So, he helped me out picking out my math class, because this year he said, "Don't take math, and wait till next year, your senior year, because then

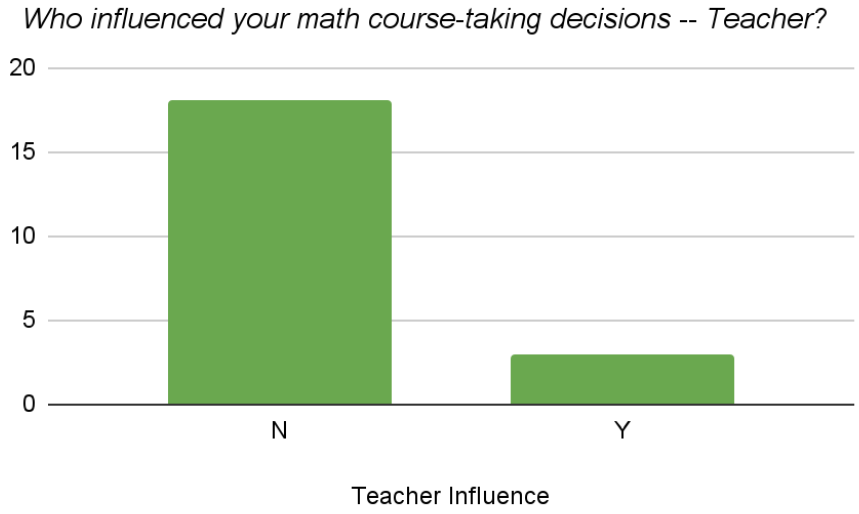
> you'll go to college with a fresh memory of math." So next year I'm going to take my math class, my Pre-Cal class, and be fresh with math in my mind for college.

Jordan's counselor seemingly went above and beyond to make sure that Jordan was on track with his math courses. However, it is interesting to note that even though Jordan had a positive experience and felt supported by the counselor, the counselor actually *discouraged* Jordan from taking more years of math in high school, making him less competitive for a UC school. Even if Jordan was on track to be in a course Beyond IM3 by his senior year, he could have taken additional math courses and gotten to an AP math course instead of stopping at Pre-calculus, the bare minimum Beyond IM3 course. Interestingly, both Roger and Jordan were juniors who had been accelerated in eighth grade math. Jordan was eligible to enroll in Pre-calculus in his junior year but was planning to take it in his senior year, while Roger was currently enrolled in Pre-calculus (as a junior) at the time of the interview. This could speak to the preferential treatment that previous students mentioned in the counselor departments at their respective schools. Jordan's experience goes back to scholarship regarding implicit biases and the racist belief systems held by many educators about the mathematical abilities of Black students, which then leads to lowered expectations for Black students' math trajectories (Martin, 2007, 2009a, 2009b).

Teachers

According to the pre-interview survey, very few students mentioned teachers as being the person that influenced their math course taking decisions. Specifically, as Figure 5.4 notes, only three students indicated that a teacher influenced their decision. Of those three, all of them mentioned that a teacher was one of the people that encouraged them to take more math classes, particularly ones Beyond IM3. However, none of the three listed their teacher as the most influential in their decision to take a math course Beyond IM3.

Graph 5.4. Teacher Influence on Beyond IM3 Course Taking



Experiences with Math Teachers. Several students mentioned having prior experiences with math teachers that seemingly impacted their disposition towards math and ultimately their decision to take a math course Beyond IM3 Vivian, a senior at Sunset High who chose to take a Beyond IM3 course remarked:

> Last year, I already knew in my head that I wanted to do Honors Pre-Cal because I knew it was going to be the same teacher [as junior year] so I was like I might as well take this class, I know the way she teaches. But this is her first-year teaching Honors Pre-Cal, so I think she's trying to get used to things. And she's rushing through it, …she just needs to work on her teaching skills for this class.

Vivian took a previous math class with her PreCal teacher. She enjoyed the way the teacher taught the material in the first class but did not enjoy the PreCal class with the same teacher. Similarly**,** another senior at Sunset HS, Ashley, made decisions based on her experiences with a specific teacher. In Ashley's words:

> I am not in math this year. I've always had a love/hate relationship with math. Middle school, I actually liked it. In ninth grade, I took advanced Math 1, and it was good because of the teacher. That's when I started to like math more. Then once I got to tenth grade it just went all back down. My last year, which was last year, was the same teacher from my freshman year so I felt good throughout the year because he helped us. He made sure we knew what we were doing. And he understood how students work in math class. He knows it's going to be hard; he knows we're going to struggle so he's there for us.

Both Ashley and Vivian's comments demonstrate the impact of one or more negative experiences with math teaching. Math is one of those subjects that students often feel intimidated by and having a few unhelpful teachers or negative experiences with math may impact students' feelings about math indefinitely (Friedman, 2018; Nath, 2021) as well as their math achievement overall (Hill et al., 2005). Ashley seemingly had one tough year in HS, and she ultimately said that math was not her thing. Vivian, on the other hand, had mostly positive experiences with math and she ultimately decided to continue her trajectory through the math pathway.

The Impact of Black Teachers. One of my quantitative sub-questions related to whether or not Black teachers made a difference in the math course taking decisions of Black students. In my interview protocol I asked students if having a Black teacher or Black math teacher would have made a difference in their overall experience at their school. Most of the student participants had *never* encountered a Black teacher, let alone a Black math teacher. Only a handful of the students had *ever* had a Black teacher. Only two of my 21 student participants had had a Black math teacher, and it was the same person, the one and only Black math teacher at Rose HS.

Several students at both Sunset and Rose HS emphasized how differently they think their schooling experience might have been if they had a Black math teacher. According to Tia, a junior at Rose HS, having a Black math teacher:

> would be helpful because we'd be the same skin color and I feel like us being the same skin color would help her or not would help her but would help me and my math experience because maybe she would help me a little bit no more because she knows like basically, at that school you kind of have to like stick together in a way, because there aren't many of us there.

Tia's feelings echoed what many of the students shared across schools about the need for more Black teachers and an influx of Black students in math classrooms. Tamera, another junior at

Rose HS, had similar sentiments when asked about having more Black teachers at her school. In Tamera's words, "Maybe I could relate to them more, maybe I would do better in the class, if I had someone who looks like me." Lisa, a senior at Sunset HS, shared her feelings about the possibility of having a Black math teacher. Lisa emphasized:

> I feel like [a Black math teacher] would connect to us more personally. Not that to learn you have to be personal with the teacher, but that background connection...it's a different feeling than when you're with someone outside of your race. It's just different.

Vivian, another senior at Sunset HS, echoed Lisa's feelings and recalled her experience with their Black Economics teacher. According to Vivian:

> The learning environment is kind of different with a teacher that's the same race as you. Our Econ class, I don't' know. There's just something different about it. I pay attention, and he's able to connect with us. He makes those jokes that we will get...while still helping us to learn the material. He'll apply [the content] to something real life that's [relevant to] Black people and then you'll laugh but you're still learning too.

Vivian's comments speak to the importance of building rapport and the ability of Black instructors to relate to their students on a deeper cultural level, bridging cultural relevance with content knowledge and expertise for deeper learning.

Myra, a senior at Sunset HS, also felt that having a Black math teacher would have been important in her academic career. For Myra, with a Black math teacher, "you're more inclined to build a relationship, and when you have that relationship, you're not scared to ask things." Again, Myra's comments emphasize the importance of teacher racial match for Black students and the potential for making rich connections between teacher and student that could help Black students feel more comfortable asking questions and engaging positively with math concepts. Laura, a senior at Rose HS who opted to not take any math courses Beyond IM3 was quite vocal about needing more Black teachers at Rose HS. In Laura's words:

> I mean I feel like there should just be more Black teachers, just because I feel like if there was a Black teacher in English, one in Chemistry, one in Algebra, just one in each subject, then Black kids could go to the class and be like "Okay, I get to feel relaxed in this class." Because [as a Black student] you're gonna be more relaxed with Black teacher than a white teacher. There just needs to be more Black people, I'm just tired of being one of the only one [of us].

Laura was really outspoken about the need for more Black teachers across the board. Her feelings were amplified by her peers. Tyreke, a senior, had similar sentiments about diversifying the teacher pool at Rose HS. According to Tyreke:

> I feel like diversity within all of our classes and all subjects would actually just improve things, not necessarily just math itself because, honestly, I can only think of one Black teacher at Rose HS and its predominantly white teachers [at Rose]. So, I think overall, teaching would benefit if we had a little bit more diversity.

Tyreke calls for the diversification of the teaching pool which echoes the suggestions of teacher education experts and policy makers (Meckler & Rabinowitz, 2019; Miller, 2018).

Individual Level -- Beyond IM3 Course Taking and Students' Relationships with Math

At the individual level, the student participants shared diverse narratives about their experiences in the math classroom. Students' relationships with math seemed to have varying impact on their decision to enroll in Beyond IM3 coursework. Students were also asked to provide suggestions based on their lived experiences about what was working and what was not in their math classrooms, including a discussion about the characteristics of a "good" math teacher. These questions were important to the findings of this dissertation as the students' responses support the literature advocating for culturally responsive and culturally relevant teaching (Gay, 2000; Ladson-Billings, 1995).

Beyond IM3 Course Taking and Student Dispositions Towards Math

Several students spoke about their positive or negative dispositions towards math. When asked to explain his relationship with math Will, a junior at Sunset HS who opted to not take additional math courses Beyond IM3 mentioned, "I'm just not good at math, I'm weak at it. So, I

already don't like the subject, and when I'm learning a new subject, it's hard to open up and really put in the time for it, especially if I don't like it already as it is." Ashley, a senior at Sunset HS, also opted out of taking Beyond IM3 coursework in her senior year of high school. Ashley remarked, "I'm honestly not a math person at all, so I feel like I wanted to give myself that personal break my senior year, just to relax and not stress over math as much as I used to, so that's why I decided not to take math [this year]." Similarly, Diavian, another senior at Sunset HS who decided not to take Beyond IM3 coursework in her senior year cited a negative disposition towards math as her major reason for not taking math in her senior year. Diavian emphasized, "I am not taking math this year because I didn't want to take math. Math has always been one of my weakest subjects, so I wanted to have my senior year as stress less as possible." Both Ashley and Diavian stated that taking math was a source of stress and for them not taking the course meant for a stress-free senior year.

In general, the students who opted out of taking a Beyond IM3 course noted not wanting to feel stressed, or negatively impacted, in their senior year of high school. They often thought of taking math as arduous and felt that they needed a break from the trauma of the math classroom. For students who opted into a Beyond IM3 math course, their feelings were generally positive about math. These findings illuminate the importance of student dispositions towards math for their math course taking decisions and how it is influenced at the individual level of analysis.

Beyond IM3 Course Taking: Solutions from the Voices of Students

The student experiences shared in this section were intended to create space for interrogating the ways math is taught and how teachers engage with students in (virtual) math classrooms. As secondary math learners, the experiential knowledge of the participants shared in this section adds a necessary component to the discussion about math teacher pedagogy and the

traits that may help inspire students to engage positively with math (Malloy, 2009; Martin, 2007). This information could have useful implications for math teacher training and professional development.

The Characteristics of a Good Math Teacher

A question on my interview protocol was "What makes a good math teacher?" The students' thoughts were varied but in general their responses shared similar sentiments about the qualities of a good math teacher. Taken together, the students' shared definition of a "good math teacher" would be a teacher who shows 1) patience, care, and flexibility and 2) enjoys teaching and has strong math content knowledge.

Patience, Care, and Flexibility. Several students cited patience and care as characteristics of a good math teacher. Richie and Nicky, both juniors at Sunset HS, agreed that patience was the most important characteristic for their ideal math teacher. Other students agreed. Specifically, Tamera, a junior from Rose HS, emphasized that a good math teacher:

> Goes over problems that students miss and like being very thorough by explaining very well like if someone has a problem with a question like explaining the whole steps, and not just saying Okay, what do you not get and then moving to a new problem start with the problem they got wrong tell them like how they got it wrong and what they can do for the next ones, and like like I said, like going over tests and homework and like kind of doing like a one on one like help them get a better grade in the class.

Eddie, a senior at Rose HS, echoed Tamera's comments in his interview. In Eddie's words, a good math teacher is:

> Probably to someone who goes, step by step, and explains well and in good detail. Because sometimes my teachers speed up what we're doing because we had to take longer on the last unit. They don't take enough time for lessons so people can understand [the content] very well.

Clearly time and pacing were important for Eddie. Eddie's comments reflect my earlier findings regarding the structural components of curriculum that act as barriers for Black students who

might want to engage positively with math. For Eddie, he emphasizes the need for more time. Often teachers' time is constrained by curriculum pacing guides from the district, county or even the state, with timing being constrained by accountability testing timelines. These time constraints clearly have implications for how students receive and retain the curriculum (Hand, 2012). For Ray, a junior at Rose HS, a good math teacher:

> Help[s] you for sure, they answer your questions, and go over questions on the board step by step and not just help you but help everyone at once and not single someone out, so [students] might not be afraid to raise their hand.

Ray emphasizes the importance of a teacher having and showing patience and care with students. Other students felt similarly about the impact of teachers being patient and willing to help even the most confused students. Specifically, Tia, a junior from Rose HS, shared that a good math teacher is:

> Someone who is willing to help even the students who are extremely confused and don't know what they're doing and who explains things over and over to make sure that the majority of the class [understands the concept] and if the other small percent doesn't [understand, then] they still stop and help them anyways. I think a good math teacher is also someone who doesn't discourage students and doesn't put them down for not remembering a certain topic.

Ray and Tia's comments about patience and willingness to help students are components of culturally relevant and responsive pedagogy and echo Martin's conception of what makes a "good" math teacher for Black students (Matthews, 2009; Hubert, 2014; Brown et al., 2019; Martin, 2007).

Tia's comment goes a step further in that she details the power that teachers wield in regards to Black students' dispositions towards math. Tia mentions how negative interactions with the teacher including discouragement and ridicule for not remembering a topic might negatively impact students' dispositions towards math. Tia's ideas reiterate the importance of teacher dispositions towards Black students and the instructional strategies used with them

(Malloy, 2009; Berry & McClain, 2009). Malloy (2009) characterizes good teachers for Black students as "facilitators of student understanding" and emphasizes building communities of learners who encourage each other and challenge themselves and their peers within a climate of mutual respect between teachers and students (pp.103-104).

In addition, several students centered care as one of the most important traits of a good math teacher. Steve, a senior at Rose HS emphasizes care in his statements about what makes a good math teacher. In Steve's words:

> I think you have to really show that you care about your students and that you'd really be willing to go out on a limb to respond to emails and to offer a lot of tutoring. Just overall just show that you care. And then when students have questions and stuff it feels like it's okay to ask a question. I feel like that shows what a good teacher is, making me feel like it was okay to ask questions or making it feel like it's okay to go to tutoring because he just wanted to see us succeed.

Steve's comments place care as something that helps foster a better math learning environment where students feel comfortable asking questions. Steve's comments also speak to the need for students to feel comfortable before asking for help from the teacher. Thus, care and having an open demeanor are crucial dispositions for teachers of Black students. Berry and McClain (2009) emphasize that teachers who hold high expectations of their students yet have a warm disposition, can have significant impacts on student motivation and achievement. Allowing room for student questions and answering student questions without judgment is one way to show warmth that Steve is referencing in his comments.

Myra, a senior at Sunset HS, underscores other students' feelings about patience and care being imperative for a teacher to be considered a "good" math teacher. According to Myra, a good math teacher has "patience [and] shows they care. They want you to understand so they ask you if you understand or need any help." Myra's comments not only speak to patience and care,

but she also adds that teachers should check for student understanding and clarify misconceptions. Rachel, a junior at Sunset HS also emphasizes the need for more math teachers to have patience as she recalled a recent experience in math class. Students are going to get stuff wrong, [math teachers] can't just yell at them like, 'They're not listening,' They *are* listening, you're just not telling it to them right." Rachel's statement echoes the statements of several students across schools that math teachers should be patient and willing to show they authentically care for their students. Rachel is also stating that yelling and negative reinforcement is counterproductive to student achievement.

Other students mentioned flexibility as a key factor in what makes a teacher a good math teacher. In his interview, Carlton, a senior at Rose HS, shared that a good math teacher "got to be able to be flexible, with their teaching, and just be understanding when someone's not getting it." Roger, a junior at Rose HS, felt similarly about teacher flexibility. Roger commented that good math teachers are those teachers who:

> add a schedule of what they want you to do. But they don't strictly adhere down to the minute to that. I felt like those teachers were also a lot nicer and a lot more flexible. I understood a lot more from them. The more strict teachers, I feel like they cut our time short. They didn't allow us to fully understand ideas. The more flexible [teachers] were, the easier it was for the students to understand the answer or the question.

Roger's statement references teachers having transparent expectations of students. Roger's points link to the literature about teaching best practices include providing learning outcomes and assignment expectations ahead of time (Adams & Love, 2009; Marzano, 2009). Roger also talks about teachers being flexible and willing to shift class time if necessary and allowing the class to spend more time digging deeper into a concept if students are not fully understanding it. Across students' suggestions, patience, care, and flexibility were important for effective math

teachers. These evidence-based characteristics are crucial to Black students' success in math classrooms (Berry & McClain, 2009; Malloy, 2009).

