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Searching for Equity in Math Education: An Examination into Issues of Course Access and Classroom Experiences for Black and Hispanic Youth

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Searching for Equity in Math Education:

An Examination into Issues of Course Access and Classroom

Experiences for Black and Hispanic Youth

by

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Searching for Equity in Math Education:

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Experiences for Black and Hispanic Youth

by

Karisma Lucia Morton, PhD

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Achieving equity in math education requires investigations into issues of access as well as experiences of students in their math classrooms. In this dissertation, I present three analytic chapters that explore equitable access by race/ethnicity to advanced math courses as well as equitable experiences within math classrooms. Specifically, in the first analytic chapter I explore the extent to which Black and Hispanic students in a large and diverse school district are underrepresented in 8th grade algebra relative to their White peers (and each other) within the context of the racial/ethnic composition of their schools. In the second analytic chapter, I examine whether those students who successfully complete algebra in the 8th grade go on to take geometry in the 9th grade at the same rate as their White peers. In these two chapters I find that equitable access to 8th grade algebra depends largely on the racial/ethnic composition of the school students attend, such that Black and Hispanic students are disadvantaged in some contexts but not in others. However, I also find that once students enter the pipeline of advanced math course-taking in the 8th grade, access to subsequent advanced math is equitable. In the final analytic chapter, I shift my focus to what happens in math classrooms by utilizing national data to examine the extent to which students perceive their 9th grade math teachers as being equitable and how these perceptions affect student outcomes. My findings indicate that the impact of having an equitable teacher on math test scores varies by race/ethnicity, such that Black students realize positive effects of having an equitable

teacher regardless of their math course level, while their Hispanic and White peers realize differing effects depending on course level.

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Introduction

Equity and Math Education

Issues of equity have been a part of discussions within the education community starting early in the history of formalized education in the US. Early debates about equitable education generally focused on who should be educated and what should be taught. Specifically, much of those early debates were centered around competing beliefs concerning equality of educational opportunity (i.e., equal opportunity for all students versus only for those who were deemed most likely to fully utilize those opportunities). In mathematics, in particular, there were opposing positions as to who should take certain math courses, especially algebra. For example, while there was a group of educators and policymakers from the humanist tradition who felt that courses like algebra should be offered to all students, there were many others, for varied reasons, who believed in selective offering of such subjects (Kliebard, 2004).

A number of key American events have helped to further develop conceptualizations of equitable education, especially in math (and science). For instance, frenzied concern for global competitiveness following the launching of Sputnik by the Russians prompted a “maximum return for minimum investment” approach to equity, while the civil rights and feminist movements emphasized equal opportunity for all students and considerations of students as individuals with unique needs (Kahle, 1996). As the student population in the US continues to diversify, conceptions of equity in math education have broadened to include attention to issues of cultural relevancy, student agency, social justice and power structures (Ladson-Billings, 1995; Gutierrez, 2013; Nasir & Cobb, 2002).

Considering the range of equity perspectives in math education, stakeholders in this educational process occupy varied positions on the range of those perspectives which, in turn, influence their actions relative to their role in education. These actions occur on both a micro and macro level from the teaching practices of teachers within math classrooms to policy initiatives made by the President. For example, teachers of mathematics who view equity as an issue of sameness or equality of educational opportunities and resources may utilize classroom practices that rely heavily on modes of instruction that intend to standardize or equalize the educational experiences of their students (Rousseau & Tate, 2003). Those who view equity in more complex ways may employ strategies and practices in the classroom that focus on eliciting student thinking (Steinberg, Empson & Carpenter, 2004), incorporation of aspects of students' culture (Ladson-Billings, 2009), and specific examinations of social issues relative to students' lives (Leonard, Brooks, Barnes-Johnson & Berry, 2010). Similarly, a desire to promote equitable education for all students has resulted in policy initiatives, such as No Child Left Behind and the Every Student Succeeds Act, which have focused heavily on addressing the educational needs of underrepresented groups through increased accountability measures, a focus on testing and the development of common national standards for school subjects.