Enjoys Teaching and Has Strong Math Content Knowledge. Students also emphasized the importance of having math teachers who love their job and have strong content knowledge. Roger, a junior from Rose HS, emphasized the need for math teachers who *want* to teach stating that a good math teacher:

> Would be someone who would come to class and want to teach. I see some teachers who I get the feeling they don't want to teach and that they're doing this for some other reason.

Roger's comments reiterate the need for teachers with pedagogical styles and dispositions that are conducive for Black students' sense of belonging and math achievement. Roger's comments also point to sociohistorical elements in which teachers implicit and explicit biases might be displayed to students in their teaching demeanor. For Roger to perceive his teachers as not wanting to teach suggests an element of the teacher's demeanor playing a role in his perception of the teacher's negative delivery.

Tyreke, a senior at Rose HS, shared Rogers' opinions and added that Rose HS was in need of math teachers who have strong math content knowledge. According to Tyreke:

> Not to be rude, but we need teachers that are possibly a lot more educated within their field of education. I feel there are a lot of teachers who didn't really start teaching because they wanted to teach if that's understandable so, especially when you have a subject as complicated and unfriendly as math, when you have a teacher just as unfriendly and without strong skills in math that's when [math] just becomes an unpopular subject.

Tyreke's impression of his teachers not wanting to teach, being unfriendly, and lacking strong content knowledge is unfortunate and speaks to the impact of teacher dispositions on Black student math achievement (Berry & McClain, 2009; Malloy, 2009). Ashley, a senior at Sunset HS, echoed Tyreke's sentiments by highlighting that for her, a good math teacher "knows what

they are doing and talking about and doesn't mess up or make mistakes in the middle of teaching, because that confuses us." Similarly, Nicky, a junior at Sunset HS shared that a good math teacher, "should be able to give you more than one example how to do a problem." In addition to showing that teachers enjoy teaching math, clearly having strong content knowledge was imperative for many of the students.

Other students felt that teachers needed to be creative with their instruction and content delivery. Will and Jordan, both juniors at Sunset HS agreed that a good math teacher is both creative and resourceful. In Jordan's words, "Math is already boring, so [math teachers] should be creative." Will echoed Jordan's sentiments and added that math teachers should do more projects. According to Will:

> I like projects. Because they bring out your creative side. My teacher now…there are no projects. I haven't had one project this year. I was really looking forward to it, because I can work with people and stuff, and I feel like it brings out my creative side. But it all takes patience because not everybody's going to be able to understand [the project], and teachers get frustrated, and they give up [when students do not understand].

To be a creative and resourceful math teacher requires strong content knowledge and a passion for teaching. It also requires a teacher to think outside of the box and step outside of their comfort zones, while being okay with not being the expert in the room. These are all traits that the students in this study felt were important for helpful math teachers. These traits are also important elements of culturally responsive pedagogy and culturally relevant teaching (Gay, 2000; Ladson-Billings, 1995).

Students' Insights Concerning Covid-19 and the Virtual Math Classroom

Collecting data at Rose HS during the Covid-19 pandemic presented a unique opportunity to ask questions about students' experiences with math amidst the Covid-19 pandemic, 2019-2020 school shutdowns, and 2020-2021 school virtual reopenings. This data is relevant to share

because of the unprecedented learning loss that has been emphasized recently as a result of the ongoing Covid-19 pandemic (Turner et al., 2020).

When asked about their biggest challenge with the shift to virtual the students had various answers. Tia, a junior at Rose HS said her biggest challenge with the switch from in-person class to virtual was "learning in general, because when we were in person [the teacher] would come over and would like just really explain it and being in person you'd like it seems to sink in more than over a computer so just learning in general is hard." Tia, who was taking a math class via zoom at the time of our interview, spoke about the negative impact of the virtual math classroom and the disconnect she was having with her math teacher:

> We get into the class she asked us what we learned the previous day we would try to remember it because she would be going so fast…She would yell at us for not remembering it and then would compare us to students in her other country, where she came from…then she would just end the zoom call. She would draw examples and stuff and she would draw them in like a minute and then say copy it down but we're only a few sentences in and she erases it all and says like 'Oh well, you should have copied it down' and we're trying to, but she keeps adding more so we're trying to add that, and then she just erases it all.

Tia and her mother, Mrs. Landry, were infuriated by the math instruction at Rose during the Covid-19 shutdown. The shift to virtual was a difficult transition that no one was equipped to handle properly, including many teachers. Specifically, the teacher's actions further emphasize the importance of teacher dispositions and content knowledge on student math dispositions. By yelling at her students and ineffectively guiding their math development, the teacher created an environment which could further disenfranchise students, especially at a time when students were already experiencing an unprecedented shift to virtual math instruction.

Tamera, another junior at Rose HS also shared her difficult experiences in the virtual math classroom, particularly due to the block scheduling system at Rose High. In Tamera's view, math in the virtual classroom is:

> a lot different from going in person. I think the teachers are still kind of struggling with what to do, like with what they're teaching because it's a lot harder. And it's kind of embarrassing for people to ask questions, sometimes because they're on zoom and stuff. And there are internet problems, and the teachers are going too fast. For our school they split up the classes, so we had 18 weeks, instead of the whole school year to learn math, so I think they're going too fast, and that was kind of hard.

Tamera talks about the impact of switching to virtual teaching midyear. Tamera's comments also speak to the hurdles many students faced with technology and internet bandwidth when everyone was working and schooling from home (Williams et al., 2021). Roger, a junior at Rose HS, also mentioned difficulties with virtual math instruction. According to Roger:

> I would say [school] changed a lot when we went virtual. It's affected how I take in information. Before, in person, I could see whatever the teacher was showing on the board, and I could read it and I could have it right next to me. But now it's either I'm watching them do it or I'm looking up stuff online trying to find out more about [the topic]. So, it's a lot harder for me to learn new topics now.

Similar to many students during the shift to virtual schooling, Roger speaks about school being more difficult for his ability to learn new material (Williams et al., 2021). Roger also touches on how he used alternate resources to supplement the content.

When asked what should be done differently in virtual schooling, the students had a wide range of answers for their teachers. Tia spoke about the need for teachers to provide a range of learning experiences and opportunities to practice. According to Tia, teachers in the virtual teaching space should:

> Post links to different sites that we could visit to practice the math or like what you're doing at the moment. They should also record the class session and then on either Google classroom or canvas whatever they decide they should post it there, so we can click it and watch how she or he does it over again, so we can try to understand it on our own.

As mentioned earlier, Tia's comments speak to the need for an overhaul in math teaching pedagogy, where teachers are better versed in math content knowledge while also finding new, fun, and exciting ways to teach the content. Tamera, a junior at Rose HS, spoke about changing

from a block schedule to a traditional schedule as one way to improve the way they learn math at Rose High. In Tamera's words:

> I would probably change the way they did the class schedule. I think if we had the whole full schedule with our six classes every day. I think they would be able to slow [their pacing] down…instead of teaching [a topic] in a week, maybe [we could have] like two weeks or a week and a half or something to learn the topic.

Tamera's comments add to a larger discussion about pacing in math classrooms, especially when planning virtual coursework. Pacing speaks to the structural elements of the math curriculum, as mentioned earlier, because often teachers' time is constrained by curriculum pacing guides from the district, county or even the state. These time constraints have clear implications for how students receive and retain the curriculum (Hand, 2012).

While many students held disdain for the virtual math classroom, other students shared some of the benefits to virtual schooling that could transfer over into the future of education. When asked about something he liked about virtual schooling Carlton, a senior at Rose HS, spoke about enjoying the flexibility and that he enjoyed learning on his own, at his own pace. Carlton points out that:

> [virtual schooling] actually wasn't that bad. I actually found myself having a better school life at home, like being homeschooled was better than regular school. Yeah, we had teachers lecturing and classes on Zoom and I would take notes and stuff, but I found myself, teaching myself this stuff online and it was way easier than sitting in a classroom. It honestly wasn't that bad.

Carlton appreciated being able to teach himself and work at his own pace, something not typically offered in a general school setting. Steve, a senior at Rose HS bridges some of what Carlton and Tamera shared in their interviews. In Steve's words, "[virtual school] was a lot easier. For one like I feel like it was easier in the sense that you had your own kind of hours…so it was a lot easier than if it was six classes. [My schedule] was more flexible." Roger, a junior at Rose HS, shared similar thoughts when asked about the shift from in-person to virtual schooling.

Roger comments on the need for teachers “to be more unique” in their teaching styles when teaching virtually. According to Roger:

> I feel math is a lot easier to understand online than it is in person, because the teachers have to be more unique with their approach. They can't just show you a piece of paper and expect you to read it. They have to be even more straightforward.

Roger’s opinions seem to speak to the need for teacher creativity in content delivery and implementation, especially via Zoom.

Overall, the students’ experiences with virtual math instruction were varied, with some components that worked and other components that left students wanting for more. Given data about “math learning loss” during the pandemic (Bailey et al., 2021), it is clear that students throughout the country struggled with the virtual math classroom. Even though many teachers were doing the best they could during an unprecedented global pandemic, the student experiences shared in this section were intended to create space for interrogating the ways we teach math and how we engage with students in (virtual) math classrooms.

Discussion

The qualitative findings suggest a multitude of factors that influence Black students’ dispositions towards math and their Beyond IM3 course taking patterns. As informed by Martin’s FAMSI framework, the qualitative data were analyzed to consider how individual, institutional, and structural factors influenced Black students’ math dispositions and Beyond IM3 course taking patterns. The students’ stories are nuanced yet important for showcasing the multifaceted nature of choice in Beyond IM3 course taking for Black secondary students. The findings demonstrate that student course taking decisions is complicated in nature. However, there were major influencers at the school and community levels that could hold implications for Black students Beyond IM3 course enrollment.

Beyond IM3 Course Taking at the Intersections of Race and Gender

The findings showcase the racialized and gendered experiences that Black students must contend with at school. As echoed in the literature (McGee & Pearman, 2015; Nasir & Shah, 2011; Wood et al., 2018), many of the students in this study discussed the racialized experiences they encountered while navigating math courses as well as what it felt like to be Black while engaging with math in their classrooms. Richie, the junior at Sunset HS who attributed his success in math to his fondness for "competition," and Hillary, the junior at Sunset HS who felt afraid to ask questions in math class, had to manage additional pressures as the "only Black person in class," pressures that are potentially associated with stereotype threat (McGee, 2018; Steele, 2003) and imposter syndrome (Clance & Imes, 1978; Cokley et al., 2017) if they did not perform as well, or in this case better than, their peers.

Taken a step further, several students commented on how their non-Black peers often made the school setting a racialized space. Specifically, several students at Rose HS talked about racialized situations that arose prior to and during Trump's presidency and situations in which non-Black students felt empowered to use the N-word publicly and without fear of retribution. Black students across the country are facing an increase in racialized incidents at schools, particularly during Trump's time as president of the United States (Kohli et al., 2017; Miller et al., 2016; Pollock et al., 2022). Such racialized experiences are creating environments that feel even more hostile and unsafe than the already anti-Black STEM classroom. These student experiences speak to the centrality of race and racism and the ways that classroom and school dynamics mimic social dynamics at play in broader society. Trends that created growing spaces for populism and white supremacy as a result of the election of former President Trump normalized anti-Black sentiment that schools were not protected from.

In addition to peers creating spaces that felt exclusionary and racially hostile for Black students, several students mentioned teachers as a source of racial hostility. Tia, a junior at Rose HS, and Will, a junior at Sunset HS both mentioned being blatantly ignored or brushed off while attempting to ask questions during or after math class. Ultimately, both students felt their teachers favored the non-Black students in the classroom, attending to the needs of the non-Black students over the needs of the Black students. For Will, a junior who held a negative disposition towards math, these sentiments reify Martin's emphasis on school level contexts and the power of student-teacher interactions. These students' experiences also echo the literature regarding the impact of racialized narratives (Nasir & Shah, 2011) and the hierarchy of mathematical ability (Martin, 2009b) on Black students' math classroom experiences. What might Will's journey have looked like had he been exposed to a teacher who answered his questions with enthusiasm and fostered his innate curiosity about the world? Instead, Will was made to feel he was being treated unfairly in relation to his non-Black peers. Several students alluded to this narrative when describing how they felt insecure and vulnerable when the makeup of their upper-level math courses were primarily white and Asian students.

In addition to findings related to race, several of the Black girls in this study felt unsupported or ignored in math classrooms. Tia and Tamera, both juniors at Rose HS, and Hillary, a junior at Sunset HS, all expressed feelings of invisibility and differential treatment in their math classrooms. Their experiences connect to the literature detailing how STEM spaces are often hostile and uninviting for Black girls, leaving them overlooked and undervalued in STEM classrooms (Chavous & Cogburn, 2007; Neal-Jackson, 2018; Joseph et al., 2016; Ricks, 2014). Because of their intersectional identities as Black students and young women, Black girls tend to be underrepresented in upper-level STEM coursework (Saw et al., 2018). Black girls

must also contend with the anti-Black nature of STEM (Joseph et al., 2016, 2019; Joseph & Cobb, 2019). For example, Black girls are often excluded from and not recommended for gifted classes (Ford, 2014; Collins et al., 2020) and upper-level math coursework (Farinde & Lewis, 2012; Joseph & Cobb, 2019), rendering them invisible in advanced STEM coursework (Chavous & Cogburn, 2007; Collins et al., 2020; Ireland et al., 2018; Kelly, 2009; Neal-Jackson, 2018; Joseph et al., 2019; Ricks, 2014).

The sentiments of the student participants echoed across schools offer insight into the micro and macro aggressions (Solorzano et al., 2000) that Black students face at school in general while also highlighting the ways the math (and STEM) classrooms continue to feel like a space not made for supporting Black students. A sociohistorical lens allows for understanding the connection across these experiences and the contexts that inform them, as centuries of exclusion from educational institutions across the U.S. persist in how Black students today are made to feel inadequate, unsupported, and ignored by non-Black teachers and peers (Griffin & Allen, 2006). These students' statements also emphasize the importance of sense of belonging scholarship that details the impact of having a critical mass of same-race peers in a school (Boston, 2017; Faircloth & Hamm, 2005; Garces & Jayakumar, 2014; Jayakumar, 2015). Taken together, the findings presented in this section showcase a delicate thread linking Black student dispositions towards math to their racialized experiences with peers and teachers within math classrooms.

Beyond IM3 Course Taking and Parents

The pivotal role of a Black student's "village" of parents, grandparents, and other sources of community support cannot be stressed enough, as indicated by the findings. The students' insights echo the literature about Black parents' influence on Black student math trajectories

(Berry, 2005; Carter Andrews, 2020; Stinson, 2009; Strayhorn, 2010; Walker, 2006). Students across both Rose and Sunset mentioned parents as highly influential in their math course taking decisions. Similar to the literature about Black parents, the students reiterated the importance of their parents' high expectations for their futures as reasons for continuing in their trajectories towards Beyond IM3 coursework. In addition, students mentioned having parents or guardians who had gone to college as important to the fact that they would also go to college, using their parents as examples for what their own math trajectories might look like. Being a second or third generation college student has major implications for the academic trajectories of Black students. The intersections of race and class can be notably seen in the relationship between parents with postsecondary education and students' understandings of what it takes to get into college. For most of my participants, college was not an option but an assumed next step along the students' academic journeys informing their course taking decisions in high school. Having parents with the experiential and institutional knowledge to guide their students as they plan for college is crucial for Black students' dispositions towards college preparatory coursework like courses Beyond IM3 (Chapman et al., 2018).

Overall, the students in this study were highly influenced by their parents' wishes and advice. For students who already exhibited positive dispositions towards math, they had no issue with enrolling in Beyond IM3 coursework. For students like Nicky and Hillary, both juniors at Sunset HS, their negative dispositions towards math ultimately discouraged them from further math coursework, allowing them to disregard their parents' intentions regarding math coursework. However, both Nicky and Hillary both intended to pursue higher education after high school. They merely did not wish to continue coursework Beyond IM3. For Nicky and

Hillary, the school level experiences outweighed the influence of parents in their decisions to take or not take Beyond IM3 coursework in high school.

Beyond IM3 Course Taking, Curriculum, and Teacher Pedagogy

The experiences of students like Nicky and Hillary, who held negative dispositions about math and decided to opt out of Beyond IM3 coursework, have implications for the need for math course sequences that fit students' postsecondary plans. Recent scholarship calls for a redesign of the secondary math pipeline to be more individualized and better aligned with students' career pathways (Daro & Asturias, 2019). Redesigning the math pathway includes expanding and diversifying the options for what counts as Beyond IM3 coursework. A redesign of the math curriculum has promise for encouraging more students to listen to the advice of their family members to continue their math pathways through courses Beyond IM3 ideally through more engaging math learning experiences.

Many students spoke about their concerns with the relevance of the current math curriculum. Will, Jordan, and Hillary, juniors at Sunset HS, discussed the importance of a more relevant math curriculum. For Will and Hillary, the irrelevance of the math curriculum influenced their decision to not enroll in Beyond IM3 coursework. These points are structural in nature as they demonstrate which courses are valued based on high school graduation requirements and college admissions policies. Relevance in math curriculum becomes unimportant when it is structurally necessary for students to enroll in courses to move forward in their math trajectories. For Jordan, a student who was accelerated in middle school math, he had been exposed to high school math in eighth grade and saw himself as capable in math classroom spaces. In addition, Jordan's reference to math being like "counting money" illuminated that even though he felt highly capable in math, he still longed for math content to relate to his

everyday life. The sentiments of Will, Hillary, and Jordan, emphasize the need for teachers to adopt culturally relevant pedagogies (Brown et al., 2019; Hubert, 2014; Tate, 1995) and instructional strategies that meet the needs of diverse learners. Previous scholarship illuminates the benefits of teacher pedagogy that centers culturally responsive, culturally relevant, and culturally sustaining ways of teaching to foster STEM interests, identities, and engagement (Aguirre & del Rosario Zavala, 2013; Leonard, et al., 2010; Paris, 2012; Tate, 1995).

Covid-19 was also a major factor in the student participants' math experiences at Rose HS, as well as across the country. The Covid-19 pandemic has affected schools in so many ways, but because math builds on prior knowledge, students are experiencing unprecedented gaps in their mathematical content knowledge (Sawchuck & Sparks, 2020). The learning loss associated with the Covid-19 pandemic has major implications for Black students' math trajectories. Given that BIPOC students are more likely to attend under resourced schools and are more likely to have underqualified teachers (Ed-Trust West, 2015) the findings related to ineffective teaching during the Covid-19 could have long lasting impacts on BIPOC students' relationships with and their dispositions towards math. Not to mention, the long term of effects of Covid-19 math learning loss on secondary and postsecondary math achievement have yet to be seen.

Beyond IM3 Course Taking and Black Teachers

My fourth research question investigates the value of Black teachers as a potential solution for increasing Black students' Beyond IM3 course enrollment. Many of the students felt strongly that Black math teachers would be more understanding and provide more culturally relevant teaching experiences. Specifically, Tyreke called for more diversity in the teacher applicant pool, since, as the research shows, most teachers are white and female (Meckler & Rabinowitz, 2019; Miller, 2018). These sentiments connect to the scholarship on teacher

matching (Egalite et al., 2015; Gershenson et al., 2017; Klopfenstein, 2005; Miller, 2018; Yarnell & Bohrnstedt, 2018) and the growth mindset of Black teachers towards Black students (McGrady & Reynolds, 2012). In addition, scholars note the importance of highly qualified Black math teachers as agents for Black students' successful progression through the math pipeline (Egalite, et al., 2015; Gershenson et al., 2017; Griffin & Allen, 2006; Klopfenstein, 2005; Martin, 2007, 2009a; McGrady & Reynolds, 2012); Spencer, 2009; Stinson, 2009; Stinson et al., 2013; Strayhorn, 2010, 2015; Terry & McGee, 2012; Thompson, 2004; Thompson & Davis, 2013; Young et al., 2017).

The findings about Black teachers support the importance of recruiting and retaining more Black teachers in districts with larger percentages of Black students. In general, most of my student participants noted the benefits of diversifying the teacher candidate pool by recruiting and retaining more Black teachers, especially in high need areas like math. Recent scholarship calls for more Black teachers in order to achieve educational justice (Hines & Hines, 2020; El-Mekki, 2021) especially in states like California where Black teachers are scarce (Schroeder et al., 2020; Taketa, 2021).

Summary

This chapter investigated the extent to which sociohistorical, community, school, and individual factors influenced the math dispositions and math course taking decisions of Black students drawing connections across the findings to established literature. This chapter presented the results of my qualitative analyses using the FAMSI framework as an analytical tool. Ultimately, the qualitative findings suggest that there are multiple layers to students' decisions to (dis)continue their math trajectory. However, parents, teachers, and curriculum were prominent reasons for students to opt into or out of Beyond IM3 coursework. Additionally, the racialized

experiences students experienced at school and within math classrooms held the potential to disrupt their Beyond IM3 course taking decisions. My qualitative findings allowed for a more nuanced understanding of Black students' decision-making processes as they contemplated Beyond IM3 course enrollment. In the next and final chapter of this dissertation I will summarize this study and discuss the quantitative and qualitative data together, as well as their implications for educators and the future of math curricula.

Chapter 6: Discussion, Implications, and Recommendations
Beyond IM3 Course Taking: Is it really a Choice?

Using a mixed methodology, this study aimed at what informs Black students' decision-making processes as they choose to take, or not take, a fourth year of math in high school. In this study I attempt to extend and build upon prior research that highlights the relationship between Black students' math experiences and their Beyond IM3 course taking patterns. The quantitative and qualitative findings offer multiple solutions for what informs Black students' decision-making processes as they choose to take, or not take, a fourth year of math in high school. The purpose of this chapter is to discuss the implications, recommendations, and scholarly significance of this dissertation study. In this chapter, I will discuss my findings as they pertain to the barriers and systems of support that impacted Black students' successful progression through coursework beyond IM3. The findings are structured this way to answer my research question regarding the barriers and systems of support that allow for Black students' successful participation in Beyond IM3 coursework.

Barriers to Students Taking Courses Beyond IM3

The quantitative and qualitative findings convey several barriers that Black students encounter as they navigate the math pathway towards coursework beyond IM3. The barriers occur at the sociohistorical, school, and individual levels. This section will discuss my findings related to these barriers.

Academic Tracking. Taken together my quantitative and qualitative findings point to academic tracking as a primary factor that negatively impacts Black students' Beyond IM3 course taking. Academic tracking is sociohistorical in nature because it is not merely based on institutional placement policies, but also structural issues such as inequitable access to upper-level math coursework. Specifically, the quantitative findings showcase the importance of being

in Algebra 1 or Integrated Math 1 by at least the eighth grade. The quantitative findings reinforce the literature that waiting until high school to take Algebra 1 is too late (Allensworth et al., 2009; Brown et al., 2013; Ngo & Velasquez, 2020; Wells, 2018) because students who are enrolled in Algebra 1 by the eighth grade are more likely to enroll in coursework beyond IM3. The quantitative findings also indicate that particular course sequences are more valuable than others and highlight eighth grade as a critical point at which many Black students are being funneled out of Beyond IM3 coursework.

Moreover, academic tracking works at the sociohistorical level because Black students in higher level classes must also navigate the racialized classroom experiences that accompany being the token Black student in an advanced math class (McGee & Pearman, 2015; Nasir & Shah, 2011). My qualitative findings illuminate how even when enrolled in upper-level classwork, Black students feel isolated, invisible, yet hyper visible. Several students mentioned feeling ignored when attempting to ask questions in class and some were even afraid to ask questions. Other students felt the need to be better than their non-Black peers. Most of the student participants felt they had to navigate feelings of imposter syndrome and stereotype threat due to the racialized nature of their math classes and the fact that they were often one of few Black students in their math classes. These elements of my student participants' experience have implications for whether or not the students develop positive or negative dispositions towards math. McGee's concept of fragile and robust mathematical identities indicates that Black students' math identities are fluid and "renegotiated around a number of factors, including the frequency of racialized events within and beyond the mathematics classroom" (2015, p. 603). According to McGee (2015) students with a fragile mathematical identity "have a delicate and vulnerable relationship with mathematics success and the persistent racialization they endure in

the discipline" (p. 604). For some students whose mathematics identities are more fragile the negative and racialized experiences faced in math may deter their continued interest in the subject which then reduces the likelihood they will continue into coursework beyond IM3. The findings demonstrate the potentially grave impact of tracking as a racialized outcome that deeply influences the experiences that Black students face in math classrooms. As McGee (2015) illuminates Black students' experiences in math classrooms have socializing effects on their identities as math learners.

Educators. The impacts of structural factors on educators and the power that educators wield makes schooling adults interact with every level of FAMSI. Students' Beyond IM3 course taking patterns were also informed to varying extents by their counselors and teachers at the school level. Specifically in the qualitative data, several students discussed having prior experiences with math teachers that negatively impacted their decision to take a math course beyond IM3. In addition, educators are often structural gatekeepers to upper level Beyond IM3 coursework, as they are the ones who make most course placement decisions. As evidenced by the quantitative data illuminating that enrollment in upper-level math course sequences by the eighth grade increased the likelihood that Black students enrolled in Beyond IM3 coursework. Taken together the findings center teachers as potential barriers to Beyond IM3 coursework. As the literature indicates, teachers' high and low expectations and biases have direct connections to whether or not they decide to recommend Black students for higher-level mathematics coursework (Berry III, 2005, 2008; Campbell, 2012; Francis, 2011; Faulkner et al., 2014). In addition, teachers who are under qualified to teach upper-level math coursework often contribute to Black students' negative dispositions towards math (Friedman, 2018) as echoed in my qualitative data. Several students mentioned teachers moving too quickly through the content,

not being elaborative when needed, and not being able to (or willing to) answer specific questions when asked. High-quality teachers create learning environments that feel safe, supportive, structured, and disciplined. These are the traits that will allow math classrooms to become spaces where Black students feel included and their voices heard, allowing for Black students' to be inspired to engage with math concepts in meaningful ways.

High School Counselors. In general, counselors play a major role in students' course decision making processes. My qualitative data highlights the potential impacts of under-resourced, understaffed schools on Black students' Beyond IM3 course taking. Recent scholarship indicates that schools are highly understaffed when it comes to filling staff positions, specifically school counselors (Whitaker et al., 2019). According to Whitaker et al. (2019) the average counselor caseload in California schools is 682 students per counselor. For context, the national average is 444 students per counselor and the recommended ratio by the American School Counselor Association is 250 students per counselor.

It is possible that the understaffed counselor department might contribute to some of the inconsistencies that student participants mentioned in my qualitative findings chapter. However, it is clear that counselors' play a major role in Black students' math trajectories. In addition, it must be noted that very few students mentioned counselors as a positive influence on their Beyond IM3 course taking. Notedly, a few students were actually dissuaded from taking Beyond IM3 coursework. Other students specifically spoke about having to advocate for themselves and to even involve their parents when attempting to advocate for upper-level math placement.

Counselors appear to be barriers to math students' Beyond IM3 course taking and contribute to academic tracking based on their institutional power and the inconsistent treatment that students mentioned. Even if Black students meet the academic requirements to be placed

into Algebra in the eighth grade, studies have shown that they are still more likely to be recommended for lower-level coursework despite their academic abilities (Faulkner et al., 2014; Riegle-Crumb, 2006). As mentioned in the quantitative findings, Black boys were both significantly underrepresented in Beyond IM3 courses. Gender bias and racism in counseling could be another primary contributor to the statistically significant differences in the percentages and numbers of Black boys and girls in Beyond IM3 coursework.

Race, Gender, Class, and Math Course Taking Patterns. The qualitative and quantitative findings demonstrate that Black students are experiencing the math classroom in racialized and gendered ways. The quantitative findings indicate that Black girls had 67% higher odds than Black boys of taking a Beyond IM3 course in high school. My qualitative data complicates the presumed success behind this finding since several Black girls noted experiences that were anti-Black and hostile to them in these spaces. These findings point to the need for mixed methods approaches and intersectional lenses when seeking to understand Black students' experiences with math and their gendered patterns of resistance and resilience in unwelcoming education spaces.

On the one hand, the quantitative results show that Black boys, who are often made to feel like traditional academic spaces are not for them, are underrepresented in upper-level math courses. This finding speaks to the overwhelming literature related to Black males' exclusionary experiences within math education (Jett et al., 2015; McGee & Pearman, 2015; McGee, 2018; Terry & McGee, 2012). As Jett et al. (2015) illuminated in their study of community-oriented spaces to enhance the academic success of Black males, teachers must create math classrooms that are guided by high expectations, care, and building of relationships. Jett et al. (2015) also

center building on students' lived experiences and lives outside of the classroom to make mathematical learning relevant and meaningful to them.

Similarly, Black girls are expected to perform well academically when given access to STEM courses, while facing racialized and gendered math classrooms through negative peer and teacher interactions (Farinde & Lewis, 2012; Francis, 2012; Neal-Jackson, 2018; Ricks, 2014). Neal-Jackson (2018) highlights that while Black girls are lauded for their tenacity in racially hostile academic spaces, their struggles with the math pathway are just as dire, possibly even more so than Black males. Together, these findings indicate that access to these courses alone is insufficient for creating open and engaging learning environments for Black students in math courses.

Systems of Support for Students Taking Courses Beyond IM3

The quantitative and qualitative findings convey several systems of support that Black students encounter as they navigate the math pathway towards coursework beyond IM3. The systems of support occur at the sociohistorical, community, and school levels. This section will discuss my findings related to these systems of support.

Beyond IM3 Course Taking and Eighth Grade Math. As mentioned in the previous chapters, there is a positive relationship between eighth grade math and future levels of math attainment (Brown et al., 2013; Kurleander et al., 2008; Neild & Balfanz, 2006; Paul, 2005; Smith, 1996; Spielhagen, 2006; Walston & McCarroll, 2010; Wang & Goldschmidt, 2003). The importance of eighth grade math is underscored by the results of my qualitative and quantitative data.

According to my quantitative data, Black students who took an accelerated math course in the eighth grade were significantly more likely to be enrolled in a course Beyond IM3 in high

school. My qualitative findings related to middle school further emphasize eighth grade math as a crucial point in the mathematical trajectories of my Black student participants. Nicky, a junior at Sunset HS, who opted to not take a Beyond IM3 course in high school recalled her best memory of math was in eighth grade, "because that's when everything basically clicked." Tamera, a junior at Rose HS who intended to take a Beyond IM3 course in her senior year, also mentioned eighth grade as she discussed when and why education became important to her. According to Tamera, education became important to her in middle school because of an eighth-grade seminar class that helped her "get stronger in math for high school." Both girls spoke to the importance of eighth grade as a turning point in their math content knowledge in preparation for high school and Beyond IM3 coursework.

For some students, accessing an important institutional school structure such as *acceleration* in eighth grade math was important for their math trajectories, making it that much more likely they would be eligible to take a Beyond IM3 course by the end of high school. Specifically, Roger, a junior at Rose HS, and Richie and Jordan, both juniors at Sunset HS, were all accelerated in eighth grade and were already enrolled in Beyond IM3 coursework as juniors. Richie and Jordan's experiences speak to the availability of accelerated math as a structural and institutional issue. Additionally, at the school level the teaching appeared to be much better and more relevant and engaging in rigorous eighth grade classes. In her pivotal research on tracking. Jeannie Oakes (2005) found that not only are lower-level courses less rigorous, but students in upper-level courses receive more engaging and stimulating content and instruction. Thus, academic tracking is not just about the academic rigor and intensity of the curriculum, but it is about stark differences in the quality of resources and instruction students receive.

The findings indicate that there are clear connections between middle school math and Beyond IM3 coursework. As indicated in the literature, acceleration in or by eighth grade math is a very important mechanism for increasing Beyond IM3 course taking because it allows for students to earn high school credit in math in the eighth grade and clears up room in their schedule to take Beyond IM3 coursework as early as their junior year. (Clotfelter et al., 2012; Gao & Johnson, 2017; Kurlaender et al., 2008; Neild & Balfanz, 2006; Rogers, 2020; Spielhagen, 2006; Walston & McCarrol, 2010; Wells, 2018). This proved consistent in my quantitative data and was a common trend in my qualitative interviews for the students who had already made it to a course Beyond IM3 by the time of their interview.

Black Teachers. According to my quantitative data, having more Black teachers and more Black math teachers were each *very* close to being statistically significant ($p = .09$ and $p = .10$ in the final model, respectively). Relatedly, my qualitative findings highlight Black teachers as part of a set of potential solutions for increasing Black student Beyond IM3 course enrollment. Centering my student participants' experiential knowledge as a crucial component of this dissertation study, it must be noted that many of them desperately felt that more Black teachers would equate to better overall classroom experiences for Black students. Given the benefits of teacher-match as it relates to Black student math achievement (Dee, 2006; Egalite et al., 2015; Gershenson et al., 2017; McGrady & Reynolds, 2012; Miller, 2018; Yarnell & Bohrnstedt, 2018), the quantitative and qualitative findings about Black teachers support the importance of recruiting and retaining more Black teachers in math classrooms.

As students shared in their conceptions of what makes a "good" math teacher, coupling support and encouragement with high expectations is very important. As indicated by a robust body of literature, teachers' expectations can either serve as motivation for Black students to

develop positive dispositions towards math or could serve as a means for developing a negative disposition towards math (Cousins-Cooper, 2000; Davis, 2014; Terry & McGee, 2012; Strayhorn, 2010). Students who had particularly negative experiences with math teachers and ultimately opted out of Beyond IM3 coursework might have benefited if their non-Black math teacher was supportive, encouraging, and taught in ways that centered cultural relevance.