The Role of Schools in Promoting Equity

A central component of the progression of equity in education broadly, and specific to math education, is the role of schools in society. One body of literature critiques schools for what is believed to be their preservation or exacerbation of inequality through social reproduction. On the other hand, there also exists research that supports the view that schools are instrumental in reducing inequalities by serving as vehicles for social mobility. It is necessary to note that there is no overwhelming consensus as to which viewpoint is correct, speaking to the validity of the evidence provided for both arguments.

Schools as Social Reproducers. There are many researchers who contend that schools are social reproducers that serve to perpetuate the current inequities that exist in different facets of society (e.g. political, economic), and that they maintain the prevalent social order by socializing students to assume the role, attitudes and behaviors that are deemed best suited for their future occupations in society. This viewpoint has its roots in the early years of formal education in the US. Social efficiency educators, as identified by Kliebard (2004), believed that students should be exposed to educational experiences that were considered appropriate for the types of jobs that they were likely to hold in society at the completion of their education.

Those believing that schools are social reproducers purport that inequality in educational experiences for different groups of students is a result of a desire to maintain unequal power structures in society through an unequal distribution of high-status knowledge (Young, 1971; Bourdieu & Passeron, 1977). Apple (1978) further posits that those who gain this type of knowledge tend to be from privileged groups who subsequently greatly influence how this knowledge is transmitted in schools. However, more recent research purports that simply expanding high-status knowledge to students may not eliminate inequality (Raftery & Hout, 1993; Lucas, 2001). Specifically, increasing opportunity through expansion efforts will more greatly benefit those from privileged groups since those groups are more likely and usually better equipped to occupy those new opportunities.

Key to social reproduction theory is the notion that students are ushered into different educational tracks based on their perceived academic ability, with those with privilege somehow always perceived as more able. Thus research has shown that the overwhelming percentage of students in the lower tracks tend to be from lower SES and minority populations (Oakes, 2005). Many studies have shown the stark differences in the types of educational experiences that students receive with some referring to these experiences as indicative of a hidden curriculum (Anyon, 1980) and pedagogy of poverty (Haberman, 1991). Within schools, students are socialized to adopt the types of behaviors that are determined to be appropriate for the types of roles they will have in society at the culmination of their educational experience. Thus researchers from this perspective offer a harsh critique of schools' roles in reproducing inequality.

Schools as Vehicles for Social Mobility. Other research provides evidence that schools in fact provide opportunities for students to move beyond their social or economic circumstances. This research supports the view that schools are vehicles of social mobility, providing the tools necessary for all students to realize the American dream of economic security. Under this view schools employ a system of meritocracy that rewards students based on their academic performance and maintains neutrality without bias towards any particular group of students. If certain groups of students are failing it is due more to non-school factors, particularly family background, than to certain aspects of schools themselves (Coleman et al., 1966).

Some researchers find that schools may prevent achievement gaps between privileged and unprivileged groups from widening. Much of this research examines achievement gaps resulting from students' differing summer experiences. Heyns (1978), in her study with elementary students tested in the fall and spring, compared students' learning gains during the school year to gains during the summer. She found that differences in learning gains were greater during the summer than during the school year and concluded that inequality between different SES and race groups increased when students were not in school. Other studies (Alexander & Entwisle, 1996; Downey, vonHippel & Broh, 2004; Gamoran, 1996) also support this claim.

The Role of Educational Research in Addressing Equity in Math

Education researchers are key players in the establishment and evolution of definitions of equity as well as the ways to go about achieving equity. However, particularly in mathematics education, there has been a great tension as to the role of researchers in the process of promoting equitable math education for all students regardless of class, gender, race/ethnicity, language, religion or other classifications. Specifically, while definitions of equity may vary, as outlined previously, two prime areas of contention exist within the mathematics education community regarding the role of math education research to promote equity.

The first position includes engagement in research that identifies and attempts to provide explanations for achievement and opportunity gaps between different groups of students. Common in the research literature are comparisons in opportunity or achievement of girls relative to boys, Black and Hispanic students relative to their White peers, language minority students relative to their native English speaking peers, and immigrant students relative to their US born peers. Proponents of this type of math education research believe that investigations of such gaps is a necessary first step to making the public as well as policy makers continuously aware of the disparities that exists and persist between groups, and a lack of such studies would support the notion that educational parity between groups has been achieved (Lubienski, 2008). Furthermore, researchers from this perspective believe that equitable access to certain educational opportunities, such as advanced math courses, is critical to ensuring that students from different backgrounds have the same chances to subsequently pursue higher education and eventually enter profitable careers (Moses & Cobb, 2001).