Parents. The findings indicate that Black student participants often had a community of support including parents, grandparents, and others in their familial circles. Literature aligns with their experiences outlining how parental relationships can positively impact Black students' math trajectories (Carter Andrews, 2020; Martin, 2006). Carter Andrews (2020) notes how parents' high expectations of their children have a socializing effect on their students. Across both school sites, Black student participants shared how influential their parents were in their math course taking decision making process. More specifically, it was the consistently high expectations that Black parents established for their children that helped certain students to elect to continue their trajectories towards Beyond IM3 coursework. Also, in alignment with extant literature, having parental figures who held high expectations about attending college positively influenced how students conceptualized their math pathways and college opportunities as they looked towards the future (Carter Andrews, 2020; Herndon & Hirt, 2004; Huguley et al., 2021; Odom & McNeese, 2014; Stinson, 2009; Strayhorn, 2010; Walker, 2006).

Notably, other parental influences, such as social capital and "being middle class," can be seen throughout this dissertation in the insider knowledge that parents with baccalaureate and post baccalaureate degree status passed along to their children regarding the college choice process and success at the undergraduate level. These parents knew to encourage their children to take coursework beyond IM3 because of their status as second or third generation college

graduates who had successfully navigated college and the admission requirements. As Chapman et al. (2018) discuss in their study of parents of second and third generation college students, parents significantly influence the postsecondary options of their students. For students who are privileged enough to have had parents or even grandparents who have attended college, they are often supported as they navigate the college going and admissions process. Thus, socioeconomic status is an important factor in student decisions about which math courses to take and how they then relate to their postsecondary options. Many of the students understood that college was not an option, and if their parents also went to college these students mostly opted into beyond IM3 coursework. There is no question that parents were extremely important for these students' math course decisions.

Implications and Recommendations

Due to the sequential nature of math as well as the structural and institutional barriers present that inform math classrooms, Black students are often inhibited from reaching levels of math coursework beyond IM3 (Joseph et al. 2019; Ladson-Billings, 2006; McGee, 2020; Oakes, 1990, 2005). In many cases, this prevents Black students from meeting college requirements, which can limit their access to certain higher education institutions. For those who are granted entry into college, many are forced to take remedial math coursework which can negatively alter their time to degree and create additional financial barriers (ACT, 2007; Hoyt & Sorensen, 2001). Thus, the findings from this study present many important points connecting Black students' math trajectories and the institutional and structural barriers that block their math pathways. In this section, I will discuss implications of this study as they pertain to 1) teachers, teaching, and teacher pedagogy, and 2) math classrooms and the math curriculum.

Teachers, Teaching, and Teacher Pedagogy

It is important for teacher preparation programs, schools, and districts to strengthen the pipelines into the teaching profession by recruiting teachers who are both highly qualified and racially diverse. The current teacher pool is comprised of mostly white women (Meckler & Rabinowitz, 2019; Miller, 2018). The findings support a need for a shift in the demographics of the teaching profession to better align with scholarship about the importance of teacher match (Egalite, et al., 2015; Gershenson et al., 2017; Klopfenstein, 2005). Schools and districts intent on enhancing the math classroom experience for Black students should focus their recruitment efforts on hiring and retaining highly qualified Black math teachers. Shifting the demographics of math teachers could prove beneficial to the successful progression of Black students through the mathematics pipeline from K12, through college, and beyond.

Simply altering the racial-ethnic diversity of teachers is not enough effort. With recent budget cuts and the ongoing pandemic, it is unlikely that schools will be able to recruit sufficient numbers of highly qualified Black teaching candidates. Therefore, schools and districts should also encourage current math teachers to tap into the cultural funds of knowledge that Black students already possess (Foote, 2009; Gonzalez et al., 2005; Ladson-Billings, 1995; Tate, 1995; Yosso, 2005). In addition to recruiting and retaining more Black math teachers, developing supportive and encouraging non-Black math teachers should be an additional solution for helping Black students see themselves as holders of STEM expertise. Specifically, teacher education programs should begin to incorporate examples of culturally relevant pedagogies and instructional strategies that meet the needs of diverse learners. Programs should leverage these approaches by teaching math topics in culturally responsive, culturally relevant, and culturally sustaining ways (Aguirre & del Rosario Zavala, 2013; Gay, 2000, 2002; Leonard, et al., 2010;

Ladson-Billings, 1995; Paris, 2012; Tate, 1995). Math teachers should use the curriculum to make connections to students' lives outside of school to develop math curricula that are more meaningful, relevant, and aligned with the needs and experiences of their beautifully brilliant Black students.

In addition, teacher education programs and school districts could realign their focus towards altering the mindsets of current and aspiring math teachers. Gutiérrez (2013) posits that in addition to learning pedagogy and instructional strategies, math teachers must learn to manifest and grow their "*political conocimiento*," or political knowledge. Teacher education programs should be structured around building the political knowledge of math teachers by developing their ability to "deconstruct the images of mathematics, public education, teaching, and learning that circulate in mainstream society" (p. 16). Similarly, Martin (2007) suggests that highly qualified math teachers should develop a deep understanding of Black students' lived realities. Both processes would help to negate the impacts of implicit and explicit biases in math classrooms noted in and beyond this current study. The deconstruction of the racialized narrative of Black students' mathematical ability via *political conocimiento* and the development of deep understandings of their students' lives, should be a humanizing experience for teachers. Teachers would then have no choice but to begin to unpack their own biases, thus creating a process that could disrupt the racial hierarchy of mathematical ability that persists today (Martin, 2009b).

Math Classrooms and the Math Curriculum

Even though early access to higher levels of the math sequence is crucial for future success in math, for Black students' access to such coursework may be insufficient to address structural inequities (Ladson-Billings, 2006). Ultimately, the research about secondary math and Black students indicates the need for robust change. Daro and Asturias (2019) call for a redesign

of math curricular pathways to better serve students from historically marginalized groups. They suggest that in lieu of academic tracking and ability grouping, schools should offer pathway options for students to choose the math course that fits their future educational and career goals. More research is needed on this concept to make any claims about its effectiveness, but it offers one potential way to better address students' needs with a varied math curriculum. The findings from their study warrant a more in-depth look at how the math curriculum's structural components impact Black students' secondary math trajectories. Future research should further explore the effects of Daro and Asturias' (2019) plan to alter the math pathways for Black students in particular to ensure that tracking would not persist in some other manner, such as through different career pursuits. Moreover, future research should investigate the effects of various alterations to the math curriculum and their impacts on students' math experiences in math classrooms across the nation. The goal should be to further explore current strategies that have worked and innovative ideas that could prove impactful to discover how to combat the structural components within the math pathway that continue to shape the math experiences of Black students.

Furthermore, scholars have suggested that math educators should begin to use math classrooms as spaces for liberation, social justice, and criticality (Darling-Hammond et al., 2002; Gutstein, 2003; Leonard et al., 2010; Martin, 2009a; Nasir & Cobb, 2007; Tate, 2013; Turner & Strawhun, 2005). One scholar, Gutstein (2003), believes that the teaching and learning of mathematics should focus on real-world activities that center the concerns of the communities served by the math teacher. Gutstein (2003) also suggests moving beyond using STEM for economic gains to instead pursue making a difference in service of humanity and nature. The math classroom does not have to be sterile and fraught with racialized notions of who should and

should not be “good” at math (Martin & McGee, 2009; Nasir & Shah, 2011). Educators must continue to foster the innate abilities of Black students, allowing them to see themselves as scientists, mathematicians, and engineers not only as a more dependable source of income, but as a pathway to social justice contributions to society.

In the realm of mathematics education research, there are calls for altering mathematics pedagogy in order to achieve liberatory and social justice outcomes for Black students (Davis, 2019; Larnell, et al., 2016; Martin & McGee, 2009; Pitts Bannister et al., 2017; Terry, 2010, 2011). The proponents for this shift in math pedagogy argue for critical and culturally relevant education that speaks to all students' full development. Martin (2007) suggests that math teachers should re-imagine the mathematics curriculum such that it could be used to empower Black students, creating change agents in their communities. Math classrooms could indeed become spaces where students learn to think critically about data and debate the facts, figures, and statistics presented in the news. What could it mean for classes of future Black mathematicians, economists, data scientists, and statisticians, if they were exposed to rigorous high-quality coursework that was also meaningful, relevant, and engaging? This alteration to the more extensive conversation about math pedagogy would require a reimagining of how the math classroom should and could operate.

Limitations of the Study

Study limitations range from factors related to available quantitative data on Black students to difficulties with qualitative data collection during the onset of the global COVID-19 pandemic. The use of publicly available quantitative data has its drawbacks, especially regarding Black students. For example, because of the small population of Black students and educators throughout The District, much of the publicly available data was redacted for privacy purposes.

This resulted in missing data for particular students and educators throughout the publicly available dataset, therefore limiting the results. In addition, the publicly available dataset includes only students who identify exclusively as Black but does not include students from mixed racial/ethnic backgrounds. While publicly available datasets have their benefits concerning convenience, they provide limited opportunities for how data are collected and how variables are defined that inevitably impacted this study.

In addition, a large portion of my qualitative data were collected amidst the COVID-19 pandemic that caused limited access to schools and transitioned math instruction to online platforms. This initially created issues with participant recruitment, but I was able to mitigate them by reaching out to parents as mentioned in Chapter 3. With the additional stressors related to the pandemic such as feelings of depression and isolation, and the social unrest of 2020, students and educators were simply managing many more stressors during the time I conducted interviews. Given that the focus group data at Sunset HS was collected prior to the pandemic, this makes the temporal contexts of data collection between Sunset and Rose quite unique and different from one another. Though important points of comparison, insights from each school cannot be directly compared given the inevitable influence of external factors.

Finally, as mentioned in Chapter 4, the quantitative findings related to male teachers and multilingual students were not reiterated in my qualitative findings. This study was convergent in nature, meaning the data was collected and analyzed concurrently. Had I collected and analyzed the quantitative data first, I would have been able to build off of my quantitative findings through my qualitative data and develop semi-structured interview questions related to the impact of multilingualism or male teachers. However, the nature of the convergent mixed-methods methodology did not entail this versatility in methodological design. Importantly, the

quantitative findings provided insightful findings that will inspire the direction of my own future scholarship.

Significance and Potential Contributions

One contribution to the field that I am most proud of is extending the conversation about the multiple factors that influence Black students' mathematics socialization and identity as related to Martin's FAMSI framework. I noticed unique challenges related to exploring the multitude of factors that Martin (2000) must have experienced while developing his framework. Specifically, I recognize the overlapping nature of Martin's the sociohistorical level and Critical Race Theory (CRT). Indeed, several authors, including Martin have paired FAMSI with Critical Race Theory (Joseph et al., 2020). Additionally, Martin's framework has become foundational scholarship for current studies that parse out the sociohistorical level to explicitly center race and racism as central to the mathematical experiences of Black students (Gholson & Wilkes, 2017).

Martin's framework was ideal for this dissertation due to the multilevel factors. As this dissertation demonstrated students' math identities and course taking patterns are multifaceted and influenced by many external and internal factors. The levels in Martin's framework helped to organize the data into themes that aligned with prior scholarly work. One challenge with Martin's framework was more of a challenge with my analysis. I noticed that my findings often felt like difficult to place into solely one category. For example, I opted to place curriculum in the sociohistorical level as a structural factor because curriculum is developed at the state and sometimes the national level. However, some curriculum components are teacher led, and teachers have leeway in how they teach the material, making curriculum seem like a school level factor when in actuality it is more sociohistorical in nature.

Ultimately, my hope is that this study will help researchers begin to disrupt the limited racial diversity in STEM fields, while also situating math as one of the major deterrents of Black students' interest and persistence in STEM. While this study points out the challenges with access to Beyond IM3 coursework, this research could be impactful for developing systems of multilevel support for Black students in STEM classrooms and could serve as an impetus for changes in math curriculum, policy, and teaching practices.

Furthermore, centering the "M" in STEM is becoming increasingly important. In the era of "fake news," it is imperative that students are becoming mathematically literate and able to think critically about numbers and statistics represented in the news and social media so that they might be able understand the world better and be fully engaged in a democratic society. Specifically, for over 20 years, scholars have called for math literacy to be seen as a civil right (Edley, 2017; Moses, 2002). With recent developments regarding the Covid-19 pandemic, ongoing police violence against Black people, and the rise in the Black maternal death rate, mathematical literacy and statistical fluency is crucial for the viability of the Black community as a whole. While I understand my dissertation is merely at the precipice of these ideas, math and education research must continue to push towards justice and equity.

Conclusion

The quantitative and qualitative findings offer implications for Black students' math trajectories. Not only must researchers and education policy makers push for more holistic approaches to math placement, it is important to also develop math teachers who are able to create warm and welcoming classroom spaces where Black students feel motivated to ask questions, make mistakes, and grow their mathematical fluency. Because they have typically been tracked into lower-level math courses and are less likely to be taught by highly qualified

teachers, many Black students fall through the cracks that line the math pathway. As a result, they have less of a chance to benefit from the positive effects of eighth-grade algebra and coursework beyond IM3. In addition to dispositions and instructional strategies, encouragement and support from high quality math teachers has the potential to increase the achievement levels of Black students, especially males (Berry 2005, 2008; Strayhorn, 2010, 2015; Terry & McGee, 2012). Coupling support and encouragement with high expectations are also very important. Teachers' expectations could either serve as motivation for Black students to learn and do well or could work as a means for discouragement from putting forth effort (Davis, 2014; Terry and McGee, 2012; Strayhorn, 2010).

In closing, this dissertation serves as my contribution to burgeoning scholarship using critical mixed methodologies that center the voices and experiential knowledge of Black math students. My hope is that this dissertation study shows that many Black students are thriving despite experiencing anti-Black math classrooms, yet there is much room for growth. We must learn from the stories of those who have been disenfranchised by the education system while amplifying the stories of those students who have managed to thrive despite the institutional and structural barriers that attempt to impede their math trajectories.

Ultimately, I hope that after reading my dissertation readers are reinvigorated by a similar inspiration as my own- the brilliance of Black students. My hope is that this dissertation inspires other work that centers Black students and highlights their capacity for greatness. As I look to the future of education, I am reminded of Dr. Bettina Love's words: "We must struggle together not only to reimagine schools but to build new schools that we are taught to believe are impossible: schools based on intersectional justice, antiracism, love, healing, and joy" (p. 11). How can we begin to shift the ideologies of STEM education towards social justice and love? I

hope my work will help in challenging and problematizing the narratives about Black students in math.

Chapter 6 is in part a reprint of material as it appears in The Negro Educational Review, 2020, Rogers Jr., Kirk D., Centering the "M" in STEM: A Review of Black Students' Math Experiences. The dissertation author was the primary investigator and author of this paper.

References

ACT, Inc. (2007). *Rigor at risk: Reaffirming quality in the high school core curriculum*. Retrieved from: www.act.org/path/policy/pdf/rigor_report.pdf

Adams, M. A., & Love, B. J. (2009). A social justice education faculty development framework for a post-grutter era. In K. Skubikowski, C. Wright, & Graf, R. (Eds.), *Social Justice Education: Inviting Faculty to Transform their Institutions*. (pp. 3-25). VA: Stylus Publishing.

Adelman, C. (1999). *Answers in the toolbox: Academic intensity, attendance patterns, and bachelor's degree attainment*. Washington, DC: U.S. Department of Education.

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college*. Washington, DC: US Department of Education.

Aguirre, J. M., & del Rosario Zavala, M. (2013). Making culturally responsive mathematics teaching explicit: A lesson analysis tool. Pedagogies: *An International Journal, 8*(2), 163–190.

Akos, P., Lambie, G. W., Milsom, A., & Gilbert, K. (2007). Early adolescents' aspirations and academic tracking: An exploratory investigation. *Professional School Counseling, 11*(1), 57-64.

Alexander, J. E., Johnson, K.E., & Kelley, K. (2012). Longitudinal analysis of the relations between opportunities to learn about science and the development of interest related to science. *Science Education, 96*(5), 763-786.

Alexander, M. (2010). *The new Jim Crow: Mass incarceration in the age of colorblindness*. New York: The New Press.

Alexander, N.N. (2015). Statistical models of identity and self-efficacy in mathematics on a national sample of Black adolescents from HSLS:09. (Unpublished Dissertation). Columbia University.

Allensworth, E., Nomi, T., Montgomery, N., & Lee, V. E. (2009). College preparatory curriculum for all: Academic consequences of requiring Algebra and English I for ninth graders in Chicago. *Educational Evaluation and Policy Analysis, 31*(4), 367-391.

Annamma, S. A., Anyon, Y., Joseph, N. M., Farrar, J., Greer, E., Downing, B., & Simmons, J. (2016). Black girls and school discipline: The complexities of being overrepresented and understudied. *Urban Education, 54*, 211-242.

Archbald, D., & Farley-Ripple, E. (2012). Predictors of placement in lower level versus higher level high school mathematics. *The High School Journal, 96*(1), 33-51.

Baber, L. D. (2020). Colorblind liberalism in postsecondary STEM education. In E. McGee and W.H. Robinson (Eds.), *Diversifying STEM: Multidisciplinary Perspectives of Race and Gender* (pp. 19-35). New Brunswick, NJ: Rutgers University Press.