An alternative position on the role of research in achieving equity in math education has a focus that deviates from the idea of "gap gazing" (Gutierrez, 2008) and focuses more on cultural contributions of students and examinations of the within group differences of students versus between group differences. Gutierrez (2008) views such research as adequately addressing the needs of various groups of students without the constant reminder that inequalities exist. She makes the argument that the math education research community is saturated with studies that identify and reiterate those inequalities without much discussion of ways to address such inequalities. Furthermore, she argues for more comprehensive studies that move away from examining equity relative to issues of access and opportunity and towards studies that explore "effective teaching and learning environments" for students from traditionally underrepresented groups and development of students' identity and awareness of power structures in society.

Brief Description of Analytic Chapters

In this dissertation I present three analytic chapters that in various ways support these two alternative positions on the role of research in mathematics education in addressing issues of equity. Through these studies, I make the argument that examining issues of equity in math education is a complex venture, requiring research of varied forms. Collectively, my three analytic chapters support the notion that research that examines gaps, both traditionally and in new ways and contexts, is needed in math education research to gain a thorough understanding of the complexities involved in achieving equity for all students. Specifically, in the first analytic chapter I explore the extent to which Black and Hispanic students in a large and diverse school district are underrepresented in 8th grade algebra relative to their White peers (and each other) within the context of the racial/ethnic composition of their schools. In the second analytic chapter, I continue my investigation into issues of access to advanced math courses by examining whether students from my first analytic chapter who successfully complete algebra in the 8th grade go on to take geometry in the 9th grade. As in the first analytic chapter, I explore this within the context of school racial/ethnic composition of students' middle and high school.

In the third and final analytic chapter, I investigate what happens in math classrooms by utilizing national data from the High School Longitudinal Study (HSLS 09) to examine the extent to which students perceive their 9th grade math teachers as being equitable and how these perceptions affect student outcomes. In this chapter I shift from focusing on gaps in access to coursework to instead focus on students' experiences of equity in the math classroom, exploring how their perceptions of teachers' equitable practices may shape the achievement of students from different racial/ethnic groups. In the conclusion of this dissertation, I end with a summary and synthesis of my findings and discuss how these three analytic chapters contribute to the conversation surrounding equity in mathematics education in the US.

Analytic Chapter One:

Who Gets in? Examining Inequality in 8th Grade Algebra

Educational practitioners, policy makers and researchers have long recognized the influence that high school course-taking has on educational, as well as labor force, outcomes (Adelman, 1999; Gamoran, 1987; Tyson, Lee, Borman & Hanson, 2007). In recent years, particular interest has also been paid to middle school, due to the identification of access to algebra in 8th grade as the gatekeeper to favorable outcomes in high school and beyond. Specifically, 8th grade algebra completion has been linked to higher standardized math test scores, more advanced math course-taking (e.g. completing Calculus in high school), increased likelihood of enrolling in a 4 year college or university, as well as an increased likelihood of pursuing a STEM major (Ma & Wilkins, 2007; Gamoran & Hannigan, 2000; Filer & Chang, 2008; Schneider, Swanson & Riegle-Crumb, 1998; Chen, 2009; Wang, 2013). As recognition of the benefits of early algebra course-taking has grown among educational policymakers as well as parents, there has been a nationwide surge in the percent of students across the US taking 8th grade algebra. For instance, according to Loveless (2016) the number of students taking algebra or higher in 8th grade has increased from 27% in 2000 to 48% in 2013.

Unfortunately, these enrollment trends do not translate across all populations of student groups, as it is well-documented that minority students are underrepresented in 8th grade algebra courses (McCoy, 2005; Cogan et al, 2001; Gamoran & Hannigan, 2000; Spielhagen, 2006; Shakrani, 1996). For example, using a nationally representative sample of 8th graders from the National Educational Longitudinal Study (NELS), Gamoran and

Hannigan (2000) found that rates of 8th grade algebra enrollment were approximately eight percentage points higher for White students than for both Black and Hispanic students. Similarly, Spielhagen (2006) used data for students in a large southeastern school district and found that 50% of White youth were taking 8th grade algebra compared to about 28% of Black and 33% of Hispanic youth. Given these enrollment trends, minority students are leaving middle school, on average, at a huge disadvantage when it comes to their secondary and postsecondary success (Smith, 1996). As such, access to algebra in 8th grade is a critical instance of educational inequality, leading some to refer to it as one of the most pressing civil rights issue of our time (Moses & Cobb, 2001).

While research has clearly established that minority youth are not taking 8th grade algebra at comparable rates to their White peers, there is, nevertheless, a surprising lack of empirical research that delves into the factors that underlie such disparities. Specifically, it is important to understand whether racial/ethnic patterns in access are primarily explained by differences in prior levels of academic performance. If so, this suggests that while inequality in 8th grade algebra is critically important because of its gatekeeper status to subsequent elite academic pathways, the roots of this inequality reach further back before the end of middle school, and thus efforts to erase it should focus on earlier years. Yet if racial/ethnic disparities remain net of earlier differences in academic performance, then attention must be paid to understand the role that race/ethnicity continues to play in determining who has access to this key course. While there are a handful of insightful studies that examine the role that prior academic performance plays in contributing to racial/ethnic disparities in 8th grade algebra, these studies are limited in their focus, including only certain academic background variables (e.g. test scores) while excluding others that may also be important (e.g. prior course level) (Bodovsky & Youn, 2012; Spielhagen, 2006; Faulkner, Stiff, Marshall, Nietfield & Crossland, 2014). In this analytic chapter, I argue that a more comprehensive approach is necessary in order to better understand the role of prior academic preparation in explaining racial/ethnic gaps in enrollment in 8th grade algebra.

Furthermore, prior empirical research on this topic has generally failed to consider the role that school context, such as the racial/ethnic composition of schools, may play in shaping inequalities in access. Given the growing number of racially/ethnically segregated schools nationwide, I argue that such an examination is critical in order for us to gain more accurate insight into the factors that shape inequality. Prior research provides reasons to anticipate that inequalities in access, as well as the extent to which prior performance explains such inequalities, may be different in racially/ethnically integrated versus predominantly minority schools (Kelly, 2009; Mickelson, 2001). Therefore, I consider how disparities in algebra may vary by school racial/ethnic composition, examining not only Black-White gaps, which are the typical focus in research studies in this area, but Hispanic-White gaps as well. The latter disparities have comparatively received very little attention in the literature (Phakeng & Moschkovich, 2013), despite the fact that Hispanics are the largest growing minority group in the country, with the Hispanic student population in particular growing at extremely rapid rates (Fry & Lopez, 2012). Finally, I also consider the potential for gaps in course-taking between Black and Hispanic youth, moving beyond the normative focus on only minority-White comparisons.

Thus in this chapter, I seek to address the limitations in prior research by conducting an in-depth empirical investigation of disparities in access to 8th grade algebra in a large, urban, low-income and high minority school district that exemplifies the local context in which vast numbers of minority youth in our country experience education. Importantly, this district is comprised of relatively large percentages of both Black and Hispanic youth, and as such it provides a critical research opportunity to investigate patterns of continuing inequality for students from both of these minority backgrounds. Specifically, I address two major research questions in this study. First, to what extent do racial/ethnic disparities in prior academic performance (including standardized test scores, grades, and level of prior course-taking), explain subsequent gaps in 8th grade algebra? Second, do patterns of inequality differ by school racial/ethnic composition, such that racial/ethnic disparities in 8th grade algebra enrollment as well as the contribution of prior academic performance in explaining such gaps, vary across school context?

Background

The Role of Prior Academic Achievement

Schools generally offer more advanced curricular opportunities to those students who perform well in class and on standardized exams. In math in particular, due to its hierarchical nature, successful completion of prerequisite math courses is necessary for continuation through the math sequence. Unfortunately, studies have shown that Black and Hispanic students have trailed behind their White peers on a number of academic indicators, including grades earned in class and the level of math courses (e.g., regular vs honors), as well as standardized test scores (Ainsworth-Darnell & Downey, 1998; Vanneman et al, 2009; Hallinan, 1994). Therefore, it stands to reason that if access to 8th grade algebra is determined largely by observable evidence of academic proficiency in math in the prior years of middle school, minority students are likely at a significant disadvantage compared to White students.