Bailey, D. H., Duncan, G. J., Murnane, R. J., & Au Yeung, N. (2021). Achievement Gaps in the Wake of COVID-19. *Educational Researcher*, *50*(5), 266–275.

Ballón, E. G. (2008). Racial Differences in High School Math Track Assignment. *Journal of Latinos and Education, 7*(4), 272–287.

Barrat, V. X., & Berliner, B. (2013). *The Invisible Achievement Gap, Part 1: Education Outcomes of Students in Foster Care in California's Public Schools*. San Francisco: WestEd.

Bates, S. L. (2004). Socioracial group differences in family and peer influences on adolescent' academic achievement (Unpublished doctoral dissertation). University of Texas at Austin.

Bell, D.A. (1992). Racial Realism. *Connecticut Law Review, 24*(2), 363-380.

Berry, R.Q., III. (2005). Voices of success: Descriptive portraits of two successful African American middle school mathematics students. *Journal of African American Studies, 8*(4), 46-62.

Berry, R.Q., III, & McClain. O.L. (2009). Contrasting pedagogical styles and their impact on African American students. In D.B. Martin (Eds.), *Mathematics teaching, learning, and liberation in the lives of Black children* (pp. 123-144). New York: Routledge.

Betts, J., Reuben, K., & Danenberg, A. (2000). *Equal resources, equal outcomes? The distribution of school resources and student achievement in Californi*a. Public Policy Institute of California Monograph.

Blanton, M., Stroud, R., Stephens, A., Gardiner, A. M., Stylianou, D. A., Knuth, E., Isler-Baykal, I., & Strachota, S. (2019). Does early algebra matter: The effectiveness of an early algebra intervention in grades 3 to 5. *American Educational Research Journal, 56*(5), 1930–1972.

Boston, C. S. (2017). The Effects of Belonging and Racial Identity on Urban African American High School Students' Achievement. *Journal of Urban Learning, Teaching, and Research*.

Bozick, R., & Ingels, S.J. (2008). *Mathematics coursetaking and achievement at the end of high school: evidence from the education longitudinal study of 2002*. (NCES 2008-319). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Braddock, J.H., II. (1990). *Tracking: Implications for student race-ethnic subgroups. Center for Research on Effective Schooling for Disadvantaged Students*, Johns Hopkins University.

Brown, B. A., Boda, P., Lemmi, C., & Monroe, X. (2019). Moving culturally relevant pedagogy from theory to practice: Exploring teachers' application of culturally relevant education in science and mathematics. *Urban Education, 54*(6), 775-803.

Brown, J., Schiller, K., Roey, S., Perkins, R., Schmidt, W., & Houang, R. (2013) *Algebra and Geometry Curricula* (NCES 2013-451). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Bullock, E. C. (2017). Only STEM can save us? Examining race, place, and STEM education as property. *Educational Studies, 53*(6), 628-641.

Burns, D., Espinoza, D., Ondrasek, N., & Yang, M. (2021). *Students experiencing homelessness: The conditions and outcomes of homelessness among California students*. Learning Policy Institute.

Byun, S. Y., Irvin, M. J., & Bell, B. A. (2015). Advanced math course taking: Effects on math achievement and college enrollment. *The Journal of Experimental Education, 83*(4), 439-468.

California Department of Education (2020a). *Enrollment by Subgroup - Sunset HS High Report.* Data Reporting Office. https://dq.cde.ca.gov/dataquest/dqcensus/EnrEthLevels.aspx?cds=37683383734654&agglevel=school&year=2019-20

California Department of Education (2020b). *Enrollment by Ethnicity - Sunset HS High Report.* Data Reporting Office. https://dq.cde.ca.gov/dataquest/dqcensus/EnrEthLevels.aspx?cds=37683383734654&agglevel=school&year=2019-20

Camera, L. (2019, June 19). *International survey: U.S. teachers are overworked, feel underappreciated.* U.S. News. Retrieved from: https://www.usnews.com/news/education-news/articles/2019-06-19/international-survey-us-teachers-are-overworked-feel-underappreciated

Campbell, S. L. (2012). For Colored girls? Factors that influence teacher recommendations into advanced courses for Black girls. *The Review of Black Political Economy, 39*(4), 389–402.

Carr, S. (2022, January 5). *Public schools are struggling to retain black teachers. These ex-teachers explain why.* Time Magazine. Retrieved from: https://time.com/6130991/black-teachers-resigning/

Carter Andrews, D. J. (2020). They shall not be moved: Black students' persistence as engineering majors. In E. McGee and W.H. Robinson (Eds.), *Diversifying STEM: Multidisciplinary Perspectives of Race and Gender* (pp. 19-35). New Brunswick, NJ: Rutgers University Press.

Chambers, T. T. V., & Spikes, D. D. (2016). "Tracking [is] for Black people": A structural critique of deficit perspectives of achievement disparities. *The Journal of Educational Foundations, 29*(1-4), 29-53.

Chapman, T.K. (2013). Origins of and connections to social justice in critical race theory in education. In M. Lynn & A.D. Dixson (Eds.), *Handbook of Critical Race Theory in Education* (pp. 81–87). New York: Routledge

Chapman, T.K. (2020). Introduction: When the magic happens. Critical race storytelling. *Telling for Liberation: Using Critical Storytelling Methodology to Advance Racial and Social Justice.* (pp. 3-11) Interactions: UCLA Journal of Education and Information Studies.

Chapman, T. K., Contreras, F., & Martinez, E. (2018). African American parents and their high-achieving students: Issues of race, class, and community in the college choice process. *Journal of African American Studies, 22*(1), 31-48

Chavous, T., & Cogburn, C. D. (2007). Superinvisible women: Black girls and women in education. *Black Women, Gender & Families, 1*(2), 24-51.

Chavous, T., Bernat, D., Schmeelk-Cone, K., Caldwell, C., Kohn-Wood, L., & Zimmerman, M. (2003). Racial identity and academic attainment among African American adolescents. *Child Development, 74*(4), 1076-1090.

Clance, P. R., & Imes, S. A. (1978). The imposter phenomenon in high achieving women: Dynamics and therapeutic intervention. *Psychotherapy: Theory, Research & Practice, 15*(3), 241–247.

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2012). *Algebra for 8th graders: Evidence on its effects from 10 North Carolina districts* (No. w18649). National Bureau of Economic Research.

Cokley, K., Smith, L., Bernard, D., Hurst, A., Jackson, S., Stone, S., Awosogba, O., Saucer, C., Bailey, M., & Roberts, D. (2017). Impostor feelings as a moderator and mediator of the relationship between perceived discrimination and mental health among racial/ethnic minority college students. *Journal of Counseling Psychology, 64*(2), 141–154.

College Board. (2011). 2011 *College-bound seniors total group profile report*. Retrieved from: www.collegeboard.com/profdownload/cbs2011_total_group_report.pdf

Collins, K. H. (2018). Confronting color-blind STEM talent development: Toward a contextual model for Black student STEM identity. *Journal of Advanced Academics, 29*(2), 143-

168.

Collins, K. H., Joseph, N. M., & Ford, D. Y. (2020). Missing in action: Gifted Black girls in science, technology, engineering, and mathematics. *Gifted Child Today, 43*(1), 55-63.

Collins, P. H. (2019). Intersectionality as critical social theory. In *Intersectionality as Critical Social Theory*. Duke University Press.

Copur-Gencturk, Y., Cimpian, J.R., Lubienski, S.T., & Thacker, I. (2020). Teachers' bias against the mathematical ability of female, Black, and Hispanic students. *American Educational Research Journal, 49*(1) 30-43.

Cousins-Cooper, K.M. (2000). Teacher expectations and their effects on African American students' success in mathematics. In M.E. Strutchens, M.L. Johnson, & W.F. Tate (Eds.), *Changing the faces of mathematics: Perspectives on African Americans* (pp. 7-14). Virginia: The National Council of Teachers of Mathematics, Inc.

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and Conducting Mixed Methods Research*. SAGE Publications, lnc.

da Costa Nunez, R., Erb-Downward, J., Kannegaard, J., Atwal, N., & Bazerjian, L. (2016). *Aftershocks: The lasting impact of homelessness on student achievement.* Institute for Children, Poverty, & Homelessness.

Darensbourg, A. M., & Blake, J. J. (2014). Examining the Academic Achievement of Black Adolescents. *Journal of Black Psychology, 40*(2), 191–212.

Darling-Hammond, L., French, J., & Garcia-Lopez, S.P. (Eds.). (2002). *Learning to teach for social justice*. Teachers College Press.

Daro, P. & Asturias, H. (2019). *Branching out: Designing high school mathematics pathways with equity in mind*. Just Equations, Inc.

Datnow, A., & Cooper, R. (1997). Peer networks of African American students in independent schools: Affirming academic success and racial identity. *Journal of Negro Education, 66*, 56–72.

Davis, A. J. (2017). *Policing the Black man: Arrest, prosecution, and imprisonment.* New York: Pantheon Books.

Davis, J. (2014) The mathematical experiences of Black males in a predominantly Black urban middle school and community. *International Journal of Education in Mathematics, Science and Technology, 2*(3), 206-222.

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. Jett, (Eds.), *Critical Race Theory in Mathematics Education* (pp. 183–205). Boulder, CO: Paradigm Publishers.

DeCuir-Gunby, J. T., & Schutz, P. A. (2017). Developing a mixed methods proposal: A practical guide for beginning researchers. Thousand Oaks, CA: Sage.

DeCuir-Gunby, J.T., &, Schutz, P.A. (2019). Critical race mixed-methodology: Designing a research study combining Critical Race Theory and mixed methods research. In J.T DeCuir-Gunby, T.K. Chapman & P.A. Schutz (Eds.), *Understanding Critical Race Research Methods and Methodologies: Lessons From the Field* (pp. 3–10). New York: Routledge.

DeCuir-Gunby, J.T., Chapman, T.K., & Schutz, P.A. (2019). Critical race theory, racial justice, and education: Understanding critical race research methods and methodologies. In J.T DeCuir-Gunby, T.K. Chapman & P.A. Schutz (Eds.), *Understanding Critical Race Research Methods and Methodologies: Lessons from the Field* (pp. 3–10). New York: Routledge.

Dee, T. (2006). The why chromosome: How a teacher's gender affects boys and girls. *Education Next, 6*(4) 68-75.

De Gregorio, S., Dhaliwal, T. K., Owens, A., Painter, G. (2020). *Growing up homeless: Student homelessness and educational outcomes in Los Angeles*. EdWorkingPaper: 20-334. Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/zrf9-2v95

De Gregorio, S., Dhaliwal, T. K., Owens, A., Painter, G. (2022). Timing and duration of student homelessness and educational outcomes in Los Angeles. *Educational Researcher.*

De Marco, H. (2022, February 10). New threat to COVID-era education: Black and Latino teachers are leaving the profession. *LA Times*. Retrieved from: https://www.latimes.com/california/story/2022-02-10/black-and-latino-teachers-california-leaving-profession-in-high-numbers

Diette, T.M. (2011). The Whiter the better? Racial composition and access to school resources for Black students. *The Review of Black Political Economy, 39*(3), 321–334.

Dumas, M. J. (2016) Against the dark: Antiblackness in education policy and discourse. *Theory Into Practice, 55*(1), 11-19.

Duncan, G.J., Dowsett, C.L., Claessens, A., Magnuson, K., Huston, A.C., Klebanov, P., Pagani, L.S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology, 43*(6), 1428-1446.

Duncombe, C. (2017). *Unequal Opportunities: Fewer resources, worse outcomes for students in schools with concentrated poverty*. The Commonwealth Institute.

Edley, C. (2017, June). *At Cal State, Algebra is a civil rights issue.* EdSource. Retrieved from: https://edsource.org/2017/at-cal-state-Algebra-is-a-civil-rights-issue/582950

(The) Education Trust-West (2013). *Black minds matter: Supporting the educational success of Black children in California*. Oakland, CA.

Egalite, A. J., & Kisida, B. (2016). School size and student achievement: A longitudinal analysis. *School Effectiveness and School Improvement, 27*(3), 406-417.

Egalite, A.J., Kisida, B., & Winters, M.A. (2015). Representation in the classroom: The effect of own-race teachers on student achievement. *Economics of Education Review 45*, 44-52.

El-Mekki, S. (2021, September 9). To achieve educational justice, we need more Black teachers. *Edsurge*. Retrieved from: https://www.edsurge.com/news/2021-09-09-to-achieve-educational-justice-we-need-more-black-teachers

Faircloth, B. S., & Hamm, J. V. (2005). Sense of belonging among high school students representing 4 ethnic groups. *Journal of Youth and Adolescence*.

Fantuzzo, J. W., LeBoeuf, W. A., Chen, C., Rouse, H. L., Culhane, D. P. (2012). The unique and combined effects of homelessness and school mobility on the educational outcomes of young children. *Educational Researcher, 41*(9), 393-402.

Farinde, A. A., & Lewis, C. W. (2012). The underrepresentation of African American female students in STEM fields: Implications for classroom teachers.

Faulkner, V.N., Stiff, L.V., Marshall, P.L., Nietfeld, J., & Crossland, C.L. (2014). Race and teacher evaluations as predictors of Algebra placement. *Journal for Research in Mathematics Education, 45*(3), 288. National Council of Teachers of Mathematics.

Finkelstein, N., Fong, A., Tiffany-Morales, J., Shields, P., & Huang, M. (2012). *College Bound in Middle School & High School? How Math Course Sequences Matter*. The Center for the Future of Teaching and Learning at WestEd.

Foote, M.Q. (2009). Stepping out of the classroom: Building teacher knowledge for developing classroom practice. *Teacher Education Quarterly, 36*(3), 39-53.

Ford, D. Y. (2014). Segregation and the Underrepresentation of Blacks and Hispanics in Gifted Education: Social Inequality and Deficit Paradigms. *Roeper Review*, *36*(3), 143–154.

Fortin, J. (2021, November 4). *California Tries to Close the Gap in Math, but Sets Off a Backlash*. The New York Times. https://www.nytimes.com/2021/11/04/us/california-math-curriculum-guidelines.html

Francis, D. V. (2012). Sugar and spice and everything nice? Teacher perceptions of Black girls in the classroom. *The Review of Black Political Economy, 39*(3), 311–320.

Francis, D. V., & Darity, W. A. (2021). Separate and Unequal Under One Roof: How the Legacy of Racialized Tracking Perpetuates Within-School Segregation. *The Russell Sage Foundation Journal of the Social Sciences*, *7*(1), 187–202.

Friedman, A. (2018, March 5). The long-term effects of ineffective teachers. Brooklyn Math Tutors. Retrieved from: https://www.brooklynmathtutors.com/the-long-term-effects-of-ineffective-teachers

Fry, R. (2007). *How far behind in math and reading are English Language Learners?* Pew Hispanic Center.

Garces, L. M., Jayakumar, U. M. (2014). Dynamic diversity toward a contextual understanding of critical mass. *Educational Researcher, 43*, 115–124.

Garcia E. E., Lawton, K., & Diniz de Figueiredo, E. H. (2010) *The education of English language learners in Arizona: A legacy of persisting achievement gaps in a restrictive language policy climate.* The Civil Rights Project.

Garcia, S. E. (2020, June). Where Did BIPOC Come From? *The New York Times*, Retrieved from: https://www.nytimes.com/article/what-is-bipoc.html

Gay, G. (2000). *Culturally responsive teaching: Theory, research, and practice.* New York: Teachers College Press.

Gershenson, S., Hart, C.M.D., Lindsay, C.A., & Papageorge, N.W. (2017) *The long-run impacts of same-race teachers*. Germany: IZA Institute of Labor Economics.

Gholson, M. L., & Wilkes, C. E. (2017). (Mis)Taken identities: Reclaiming identities of the "collective Black" in mathematics education research through an exercise in Black specificity. *American Educational Research Association (AERA)*.

González, N., Moll, L. C., & Amanti, C. (Eds.). (2005). *Funds of knowledge: Theorizing practices in households, communities, and classrooms*. Lawrence Erlbaum Associates Publishers.

Goodenow, C., & Grady, K. E. (1993). The relationship of school belonging and friends' values to academic motivation among urban adolescent students. *Journal of Experimental Education*.

Goodrich, J. M., Thayer, L., & Leiva, S. (2021). Evaluating Achievement Gaps Between Monolingual and Multilingual Students. In Educational Researcher (Vol. 50, Issue 7, pp. 429–441). American Educational Research Association (AERA).

Griffin, K. A. (2018, April 23). Addressing STEM culture and climate to increase diversity in STEM disciplines. *Higher Education Today.* Retrieved from: https://www.higheredtoday.org/2018/04/23/addressing-stem-culture-climate-increase-diversity-stem-disciplines/

Griffin, K., & Allen, W. (2006). Mo' money, mo' problems? High-achieving Black high school students' experiences with resources, racial climate, and resilience. *The Journal of Negro Education, 75*(3), 478-494.

Griffin, K. A., Cunningham, E. L., & George Mwangi, C. A. (2016). Defining diversity: Ethnic differences in Black students' perceptions of racial climate. *Journal of Diversity in Higher Education*, *9*(1), 34–49.