Yet surprisingly, very little empirical research has been done to determine the extent to which differences in academic priors explain racial/ethnic disparities in 8th grade algebra enrollment. Furthermore, the few studies that do address this offer limited evidence and mixed results, finding that Hispanic-White gaps in 8th grade algebra enrollment may be explained by prior achievement, while Black-White gaps may not. For example, using data from students from a school district in the southeast, Spielhagen (2006) found that net of academic background, there were no differences between Hispanic and White students. However, a comparison of White and Black students revealed that the former were still 1.4 times as likely as the latter to be enrolled in 8th grade algebra. Similarly, Bodovsky and Youn (2012), found that Black youth, not Hispanic youth, in their sample of students from the Early Childhood Longitudinal Study-Kindergarten Cohort (ECLS-K), had lower likelihood of enrollment into the course compared to their White peers. Specifically, Black youth had odds of algebra enrollment that were about half that of their White peers even when some measures of prior academic preparation were accounted for. Similarly, Faulkner and colleagues (2014), also using ECLS-K, found that Black students were less likely to be placed in 8th grade algebra relative to White students net of academic preparation. The authors did not explore Hispanic-White gaps in this study.

While providing valuable insight into the possible role of academic background on racial/ethnic disparities in enrollment, these studies are limited due to incomplete measures of academic priors. For instance, Bodovsky and Youn (2012) consider only test scores in their analyses while Spielhagen (2006) and Faulkner and colleagues (2014) utilized math test scores and some measure of teacher evaluation of students. I argue that to fully investigate the impact that academic background has on gaps in 8th grade algebra enrollment, a more comprehensive examination of academic background is necessary. Specifically, I contend that in addition to grades and test scores, the level of prior math course placement should also be considered. Research on tracking has clearly established that students in advanced classes earlier on are likely to continue on that path, while those who have been placed in regular or lower level classes are very unlikely to be able to jump into a higher level course (Oakes, 1985; Lucas, 1999). Thus, students in honors math classes in 7th grade are much more likely than their peers in regular classes to advance into 8th grade algebra. By including all three measures of prior academic performance, this chapter provides a holistic and multifaceted view of the academic factors that could influence placement into 8th grade algebra.

Considering School Racial/Ethnic Composition

Opportunities to take advanced courses are certainly not constant across schools across the nation, nor are they necessarily constant across schools in the same district

(Gamoran, 1987; Kao & Thompson, 2003). The steady increase in the number of racially/ethnically segregated schools in the US (Orfield, Ee, Frankenberg & Siegel-Hawley, 2016) further warrants that researchers should pay attention not only to racial/ethnic gaps in course-taking within integrated schools that are relatively diverse in their student composition, but also in high minority schools where there still may be the potential for White students' overrepresentation in advanced courses relative to their minority peers.

Just as prior research reveals relatively little about the extent to which academic background helps to explain racial/ethnic gaps in 8th grade algebra enrollment, we know even less about the role that school racial/ethnic composition may play in shaping these gaps. However, we do gain some insight into this issue from a broader research literature on racial/ethnic disparities in advanced math course-taking in high school that has specifically examined how inequality is created and maintained within integrated schools. While the historical impetus for creating more integrated schools was to provide more equitable educational experiences for Black students relative to White students in the 1960s, research on high schools in particular has clearly documented that minority students remain substantially disadvantaged relative to their White peers in access to advanced courses within integrated schools (Noguera & Wing, 2006; Muller, Riegle-Crumb, Schiller, Wilkinson & Frank, 2010; Lucas & Berends, 2002; Tyson, 2011). Arguably, this "second-generation segregation" essentially repackages racial/ethnic segregation from one that occurs between schools to one that occurs within schools, such that Black and Hispanic students are over-represented in the lowest level classes while their White peers are over-represented in more advanced classes (Oakes, 1985; Welner & Oakes 1996; Muller et al, 2010; Riegle-Crumb & Grodsky, 2010). A poignant example of this trend is offered by Mickelson's (2001) study of high school seniors in a desegregated high school in the Charlotte-Mecklenberg school district. She finds that while Black students made up about 35% of the school population, they made up less than 3% of students in Advanced Placement courses.

Yet while this research clearly demonstrates that racial/ethnic inequality in representation in advanced courses in high school often remains strong in integrated schools, it rarely considers the extent to which such inequality is explained by students' prior academic performance. Notably, a few studies, some qualitative (Noguera & Wing, 2006) and others quantitative (Kelly, 2009) do provide some evidence that racial/ethnic gaps in advanced course-taking remain net of differences in academic background in integrated schools. For example, Kelly (2009) finds that within integrated schools, Black students were less likely to be enrolled in a higher math sequence than their White peers net of prior math grades, test scores and track placement. Also, while research on Black-White differences is very limited, to my knowledge there are no studies that examine Hispanic-White differences in course-taking within integrated schools.

Furthermore, we know very little about disparities in advanced course-taking within predominantly minority schools, which is critical as most minority students attend schools where they comprise a large percentage of the student body (Orfield, Kucsera & Siegel-Hawley, 2012). The limited research in this area provides somewhat ambiguous evidence of how inequality may diverge from what occurs within integrated school settings. For instance, utilizing a nationally representative sample of 9th graders, Kelly (2009) finds that rates of advanced course-taking among White and Black youth are relatively equitable in predominantly Black schools. Yet some qualitative studies suggest that even within high-minority schools, White students maintain a privileged academic status, and are viewed more favorably by teachers (Morris, 2007; Berry, 2008). If so, then White privilege, in the form of higher rates of advanced math course-taking, may still be apparent in schools that are predominantly minority. As with research in integrated schools, virtually nothing has been done to investigate disparities between Hispanic and White students within predominantly minority schools.

Stepping back, the extant literature offers some critical information about the maintenance of disparities in enrollment in advanced courses in both integrated and high-minority contexts, but the findings are incomplete. First, as evidenced above, we know very little about the extent to which prior academic performance works differently to explain disparities across different school contexts because few studies empirically assess this possibility. Second, the vast majority of the racial/ethnic comparisons included in the literature are between Black and White students, with very little attention to Hispanic-White comparisons. This is a critical omission in the literature as Hispanic students are the largest minority group in US public schools (Kena et al., 2016). Third, while minority-White comparisons are certainly important to continue to examine, I argue that it is also important to consider the comparisons of minority groups relative to each other, given the growing number of school districts that have a large representation of at least two minority groups. For instance, among the 20 largest school districts in the US, the average percentage of Black and Hispanic youth is 31.7% and 38.4%, respectively (KewalRamani, Gilbertson, Fox & Provasnik, 2007). Such patterns clearly indicate that research needs to move beyond simple minority-White comparisons. Thus in this chapter I will examine whether racial/ethnic gaps in access to 8th grade algebra are explained by indicators of prior academic performance, and whether such patterns may differ across school racial/ethnic contexts. Specifically, I examine inequality in both integrated as well as high-minority schools, and importantly consider inequality not only between White youth and their minority peers, but also between students from different minority groups.

Data and Methods

For this study I utilize data from students from a large and diverse urban school district in the southwest. The district is comprised of approximately 200,000 students who are largely minority (approximately 62% Hispanic and 25% African-American), about 25% LEP (Limited English Proficient) and more than 75% eligible for free or reduced lunch. The research team collected administrative data (including academic transcript data) and survey data, for more than 30,000 middle schoolers from this district every year starting in the 2009-2010 school year and culminating in the 2014-2015 school year when many of the students were high schoolers. I base the analyses for this study on 10,489 students who were 8th graders during the 2010-2011 or 2011-2012 school years. I restrict my sample to students who are identified as White, Black or Hispanic on their academic record provided by the school district. Asian students and students from other racial/ethnic groups make up less than 4% of the student population and were, therefore, not included in these analyses.

My dependent variable is algebra enrollment where 1 corresponds to enrollment in algebra and 0 corresponds to enrollment in a course lower than algebra (e.g. Pre-algebra). My measure of algebra enrollment was determined from student transcripts which indicate the math course taken in 8th grade.