Guinier, L. (2016). *The Tyranny of the Meritocracy: Democratizing Higher Education in America*. Beacon Press.

Gutierrez, R. (2013). Why (urban) mathematics teachers need political knowledge. *Journal of Urban Mathematics Education, 6*(2), 7-19.

Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education, 34*(1), 37-73.

Hand, V., Penuel, W. R., & Gutiérrez, K. D. (2012). (Re) framing educational possibility: Attending to power and equity in shaping access to and within learning opportunities. *Human Development, 55*(5-6), 250-268.

Hansen, M., Levesque, E., Valant, J., & Quintero, D. (2018). *The 2018 Brown Center report on American education: How well are American students learning?* Brown Center of Educational Policy at Brookings Institute.

Harris, C. I. (1992). Whiteness as property. *Harvard Law Review*, *106*(8), 1707–1791.

Hemphill, F. C., Vanneman, A. & Rahman, T. (2011). *Achievement gaps: How Hispanic and White students in public schools perform in mathematics and reading on the National Assessment of Educational Progress.* National Assessment of Educational Progress.

Henry, M., Watt, R., Rosenthal, L., & Shivji, A. (2017). *The 2017 annual homeless assessment report (AHAR) to congress* (Issue December, pp. 1–94). The U.S. Department of Housing and Urban Development.

Herndon, M. K., & Hirt, J. B. (2004). Black students and their families: What leads to success in college. *Journal of Black Studies 34*(4), 289-513.

Hines, E. & Hines, M. (2020, August 11). Want to support Black students? Invest in Black teachers. *Time*. Retrieved from: https://time.com/5876164/black-teachers/

Hong, J. (2021, November 19). *Understanding the debate behind California's new math framework*. Cal Matters. https://calmatters.org/education/k-12-education/2021/11/california-math/

Hoyt, J., & Sorensen, C. (2001). High school preparation, placement testing, and college remediation. *Journal of Developmental Education, 25*(2), 26-34.

Hubert, T. L. (2014). Learners of mathematics: High school students' perspectives of culturally relevant mathematics pedagogy. *Journal of African American Studies, 18*(3), 324-336.

Huguley, J. P., Delale-O' Connor, L. Wang, M., & Parr, A. K. (2021). African American parents' educational involvement in urban schools: Contextualized strategies for student success in adolescence. *Educational Researcher, 50*(1), 6-16.

Ireland, D. T., Freeman, K. E., Winston-Proctor, C. E., DeLaine, K. D., McDonald Lowe, S., & Woodson, K. M. (2018). (Un) hidden figures: A synthesis of research examining the intersectional experiences of Black women and girls in STEM education. *Review of Research in Education, 42*(1), 226-254.

Irizarry, Y. (2021). On track or derailed? Race, advanced math, and the transition to high school. *Socius, 7*.

Jayakumar, U. M. (2015). Why are all the black students still sitting together in the proverbial college cafeteria? A look at research informing the figurative question being taken by the Supreme Court in Fisher. Los Angeles: Higher Education Research Institute, UCLA.

Jayakumar, U. M., Garces, L. M., Park, J. J. (2018). Reclaiming diversity: Advancing the next generation of diversity research toward racial equity. In Paulsen, M. B. (Ed.), *Higher education: Handbook of theory and research* (pp. 11–79). Cham, Switzerland: Springer.

Jayakumar, U., Vue, R., & Allen, W. (2013). Pathways to college for young Black scholars: A community cultural wealth perspective. *Harvard Educational Review, 83*(4), 551-579.

Jett, C. C. (2019). Using personal narratives to elucidate my CRT(Me) journey. In J. Davis & C. Jett, (Eds.), *Critical Race Theory in Mathematics Education* (pp. 164–182). Boulder, CO: Paradigm Publishers.

Jett, C. C., Stinson, D. W., & Williams, B. A. (2015). Communities for and with Black male students: Four strategies can be effective in creating supportive learning environments. *Mathematics Teacher, 109*(4), 284–289.

Jett, C. C., and Davis, J. (2020). Black males' STEM experiences: Factors that contribute to their success. In E. McGee and W.H. Robinson (Eds.), *Diversifying STEM: Multidisciplinary Perspectives of Race and Gender* (pp. 19-35). Rutgers University Press.

Joseph, N. M., & Cobb, F. (2019). Anti-blackness is in the air: Problematizing Black students' mathematics education pathways from curriculum to standardized assessments. In J. Davis & C. Jett (Eds.), *Critical Race Theory in Mathematics Education* (pp. 140-163). New York, NY: Routledge.

Joseph, N. M., Viesca, K. M., & Bianco, M. (2016). Black female adolescents and racism in schools: Experiences in a colorblind society. *The High School, 100*, 4-25.

Joseph, N. M., Hailu, M., & Boston, D. (2017). Black women's and girls' persistence in the P–20 mathematics pipeline: Two decades of children, youth, and adult education research. *Review of Research in Education, 41*(1), 203-227.

Joseph, N. M., Hailu, M. F., & Matthews, J. S. (2019). Normalizing Black Girls' Humanity in Mathematics Classrooms. *Harvard Educational Review*, *89*(1), 132–155.

Joseph, N. M., Tyler, A. L., Howard, N. R., Akridge, S. L., & Rugo, K. R. (2020). The role of socialization in shaping Black girls' mathematics identity: An analysis of the high school longitudinal study 2009. *Teacher's College Record*, *122*(11).

Kelly, S. (2009). The Black-White gap in mathematics course taking. *Sociology of Education, 82*, 47-69.

Kendi, I. X. (2016). *Stamped from the beginning: The definitive history of racist ideas in America.* New York, NY: Bold Type Books.

Kim, J., Kim, J., DesJardins, S. L., & McCall, B. P. (2015). Completing Algebra II in high school: Does it increase college access and success? *The Journal of Higher Education, 86*(4), 628–662.

King Miller, B. A. (2017). Navigating STEM: Afro Caribbean women overcoming barriers of gender and race. *SAGE Open*, *7*(4), 1-14.

Klopfenstein, K. (2005). Beyond test scores: The impact of Black teacher role models on rigorous math taking. *Contemporary Economic Policy, 23*(3), 416–428.

Kohli, R., Pizarro, M., & Nevárez, A. (2017). The "New Racism" of K–12 Schools: Centering Critical Research on Racism. *Review of Research in Education*, *41*(1), 182–202.

Kunjufu, J. (1988). *To be popular or smart: The Black peer group*. Chicago, Ill: African American Images.

Kurlaender, M., Reardon, S. F., & Jackson, J. (2008). *Middle school predictors of high school achievement in three California school districts*. California Dropout Research Project Report #13. Santa Barbara, CA: California Dropout Research Project.

Ladson-Billings, G. (1995). But that's just good teaching! The case for culturally relevant

pedagogy. *Theory Into Practice, 34*(3), 159–165.

Ladson-Billings, G. (2006). From the achievement gap to the educational debt: Understanding achievement in U.S. schools. *Educational Researcher, 35*(7) 3-12.

Ladson-Billings, G. & Tate IV, W.F. (1995). Towards a critical race theory of education. *Teachers College Record, 97*(1), 47-68.

Langdon, D., McKittrick, G., Beede, D., Khan, B., & Doms, M. (2011). *STEM: Good jobs now and for the future*. U.S. Department of Commerce, Economics and Statistics Administration Issue Brief #03-11.

Larnell, G.V., Bullock, E.C., & Jett, C.C. (2016). Rethinking teaching and learning mathematics for social justice from a critical race perspective. *Journal of Education, 196*(1), 19-29.

Leath, S., Mathews, C., Harrison, A., & Chavous, T. (2019). Racial identity, racial discrimination, and classroom engagement outcomes among black girls and boys in predominantly black and predominantly white school districts. *American Educational Research Journal, 56*(4), 1318–1352.

Leggett-Robinson, P. M. (2017). Native-born and foreign-born Black students in STEM: Addressing STEM identity and belonging barriers and their effects on stem retention and persistence at the two year college. American Society for Engineering Education.

Leonard, J., Brooks, W., Barnes-Johnson, J., & Berry, R.Q., III (2010). The nuances and complexities of teaching mathematics for cultural relevance and social justice. *Journal of Teacher Education*, *61*(3), 261–270.

Levine, P. B., & Zimmerman, D. J. (1995). The benefit of additional high-school math and science classes for young men and women. *Journal of Business & Economic Statistics, 13*(2), 137-149.

Long, M. C., Conger, D., & Iatarola, P. (2012). Effects of high school course-taking on secondary and postsecondary success. *American Educational Research Journal, 49*(2), 285–322.

Love, B. L. (2019). *We want to do more than survive: Abolitionist teaching and the pursuit of education freedom*. Boston: Beacon Press.

Ma, X. (2000). A longitudinal assessment of antecedent course work in mathematics and subsequent mathematical attainment. *The Journal of Educational Research, 94*(1), 16-28.

Macdonald, H. Zinth, J. D., & Pompelia, S. (2019). *50 State Comparison: High School Graduation Requirements.* The Education Commission of the States. Retrieved from: https://www.ecs.org/high-school-graduation-requirements/

Mao, A. & Lee, A. (2021, June 15). The American teacher's plight: Underappreciated, underpaid and overworked. The New York Times. Retrieved from: https://www.nytimes.com/2021/06/15/learning/the-american-teachers-plight-underappreciated-underpaid-and-overworked.html

Malloy, C. E. (2009). Instructional strategies and dispositions of teachers who help African American students gain conceptual understanding. In D. Martin (Ed.), *Mathematics teaching, learning, and liberation of the lives of Black children* (pp. 88-122). New York: Routledge.

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

Martin, D. B. (2007). Beyond missionaries or cannibals: Who should teach mathematics to African American children? *The High School Journal, 91*(1), 6-28.

Martin, D. B. (2009a). Liberating the production of knowledge about African American children and mathematics. In D. Martin (Eds.), *Mathematics Teaching, Learning, and Liberation in The Lives of Black Children*. (pp. 3-38). New York, NY: Routledge.

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

Martin, D. B. (2012). Learning mathematics while Black. *Educational Foundations, 26*(1), 47-66.

Martin, D. B. (2018). Mathematics learning and participation as racialized forms of experience: African American parents speak on the struggle for mathematics literacy. In *Urban Parents' Perspectives on Children's Mathematics Learning and Issues of Equity in Mathematics Education* (pp. 197-229). Routledge.

Martin, D. B., & Larnell, G. V. (2013). Urban mathematics education. *Handbook of Urban Education*, 373-393.

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

Marzano, R. J. (2009). *Designing and Teaching Learning Goals and Objectives: Classroom Strategies That Work*. Marzano Research.

Matthews, L. E. (2009). "This little light of mine!" Entering voices of cultural relevancy into the

mathematics teaching conversation. In D. Martin (Ed.), *Mathematics teaching, learning, and liberation of the lives of Black children* (pp. 63-87). New York: Routledge.

McClure, E. (2017). More than a foundation: Young children are capable STEM learners. *The Journal of the National Association for the Education of Young Children, 72*(5), 83-89.

McGee, E. O. (2013). Threatened and placed at risk: High achieving African American males in urban high schools. *Springer Science and Business Media LLC*.

McGee, E. O. (2015). Robust and fragile mathematical identities: A framework for exploring high achievement among Black college students. *Journal for Research Mathematics Education, 46*(5), 599–625.

McGee, E. O. (2018). "Black genius, Asian fail": The detriment of stereotype lift and stereotype threat in high-achieving Asian and Black STEM students. *AERA Open, 4*(4), 1-6.

McGee, E. O. (2020). *Black, Brown, Bruised: How racialized STEM education stifles innovation*. Cambridge, MA: Harvard Education Press.

McGee, E. O., & Pearman, A., (2015). Understanding Black male mathematics high achievers from the inside out: Internal risk and protective factors in high school. *The Urban Review, 47*(3), 513–540.

McGrady, P. B., & Reynolds, J. R. (2012). Racial mismatch in the classroom: Beyond Black-white differences. *Sociology of Education 86*(1), 3-17.

Meckler, L., & Rabinowitz, K. (2019, December 27). *Most teachers are white, even as schools are more diverse than ever*. The Washington Post. https://www.washingtonpost.com/graphics/2019/local/education/teacher-diversity/

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: a guide to design and implementation* (Fourth edition). San Francisco, CA: Jossey-Bass.

Miller, C. C. (2018, March). Does Teacher Diversity Matter in Student Learning? *The New York Times*, Retrieved from: https://www.nytimes.com/2018/09/10/upshot/teacher-diversity-effect-students-learning.html?auth=login-facebook.

Miller, C., & Werner-Winslow, A. (2016, November 29). *Ten Days After: Harassment and Intimidation in the Aftermath of the Election*. Southern Poverty Law Center. https://www.splcenter.org/20161129/ten-days-after-harassment-and-intimidation-aftermath-election

Miller, L. S., Ozturk, M. D., & Chaves, L. (2005). Increasing African American, Latino, and Native American representation among high achieving undergraduates at selective colleges and universities. *UC Berkeley: Institute for the Study of Societal Issues.* Retrieved from https://escholarship.org/uc/item/10s3p1xt

Milner IV, H. R. & Howard, T.C. (2013). Counter-narrative as method: race, policy, and research for teacher education. *Race Ethnicity and Education, 16*(4), 536-561.

Moody, V. R. (2004). Sociocultural Orientations and the Mathematical Success of African American Students. *The Journal of Educational Research, 97*(3), 135–146.

Morgan, I., & Amerikaner, A. (2018, February 27). Funding gap 2018. Retrieved from https://edtrust.org/resource/funding-gaps-2018/

Morris, E. W. (2007). "Ladies" or "Loudies"? *Youth & Society, 38*(4), 490–515. SAGE Publications.

Morris, M. (2016). *Pushout: The criminalization of Black girls in schools*. New York, NY: The New Press.

Morrison, N. (2015, April 27). *If Teachers Feel Undervalued It's Because They Are.* Forbes. Retrieved from: https://www.forbes.com/sites/nickmorrison/2015/04/27/if-teachers-feel-undervalued-its-because-they-are/?sh=559b29e6412b

Moses, R. P. & Cobb, C.E. (2002). *Radical equations: Civil rights from Mississippi to the Algebra project*. Boston, MA: Beacon Press

Murphy, M. C., & Zirkel, S. (2015). Race and belonging in school: How anticipated and experienced belonging affect choice, persistence, and performance. *Teachers College Record, 117*(12), 1-40

Museus, S. D., Palmer, R. T., Davis, R. J., Maramba, D. C., Ward, K., & Wolf-Wendel, L. (2011). *Racial and ethnic minority students' success in STEM education*. San Francisco, Calif.: Hoboken, N.J: Jossey-Bass Inc. Wiley Periodicals.

Mwangi, C. A. G., & Fries–Britt, S. (2015). Black within Black: The perceptions of Black immigrant collegians and their U.S. college experience. In About Campus: Enriching the Student Learning Experience (Vol. 20, Issue 2, pp. 16–23). SAGE Publications.

Nasir, N. S., & Cobb, P. (Eds.). (2007). *Improving access to mathematics: Diversity and equity in the classroom*. Teachers College Press.

Nasir, N. S., McLaughlin, M. W., & Jones, A. (2009). What does it mean to be African? American? Constructions of race and academic identity in an urban public high school. *American Educational Research Journal, 46*(1), 73–114.

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.

Nath, J. D. (2021, October 25). Multiplying the impact of math catch-up. *The Journal*. Retrieved from: https://thejournal.com/articles/2021/10/25/multiplying-the-impact-of-math-catchup.aspx

National Academy of Sciences (2011). *Expanding underrepresented minority participation: America's science and technology talent at a crossroads.* Washington, DC: National Council of Supervisors of Mathematics (NCSM) & National Council of Teachers of Mathematics (NCTM). (2018). *Building STEM Education on a Sound Mathematical* Academies Press. Nat*Foundation: A joint position statement on STEM from the National Council of Supervisors of Mathematics and the National Council of Teachers of Mathematics*.

National Science and Technological Council (NSTC). (2018). *Charting a course for success: America's strategy for STEM education.* Committee on STEM Education, NSTC.

National Science Foundation (2017). *Women, minorities, and persons with disabilities in science and engineering: 2017*. Arlington, VA: National Center for Science and Engineering Statistics.

Neal-Jackson, A. (2018). A meta-ethnographic review of the experiences of African American girls and young women in K–12 education. *Review of Educational Research, 88*(4), 508-546.

Ngo, F. J., & Velasquez, D. (2020). Inside the math trap: Chronic math tracking from high school to community college. *Urban Education*.

Noonan, R. (2017). *STEM jobs: 2017 Update*. Washington, DC: Office of the Chief Economist, Economics and Statistics Administration, U.S. Department of Commerce.

Oakes, J. (1990). *Multiplying Inequalities: The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science*.

Oakes, J. (2005). *Keeping track: how schools structure inequality* (2nd Ed). New Haven, Conn.: Yale Univ. Press.

Odom, L. L., & McNeese, R. M. (2014). Having our say: High achieving African American male college graduates speak about parental involvement and parenting style. *National Council of Professors of Educational Administration (NCPEA) Education Leadership Review of Doctoral Research 1*(1), 91-105.