My key independent variables are three measures of academic background from students' 7th grade year. They include *math grade*, a standardized continuous measure of students' grade received in their 7th grade math class, *math test,* a standardized version of students' 7th grade math test score on the state accountability exam and, *honors math*, which is a dichotomous variable where 1 indicates that the 7th grade math course was an honors course and 0 otherwise. All of these measures were taken from students' administrative records, specifically student transcripts and test score records compiled by the district. As mentioned previously, I include all three of these measures in order to have a more thorough representation of academic priors leading into 8th grade algebra enrollment than what has been utilized in previous research studies.

As social class background has a strong association with both race/ethnicity and prior academic achievement, including proxy measures for this better enables me to assess the unique contribution of students' race/ethnicity to their chances of enrolling in algebra. I therefore include a measure for *free/reduced lunch*, which is available through administrative records and coded as 1 if students were eligible for free or reduced lunch and 0 otherwise. The second measure is *books at home*, an ordinal variable created from a survey question asking students to estimate the number of books they have in their home, where 1 indicates the lowest response of "Few (0 to 10)" and 4 represented the highest response of “Enough to fill several bookcases (more than 100)”. *Books at home* is often used as a proxy for social class in research studies utilizing surveys from adolescents due to it capturing observable measures of family resources (Kastberg et al, 2013).

I also include a number of controls in this study. These include *female*, with a value of 1 for females and 0 for males, and Limited English Proficient (*LEP)* status, coded 1 if the student was categorized as LEP on their middle school transcript and 0 otherwise. I also control on *school size* and *school free/reduced lunch* which captures the percentage of students eligible for free/reduced lunch for each middle school. I obtained these school level measures from profile data available for each school through the state’s education agency website. Finally, as my data are taken from two different cohorts, my multivariate analyses include a dichotomous variable to capture this.

The purpose of this analytic chapter is to investigate the likelihood of enrollment in 8^{th} grade algebra for minority students relative to their White peers (and each other), net of prior academic performance. In order to investigate the possible racial/ethnic differences in likelihood of enrollment across school contexts, two separate sets of analyses were conducted, the first for students in schools classified as “integrated” and the second for students in schools classified as “predominantly Hispanic”. I define an integrated school as one having no more than 60% of any one racial/ethnic group and at least 20% of each of the numerical minority groups. I define a predominantly Hispanic school as one that is more than 60% Hispanic. I note that most schools in the district fall into the predominantly Hispanic classification, while far fewer can be classified as integrated. Accordingly, my sample includes data from 5 integrated middle schools (n=3125 students) and from 15 predominantly Hispanic schools (n=7364 students). My analyses include descriptive results about the characteristics of students in each of these school types, as well as two-level, multivariate logistic regression random effects models, where students are nested within middle schools.

Results

Descriptive Results

Comparing Integrated and Predominantly Hispanic Schools. To give a sense of how these two school types differ in terms of characteristics of students they serve, Table 1.1 provides descriptive statistics on algebra enrollment, academic background, and controls. I note that as indicated in the table, all differences in means between students from integrated schools and predominantly Hispanic schools are statistically significant. Overall, students in integrated schools take 8th grade algebra in larger numbers (36%) than their peers in predominantly Hispanic schools (23%). Students attending integrated schools have higher values on the academic measures than their peers in predominantly Hispanic schools. For instance, students from integrated schools have mean math grades that are a tenth of a standard deviation higher than the mean math grades of their peers in predominantly Hispanic schools. Differences in math test scores are more pronounced as they differ by almost a half a standard deviation. Also, 70% of students in integrated schools took an honors math course in the 7^{th} grade, while only 43% of students in predominantly Hispanic schools did the same. In addition, students within integrated schools come from higher social class backgrounds as indicated by a lower percentage of students eligible for free/reduced lunch and a higher mean score on the *books at home* measure. Lastly, the difference between school types in the percentage of LEP students (i.e. 18% for integrated schools vs 50% for predominantly Hispanic schools) demonstrates a stark difference in the percentage of students who may be hindered from taking an advanced math course such as 8th grade algebra due to being previously classified as LEP (Wang & Goldschmidt, 1999; Callahan, Wilkinson, & Muller, 2010). Thus Table 1.1 reveals that within the same school district, these two school types diverge considerably in terms of the academic and social background of the students that attend them.