Paris, D. (2012). Culturally sustaining pedagogy, a needed change in stance, terminology, and practice. *Educational Researcher, 41*(3), 93-97.

Parsons, S., & Bynner, J. (2005). *Does numeracy matter more?* London: National Research and Development Centre for Adult Literacy and Numeracy. Retrieved from: https://www.researchgate.net/publication/245969683_Does_Numeracy_Matter_More

Paul, F. G. (2005). Grouping Within Algebra I: A structural sieve with powerful effects for low-income, minority, and immigrant students. *Educational Policy, 19*(2), 262–282.

Perez Huber, L., Lopez, C. B., Malagon, M. C., Velez, V., & Solorzano, D. G. (2008). Getting beyond the 'symptom,' acknowledging the 'disease': theorizing racist nativism. *Contemporary Justice Review, 11*(1), 39–51.

Pinder, P. J. (2014). Academic performance of immigrants of African heritage in STEM: A look at two world continents. Untested Ideas Research Center 2nd International Conference.

Pitts Bannister, V.R., Davis, J., Mutegi, J., Thompson, L., & Lewis, D. (2017). "Returning to the root" of the problem: Improving the social conditions of African Americans through science and mathematics education. *In Catalyst: A Social Justice Forum, 7*(1), 5-14.

Pollock, M., Rogers, J., Kwako, A., Matchiner, A., Kendall, R., Bingener, C., Reece, E., Kennedy, B., Howard, J. (2021). *The conflict campaign: Exploring local experiences of the campaign to ban "Critical Race Theory" in public K-12 education in the U.S., 2020-2021.* UCLA Institute for Democracy, Education, and Access.

Raabe, I. J., Boda, Z., & Stadtfeld, C. (2019). The social pipeline: How friend influence and peer exposure widen the STEM gender gap. *Sociology of Education, 92*(2), 105–123.

Ray, V. (2019). A Theory of Racialized Organizations. *American Sociological Review*, *84*(1), 26–53.

Rice, J. K. (2010). *The impact of teacher experience: Examining the evidence and policy implications.* National Center for Analysis of Longitudinal Data in Education Research.

Ricks, S. A. (2014). Falling through the cracks: Black girls and education. *Interdisciplinary Journal of Teaching and Learning, 4*(1), 10-21.

Riegle-Crumb, C. (2006). The path through math: Course sequences and academic performance at the intersection of race ethnicity and gender. *American Journal of Education, 113*(1), 101–122.

Riegle-Crumb, C., Moore, C., & Ramos-Wada, A. (2011). Who wants to have a career in science or math? Exploring adolescents' future aspirations by gender and race/ethnicity. *Science Education, 95*(3), 458-476.

Rivera-Batiz, F. (1992). Quantitative literacy and the likelihood of employment among young adults in the United States. *Journal of Human Resources, 27*(2), 313–328.

Robinson, M. (2003). Student enrollment in high school AP Sciences and Calculus: How does it correlate with STEM careers? *Bulletin of Science, Technology & Society, 23*(4), 265–273.

Robinson-Cimpian, J.P., Lubienski, S.T., Ganley, C.M., & Copur-Gencturk, Y. (2014). Teachers' perceptions of students' mathematics proficiency may exacerbate early gender gaps in achievement. *Developmental Psychology, 50*(4), 1262–1281.

Rogers Jr., K. D. (2020). Centering the "M" in STEM: A Review of Black Students' Math Experiences. *The Negro Educational Review, 71*(1-4), 7–52.

Rose, B. A., Henneberger, A. K., Mushonga, D. R., Uretsky, M. C., Preston, A. M. (2021) *Distinguishing the Roles of Poverty and Homelessness in Long-Term Academic and Workforce Outcomes.* Baltimore, MD: Maryland Longitudinal Data System Center.

Rose, H., & Betts, J.R. (2004). The effect of high school courses on earnings. *Review of Economics and Statistics, 86*(2), 497-513.

Rothstein, R. (2017). *The Color of Law: A Forgotten History of How our Government Segregated America*. New York: Liveright Publishing Corporation.

Ryan, A. M. (2001). The peer group as a context for the development of young adolescent motivation and achievement. *Child Development*, 72, 1135-1150.

Sadler, P. M., Sonnert, G., Hazari, Z. & Tai, R. (2014). The role of advanced high school coursework in increasing stem career interest. *Science Educator, 23*(1), 1-13.

Sarama, J., Lange, A.A., Clements, D.H., & Wolfe, C.B. (2012). The impacts of an early mathematics curriculum on oral language and literacy. *Early Childhood Research Quarterly 27*(3), 489-502.

Saw, G., Chang C., & Chan, H. (2018). Cross-sectional and longitudinal disparities in STEM career aspirations at the intersection of gender, race/ethnicity, and socioeconomic status. *Educational Researcher, 47*(8), 525-532.

Sawchuk, S. (2018, May 22). Unlocking STEM pathways for all students: Which policies open doors for students to STEM—and which slam them shut? *Education Week.* Retrieved from: https://www.edweek.org/ew/articles/2018/05/23/unlocking-stem-pathways-for-all-students.html

Sawchuck, S., & Sparks, S. D. (2020, December 2). *Kids* are behind in math because of Covid-19. here's what research says could help. *Education Week. Retrieved from: https://www.edweek.org/teaching-learning/kids-are-behind-in-math-because-of-covid-19-heres-what-research-says-could-help/2020/12#:~:text=Three%20studies%20based%20on%20NWEA,learn%20in%20a%20typical%20year.*

Scheurich, J. J., & Young, M. D. (1997). Coloring epistemologies: Are our research epistemologies racially biased? *Educational Researcher, 26*(4), 4-16.

Schiller, K. S., & Muller, C. (2003). Raising the bar and equity? Effects of state high school graduation requirements and accountability policies on students' mathematics course taking. *Educational Evaluation and Policy Analysis, 25(*3), 299-318.

Schroeder, L. Taketa, K., & McDonald, J. (2020, June 27). Blacks, other people of color under-represented among San Diego teachers. *The San Diego Tribune*. Retrieved from: https://www.sandiegouniontribune.com/news/watchdog/story/2020-06-27/blacks-other-people-of-color-under-represented-among-state-and-local-educators

Semuels, A. (2016, August 25). *Good school, Rich school; Bad school, Poor school: The inequality at the heart of America's education system*. The Atlantic. Retrieved from: https://www.theatlantic.com/business/archive/2016/08/property-taxes-and-unequal-schools/497333/

Shafer, L. (2016). *Summer Math Loss: Why Kids Lose Math Knowledge, and How Families Can Work to Counteract It.* Harvard Graduate School of Education. Retrieved from: https://www.gse.harvard.edu/news/uk/16/06/summer-math-loss

Sidanius, J., Levin, S., & Pratto, F. (1998). Hierarchical group relations, institutional terror, dynamics of the criminal justice system. In J. L. Eberhardt and S. T. Fiske (Eds.), *Confronting racism: The problem and the response*. Thousand Oaks, CA: SAGE.

Smalls, C., White, R., Chavous, T., & Sellers, R. (2007). Racial ideological beliefs and racial discrimination experiences as predictors of academic engagement among African American adolescents. *Journal of Black Psychology, 33*(3), 299-330.

Smith, J.B. (1996). Does an extra year make any difference? The impact of early access to Algebra on long-term gains in mathematics attainment. *Educational Evaluation and Policy Analysis, 18*(2), 141–153.

Solórzano, D. G. (1997). Images and words that wound: Critical race theory, racial stereotyping, and teacher education. *Teacher Education Quarterly, 24*(3), 5-19.

Solórzano, D. G. (1998). Critical race theory, race and gender microaggressions, and the experience Chicana and Chicano scholars. *Qualitative Studies in Education, 11*(1), 121-136.

Solórzano, D. G., & Ornelas, A. (2004). A critical race analysis of Latina/o and African-American advanced placement enrollment in public high schools. *The High School Journal, 87*(3), 15-26.

Solórzano, D. G., & Yosso, T. J. (2001). Critical race and LatCrit theory and method: Counter-storytelling. *International Journal of Qualitative Studies in Education, 14*(4), 471–495.

Solórzano, D. G., & Yosso, T.J. (2000). Toward a critical race theory of Chicana and Chicano education. *Charting new terrains of Chicana(o)/Latina(o) education,* 35-65.

Solórzano, D. G., Ceja, M., & Yosso, T. (2000). Critical Race Theory, Racial Microaggressions, and Campus Racial Climate: The Experiences of African American College Students. *The Journal of Negro Education, 69*(1/2), 60–73. http://www.jstor.org/stable/2696265

Sparks, D. M. (2018). Are you African or African-American? Exploring the identity experiences of female STEM students born in Africa now living in America. *The International Journal of Gender, Science, and Technology, 10*(2), 330-338.

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

Spielhagen, F. R. (2006). Closing the achievement gap in math: The long-term effects of eighth-grade Algebra. *Journal of Advanced Academics, 18*(1), 34-59.

Starck, J. G., Riddle, T., Sinclair, S., & Warikoo, N. (2020). Teachers are people too: Examining the racial bias of teachers compared to other American adults. *Educational Researcher, 49*(4) 273-284.

Steele, C. (2003). Stereotype threat and African American student achievement. In T. Perry, C. Steele, & A. Hilliard III (Eds.), *Young, Gifted and Black: Promoting High Achievement Among African American Students*.

Stinson, D. W. (2009). Negotiating sociocultural discourses: The counter storytelling of academically and mathematically successful African American male students. In D.B. Martin (Ed.), *Mathematics teaching, learning, and liberation in the lives of Black children*. (pp. 265-288). New York, NY: Routledge.

Stinson, D. W., Jett, C.C., Williams, B.A. (2013). Counterstories from mathematically successful African American male students: Implications for mathematics teachers and teacher educators. In J. Leonard & D.B. Martin (Eds.), *The Brilliance of Black Children in Mathematics: Beyond the Numbers and Toward New Discourse,* (pp. 221–246). Charlotte, NC: Information Age Publishing, Inc.

Strayhorn, T. L. (2010). The role of schools, families, and psychological variables on math achievement on math achievement of Black high school students. *The High School Journal, 93*(4), 177-194.

Strutchens, M. E. (2000). Confronting beliefs and stereotypes that impede the mathematical empowerment of African American students. In M.E. Strutchens, M.L. Johnson, & W.F. Tate (Eds.), *Changing the faces of mathematics: Perspectives on African Americans* (pp. 7-14). Virginia: The National Council of Teachers of Mathematics, Inc.

Sue, D. W., Capodilupo, C.M., Torino, G.C., Bucceri, J.M., Holder, A.M.B., Nadal, K.L., & Esquilin, M. (2007). Racial microaggressions in everyday life: Implications for clinical practice. *American Psychologist, 62*(4), 271-286.

Tadayon, A. (2022, January 24). California woefully lacks Black teachers. *EdSource*. Retrieved from: https://www.ktvu.com/news/california-woefully-lacks-black-teachers

Taketa, K. (2021, February 23). NAACP San Diego calls for more Black teachers. *San Diego Tribune*. Retrieved from: https://www.sandiegouniontribune.com/news/education/story/2021-02-23/naacp-san-diego-calls-for-more-black-teachers

Tate, W. F. (1995). Returning to the root: A culturally relevant approach to mathematics pedagogy. *Theory into practice, 34*(3), 166-173.

Tate, W. F. (2013). Race, retrenchment and the reform of school mathematics. In E. Gutstein, & B. Peterson (Eds.), *Rethinking mathematics: Teaching social justice by the numbers* (pp. 42-51). Wisconsin: Rethinking Schools, Ltd.

Teitelbaum, P. (2003). The influence of high school graduation requirement policies in mathematics and science on student course-taking patterns and achievement. *Educational Evaluation and Policy Analysis, 25*(1), 31-57.

Terada, Y. (2021, March 26) *Why Black teachers walk away*. Edutopia. Retrieved from: https://www.edutopia.org/article/why-black-teachers-walk-away

Terry, C. L. (2010). Prisons, pipelines, and the president: Developing critical math literacy through participatory action research. *Journal of African American Males in Education, 1*(2), 73-104.

Terry, C. L. (2011). Mathematical counterstory and African American students: Urban mathematics education from a critical race theory perspective. *Journal of Urban Mathematics Education at Teachers College, 3*(2), 73-85.

Terry, C. L., & McGee, E.O. (2012). “I’ve come too far, I've worked too hard”: Reinforcement of support structures among Black male mathematics students. *Journal of Mathematics Education at Teachers College, 3*(2), 73-85.

Thompson, G. L. (2004). *Through ebony eyes: What teachers need to know but are afraid to ask about African American students*. San Francisco, CA: Jossey-Bass.

Thompson, L. R., & Davis, J. (2013). The meaning high-achieving African American males in an urban high school ascribe to mathematics. *The Urban Review, 45*(4), 490–517.

Trusty, J., & Niles, S.G. (2003). High-school math courses and completion of the bachelor's

degree. *Professional School Counseling*, 99-107.

Turner, E. E. & Strawhun, B.T. (2005). "With math, it's like you have more defense": Students investigate overcrowding at their school. In E. Gutstein & B. Peterson (Eds.), *Rethinking Mathematics: Teaching Social Justice by the Numbers* (pp. 81–87). Milwaukee, WI: Rethinking Schools.

Turner, K. L., Hughes, M., Presland, K. (2020). Learning Loss, a potential challenge for transition to undergraduate study following COVID19 school disruption. *Journal of Chemical Education 97*, 3346-3352.

Tyson, W., Lee, R., Borman, K.M., & Hanson, M.A. (2007). Science, Technology, Engineering, and Mathematics (STEM) Pathways: High school science and math coursework and postsecondary degree attainment. *Journal of Education for Students Placed at Risk (JESPAR), 12*(3), 243–270.

U.S. Department of Education (2018, November). *A leak in the STEM pipeline: Taking Algebra early*. Retrieved from: https://www2.ed.gov/datastory/stem/Algebra/index.html#_ftn3

Walker, E. N. (2006). Urban high school students' academic communities and their effects on mathematics success. *American Educational Research Journal, 43*(1), 43–73.

Walston, J., & McCarroll, J.C. (2010). *Eighth-grade Algebra: Findings from the eighth grade round of the early childhood longitudinal study, Kindergarten class of 1998-99*. National Center for Education Statistics, U.S. Department of Education.

Wang, J., & Goldschmidt, P. (2003). Importance of middle school mathematics on high school students' mathematics achievement. *The Journal of Educational Research, 97*(1), 3-17.

Warne, R. T., Sonnert, G., & Sadler, P. M. (2019). The relationship between Advanced Placement mathematics courses and students' STEM career interest. In Educational Researcher (Vol. 48, Issue 2, pp. 101–111). American Educational Research Association (AERA). https://doi.org/10.3102/0013189x19825811

Wells, C. L. (2018). Understanding issues associated with tracking students in mathematics education. *Journal of Mathematics Education, 11*(2), 68-84.

Whitaker, A., Torres-Guillen, S., Morton, M., Jordan, H., Coyle, S., Mann, A., Sun, W. (2019). *Cops and No Counselors: How the Lack of School Mental Health Staff is Harming Students*. The American Civil Liberties Union. Retrieved from: https://www.aclu.org/report/cops-and-no-counselors

Whitehurst, G. J., & Chingos, M. M. (2011). *Class Size: What research says and what it means for state policy*. Brown Center on Educational Policy at the Brookings Institution.

Whitman, K. L. (2016). Students on the margins-margins: A critical examination of research on

African American foster youth in higher education. *Urban Education Research & Policy Annuals*, *4*(1).47-54

Wiegmann, W., Putnam-Hornstein, E., Barrat, V. X., Magruder, J. & Needell, B. (2014). *The Invisible Achievement Gap Part 2: How the Foster Care Experiences of California Public School Students Are Associated with Their Education Outcomes*. The Stuart Foundation.

Williams, T. K., McIntosh, R. W., & Russell III, W. B. (2021). Equity in distance education during Covid-19. *Research in Social Sciences and Technology, 6*(1), 1-24.

Wood, J. L., Harris III, F., & Howard, T.C. (2018). *Get Out! Black Male Suspensions in California Public Schools*. San Diego, CA: Community College Equity Assessment Lab and the UCLA Black Male Institute.

Yarnell, L. M., & Bohrnstedt, G. W. (2018). Student-teacher racial match and its association with Black student achievement: An exploration using multilevel structural equation modeling. In American Educational Research Journal (Vol. 55, Issue 2, pp. 287–324).

Yonezawa, S., Wells, A.S., & Serna, I. (2002). Choosing tracks: "Freedom of choice" in detracking schools. *American Educational Research Journal, 39*(1), 37-67.

Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education (8)*1, 69–91.

Young, J. L., Young, J. R., & Capraro, M. M. (2017). Black Girls' Achievement in Middle Grades Mathematics: How Can Socializing Agents Help? *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 90*(3), 70–76.

Zelkowski, J. (2011). Defining the intensity of high school mathematics: Distinguishing the difference between college-ready and college-eligible students. *American Secondary Education 39*(2), 27-54.

Appendix A

Student Focus Group and Individual Interview Protocol

(Prior to starting, interviewer hands out/provides a link/tiny url for survey)

Script: *Thank you for helping us with our research today. We are interested in learning about African/African American/Black students' experiences with math. We specifically want to know about what ultimately impacted your decision to take a fourth year of math or not and we look forward to hearing about your personal experiences. Please answer honestly. Every story is valuable and will inform our work in some way. This work will be used to inform us and your district about how to better assist African American/Black students to achieve their goals. As juniors and seniors, you have a great opportunity to provide feedback about your past math experiences.*

For this conversation to be successful, we should make a few agreements. Let's all agree not to specifically name educators. Please be mindful to speak one at a time. We will not share any recordings of this conversation with anyone outside of the research group. All quotes will be anonymized. If you don't understand my question, please let me know and I will reword the question. Also please speak one at a time loudly and clearly. We are audio-recording this focus group.

FAMSI (Sociohistorical, community, school, individual)
RQs RQA, RQB, RQC

RQ1: What informs Black students' decision-making processes as they choose to take, or not take, a fourth year of math, beyond IM3, in high school?

RQA: How do the positive (and negative) schooling experiences of Black students shape their dispositions towards math and their decision to (dis)continue an academic trajectory in high school math?
RQB: To what extent do institutional and structural factors influence the likelihood that a Black student will enroll in a Beyond IM3 math course by their senior year of high school?
RQC: How does the concentration of Black math teachers in a school impact the likelihood that a Black student will enroll in a Beyond IM3 math course by their senior year of high school?

Section I: Background RQA, RQB

1. Tell me a little about yourself. Are you from San Diego? If not, where did you grow up?
2. Can you describe the demographics of your neighborhood? Sociohistorical, community
3. Tell me about your parents. What do they do? Where are they from? What is their racial/ethnic background? community
4. How involved are your parents in your schooling? community

5. How do you feel about school? Is education important to you? If so, when and why did education become important to you? Individual
6. How has COVID changed your schooling experiences? What do you like or dislike about the shift to virtual schooling? Individual school
7. Are you involved in any extracurricular activities? Describe a day in the life of (student name). What is Henry/Morse like for you? Is it different for you than for other students? (Pre-COVID and now) Individual school
8. Describe your school pre-COVID. Individual school
    a. How well resourced do you think your school is in relation to other schools in the area? Sociohistorical, community, school
    b. Is race a factor at Henry? What about in your friend groups? (How you chose them, who you remained friends with, etc.) Sociohistorical, community, school
    c. Has race ever come up in your schooling experiences with teachers and/or with your friends? How so? Sociohistorical, community, school
    d. Have you and your parents ever talked about race or racism? How did that go?
        i. How (if at all) were you prepared to cope with racism at home? Sociohistorical, community

Section II: Experiences in Math Courses – Math Content, Teachers, & Course Decisions RQA

9. Choose your favorite math course and tell me why? Choose your least favorite and tell me why? (Was it the math, the teacher, or something else?) Sociohistorical, community, school, individual RQA
10. What was your most difficult math class and why? What was your easiest math class and why? (Was it the math, the teacher, or something else?) Sociohistorical, community, school, individual RQA
11. How do you feel about math? Individual RQA
    a. What do you love? Sociohistorical, community, school, individual
    b. What do you NOT love about math? Sociohistorical, community, school, individual
    c. Do you consider yourself a math person? Individual
    d. Why? Why not? Sociohistorical, community, school, individual RQA
12. Are you planning to take math next year? Why or why not?
    a. Why did you choose to take a math class this year? (What were you told? By whom?) Sociohistorical, community, school, individual RQA
    b. Why did you choose not to take math this year? (What were you told? By whom?) What are you taking instead? Sociohistorical, community, school, individual RQA
    c. Why did you choose to take a math class next year? (What were you told? By whom?) Sociohistorical, community, school, individual RQA

13. What advice would you give to a freshman? What would you tell them about the math classes here? Sociohistorical, school, individual RQA
    a. Possible additional questions (if not mentioned above): Is it typical within your math classes, for Black students to be a smaller group? Sociohistorical
    b. Do you think that being in that class with more students that look like you would make a difference? Sociohistorical, community, school, individual

Section III: Placement and Course Taking (identity, institutions, interactions/lived experiences)

14. Who, if anyone, has influenced the mathematics courses you chose to take in high school? How did they influence you? Sociohistorical, community, school, individual RQA
    a. (E.g., My counselor discouraged me in 9th grade from taking Adv Integrated Math 1, Mom encouraged me to take…; My teacher recommended me for…)
15. How have your experiences in math shaped your math course-taking in high school so far? Sociohistorical, community, school, individual RQA
16. What makes a good math teacher? Sociohistorical, community, school, individual RQA, RQC
    a. (Anticipate the need for a follow-up question or two. E.g., Did you choose to take an advanced course or not based on some experiences in a previous course? Did some particular experience shape your decision to take a fourth year of math or not?)
    b. Have you ever had a Black math/science teacher? If so, what was that like? If not, do you think your math experiences or schooling experiences would have been different? How so? Sociohistorical, school, individual RQC
    c. Have you had any experiences in middle to high school, with teachers of color that encouraged your dispositions/feelings towards math? Sociohistorical, community, school, individual RQC

Section IV: Future/Career/STEM Interest

17. What are your future plans? How does math fit into your graduation plans and future career goals? Sociohistorical, community, school, individual
18. When and how did you decide that you wanted to go to college following high school? Who (if anyone) guided/ informed you in making that decision? Sociohistorical, community, school, individual RQA, RQB,
    a. Can you think of any key moments in your K-12 schooling experiences that helped support your educational aspirations or current career interest? Sociohistorical, community, school, individual
        i. Any experiences or relationships with school staff?

b. Can you think of any key moments in your K-12 schooling experiences that hindered your educational aspirations or current career interest? Sociohistorical, community, school, individual
    i. To what extent did race factor into the obstacles you experienced in K-12? Sociohistorical, community, school, individual

19. How do you think your racial identity has influenced your academic outcomes and experiences? Sociohistorical, community, school, individual
20. Is there anything else that you feel I should know about your experiences with math at Morse/Henry? Sociohistorical, community, school, individual RQA, RQB, RQC

Appendix B

Data Matrix, Sunset HS -- See this link for more details

Pseudonym	Gender	High School	Year	Current Math (From Survey)	Previous Math (From Survey)	Beyond IM3 Course	For Juniors: Are you planning to take a fourth-year of math next year?	For Juniors: Which class?	For Seniors: Why did you choose to take math this year (or not)?	Favorite Math	Reason	Least Favorite Math	Reason	For Seniors: Why did you choose to take a math class this year? (What were you told? By whom?)	What advice would you give to a freshman? What would you tell them about the math classes here?	Seniors: Experiences in math up to this point and how that has shaped decisions about math and math courses	Seniors: Can we specify, for you specifically, what makes a good math teacher? In your eyes?	How does math fit into your graduation plans and future career goals?
Lisa	F	Sunset HS	Senior	Statistics	IM3	Y			**College Goals** - I chose to take Statistics because I just felt like it would give me the upper leg in college, seeing how I plan on going to a four year or community college next year. I just felt like it would be really helpful and set me higher from the rest.	IM 3	**Teacher** - So my favorite would have to be Integrated Math 3, which was last year, as a junior because that's when I really started understanding math and also I had a really good teacher. I got As on tests and I was like "hold up" because I was...before that I really wasn't a math person. All my tests I would get a "C" or a "D" but then last year I understood and yeah that was a really good year and math course.	7th Grade math	**Content/Ability/Math Identity** - I think seventh grade would have to be my worst because...I don't even remember what type of math that was, but I just remember seventh grade I was not good at math...I don't know, I just think I found the material a little bit harder, so I wasn't trying to be challenged just in middle school and thinking "oh it's just another class", but once I got into high school it was better.	**Self (College Goals)** - I chose to take math because, like Elijah said, going into college, you're going to need just that extra year of math and my teacher last year also was saying that since I did good in Integrated Math 3 that Stats is kind of like it and she thought I would do really well, so that also influenced me to take that last year.	**Teachers** - I agree with Quloni because a lot of times regular teachers feel like "oh these are the kids who are going to slack off, these are the kids who didn't really want to take math but they have to", where as advanced, you're picking that you want to take that challenge and that you actually want to be there and that's a bad attitude to have but it's still since you know that that's what's going on as a freshman, you should take that advanced class and be around people	I guess mine started in ninth grade. It was just like high school now, so I'm like "okay math isn't going anywhere!" plus I had a good teacher and as a freshman I ended up with a B my first semester, I think, so my mom was just encouraging me like "okay that's good" because a lot of kids have that adjustment time but she's like "you're doing good so just keep going" and then I really just applied myself to math and then that's when...I did	**Patience, Willingness to help students** - I would like to go back to patience because that's the first thing that came to my mind. Because last year, I kind of felt bad, but then my teacher was like "don't worry about it" because I would always ask questions. I'd be like "how'd you get that" or "how'd you get that". You can genuinely tell that she didn't care that I was asking a lot of questions, she was glad. And she didn't...Some other teacher will just	
Ashley	F	Sunset HS	Senior	None	IM3	N			**Disposition towards Math (Negative)** - I am not in math this year. I'm honestly not a math person at all, so I feel like I wanted to give myself that personal break my senior year, just to relax. And I stress over math as much as I used to, so that's why I decided not to take math	8th Grade math	**Teacher** - My favorite math course I think was eighth grade. What was that? What was eighth grade? But, I think it was just how the teacher was and how she taught us and she taught until we understood it completely even if we had to keep learning and keep learning and keep learning.	IM 2	**Teacher** - And my worst was Integrated Math 2. My teacher...I did not like how she taught. It was just copy notes every single day and then test after a week.	**Self (Motivation, Math Identity/Ability)** - So I actually did have math on my schedule and then when we got our official schedules, I decided to get out of math because I just knew it was going to be too much for me, a hassle. Math is hard, I don't like math. So I decided...I was like "yeah no" I'm just going to change it and that's how it's going to be.	**Teachers - (Agreed with previous statement about "teacher shopping")**	For me, I always had a love/hate relationship with math. Middle school, I actually liked it. In ninth grade, I took advanced Math 1 and it was good because of the teacher. That's when I started to like math more. Then once I got to tenth grade it just went all back down. My last year, which was last year, was the same teacher from my freshman year so I had good throughout the year because he helped us. He made sure we knew what we were	**Patience, Content Knowledge** - Patience. [crosstalk 00:27:59] And a teacher that knows what they are doing and talking about and doesn't mess up in the middle of teaching, because that confuses us.	
Myra	F	Sunset HS	Senior	Pre-Calculus	IM3	Y			**College Goals** - I decided to take math because I knew I was going to apply to UCs and I needed that fourth year of math just to stand out in the apps. And I also like math. It's one of my strong subjects so...	IM 2	**Ability/Content/Teacher** - My favorite class was last year's Math 2. It was so easy and I liked the way my teacher taught also. It worked with me. It worked with me. So I was getting good grades on tests and the class was really easy.	Honors Pre-Calculus	**Teacher** - And my least favorite is this year... Honors Pre-Calc...The teacher this year...I don't know, I think makes stuff a little more complicated than what it is. Because once I have another student explain it to me, I'm like "oh that's it?"...	**Self (Motivation, College Goals, Math Identity)** - Since I've always liked math, I walked into high school with a plan that I was going to take math for all four years already. I think I knew I was going to take math for four years because I knew I wanted to go a four year university also. I also really do enjoy math so taking it for four years wasn't a hassle for me, it was just already a given.	**Teachers** - Get the right teacher....Ovric: Can I follow up, Ariam? **So you had said earlier...I noted that you said "get the right teacher". Can you say a little bit more about that? I know you've gone in to what you mean by the right teacher? But, can say a little bit about, that?** Ariam: Okay, so freshman year, I understood math just as easily as I did. I think it's because of the way the classroom worked, how it operates. It's an environment for me to	My love for math started in sixth grade. My middle school teacher made math really fun for us. She was really patient with our class and that helped a lot because some of the middle schoolers were bad. From that point on, I don't know, math was just easy to me. It just came naturally.	**Caring/Willingness to help students** - ...and a teacher that shows they cares. They want you to understand so they ask you "do you understand?", "do you need any help?"	
Geoffrey	M	Sunset HS	Senior	Pre-Calculus	IM3	Y			**College Goals** - I decided to take math this year because I knew that if I was going to college that it would help me not to take a year of so I could remember what I previously learned so...when I go to college and it could help me in my career.	IM 1	**Content/Math Identity** - I'll say my favorite math class was probably freshman year because it came easier to me and I genuinely liked math	IM 2	**Teacher** - and my least favorite was sophomore year, Integrated Math 2. The teacher, she was not interactive with the students where they understand it thoroughly. She was always having her TA teach the class instead of her. She would just sit on her chair and the TA would do it.	**Self (College Goals) /Teachers/Older Students** - I wanted to take math this year because I knew if I was going to college, math was going to be in college so I wanted to prepare my brain for it, for the future coming up. I heard stories from other teachers...their past students went back to them, said they wish they'd took a fourth year their senior year and how they were behind their first year of college.	**Teachers - (Agreed with previous statement about "teacher shopping") and added:** Especially at Morse	**Kirk: You talked about, specifically you talked about, being a math person and liking math a lot. Can you talk about what experience shaped that or where did that start for you?** Elijah: I'd say middle school. My middle school teacher in 6th grade. He was really big on us understanding and he wasinteracting with us students one-on-one if they didn't specifically understand one equation or that specific problem. He influenced me to understand math more	(Agreed with patience)	
Vivian	F	Sunset HS	Senior	Pre-Calculus	IM3	Y			**Disposition towards Math (Positive)** - I chose to take a math class this year because math has always been my strongest subject. I love math so it's something that I just wanted to stick with. Even though I know it was going to be challenging, I enjoy challenging myself.	IM 3	**Content/Math Identity/Ability** - My favorite year of math was last year, Advanced Math 3. I liked the way, the pace, of the way the class was moving and I liked triangles and geometry and stuff like that. It came really easy to me, which I enjoyed	Honors Pre-Calculus	**Teacher/Content** - And I hate this year. I hate this year. All the first semester. Now, the second semester is easy because we're doing triangles and stuff like that and it's the same teacher from last year. This is her first year teaching Honors Pre-Calc, so I think she's trying to get used to things. And she's rushing through it, but she just needs to work on her teaching skills for this class.	**Parent (Mom)/Self (Motivation)/Teacher** - I was already thinking about, during Articulation, which is when we plan our next schedule for the next school year, I already know in my head that I wanted to do Honors Pre-Calc because I knew it was going to be the same teacher so I was like "might as well take this class, you know the way she teaches". So that's one reason and then...I don't know, I just enjoy math and I knew it was going to come	**Teachers** - I would say, take an advanced class. Because I feel at Morse the advanced teachers, they reach out more rather than the regular teachers...From what I've heard is that they'll just give you work and let you do it on your own. So I suggest taking an advanced class and if you don't like it and that's somewhere where you don't see yourself then just switch out because you know you best...The counselors say don't teacher shop, but you've got to stop	Like I said, I've always been a good student in math and science like bio. Bio and math have just always been my strongest subjects in school, so I knew I was going to take math my four years, but I was always questioning it my junior year because I was like "that's senior year, I want to chill". But, math is just a passion that I care for within high school. Yeah...**Kirk: Can I ask where it started for you?** Quiana: I think it really started pretty early	**One on One support/tutoring from teacher** - I know some math teachers do offer tutoring. And the one-on-one sessions might help better because that's what works for me in this class now. Because I can't be in that class with everybody because I don't understand the way she's explaining it until it's me and her...Yeah because that recently happened to me. I was asking a question, I didn't do the homework because I was just really stuck. I	
Diavian	F	Sunset HS	Senior	None	IM3	N			**Disposition towards Math (Negative)** - I am not taking math this year because I didn't want to take math and math always been one of my weakest subjects so I wanted to have my senior year as stress less as possible	IM 3	**Teacher** - My favorite year of math was Integrated Math 3 because the teacher I had, I understanded him and if I asked for help personally, he would actually come help, instead of trying to rush.	IM 1	**Teacher** - And my least favorite year of math is Integrated Math 1 because me and my teacher always bumped heads, and I just didn't understand him.	**Self (Motivation)/Older Students** - I chose not to take math because I would ask other seniors, well old seniors, if they liked math or if they suggest me to take math and they would tell me no. Some would tell me yes, but they would always tell me it's my opinion. So I just chose not to take math because I didn't want to take math.	**Teachers - (In response to another student's comment about "Teacher shopping" at Morse)** It's just because how some of the teachers treat the other students. They have sides. This student's bad, I'm not going to help this student. They just judge you by how you look. Honestly,	I honestly really stopped liking math when I came into my high school year because of the teacher that I had. Like I said, I didn't understand him. And he would just move too fast. When I would have one teacher, he was moving too fast, then my sophomore year, my teacher was still moving too fast until I got into junior year and I was getting the flow of how he was teaching.	(Agreed with patience)	