Table 1.1. Descriptive Statistics: Means and Proportions *by School Type*

	Integrated Schools	Predominantly Hispanic Schools
8th grade Algebra	0.36***	0.23
Race/Ethnicity		
White	0.28	0.02
Black	0.31	0.12
Hispanic	0.41	0.84
7th Grade Academic Priors		
Math Test Score (Standardized)	0.29 (0.99)***	-0.12 (0.98)
Math Grade (Standardized)	0.07 (1.04)***	-0.03 (0.98)
Honors Math	0.70***	0.43
Controls		
Free/Reduced Lunch	0.61***	0.97
Books at Home	2.78 (0.99)***	1.95 (0.93)
Female	0.53	0.51
LEP	0.18***	0.50
N (school)	5	15
N (students)	3125	7364

*** p<0.001, ** p<0.01, * p<0.05, standard deviations in parentheses

I now turn to descriptively consider the extent to which there are racial/ethnic differences in algebra enrollment within each of these school types. Beginning first with integrated schools, Figure 1.1 reveals that White students in integrated schools are overrepresented in 8th grade algebra while their Black and Hispanic peers are underrepresented. Specifically, White students are taking algebra at a rate more than twice that of their Black and Hispanic peers (61.3% of White students vs 26.5% of Black students and 28.4% of Hispanic students). Thus, White students have a clear course-taking advantage over Black and Hispanic students, while Hispanic students have a slight advantage relative to Black students. Similarly, in predominantly Hispanic schools (see Figure 1.2), I also find that White students have an advantage in algebra enrollment relative to their minority peers, and Hispanic students have a slight advantage over their Black peers. Specifically, White students are taking algebra at a rate that is about twice that of their minority peers (42.7% White students vs 20.7% Black students and 23.5% Hispanic students) and the Hispanic-Black enrollment rate differs by about 3 percentage points.

Figure 1.1. 8th Grade Algebra Enrollment by Race/Ethnicity for Students in *Integrated Schools*

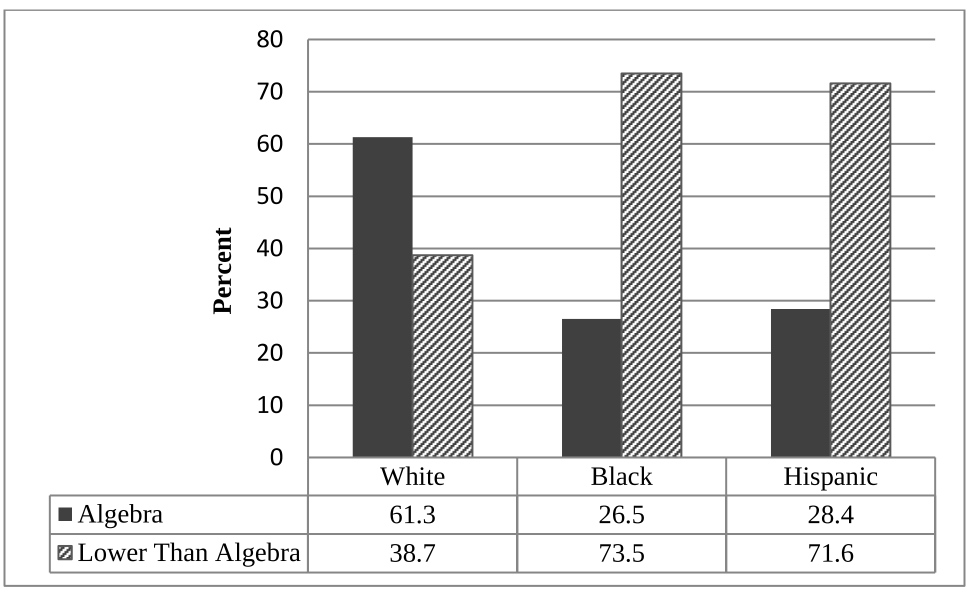
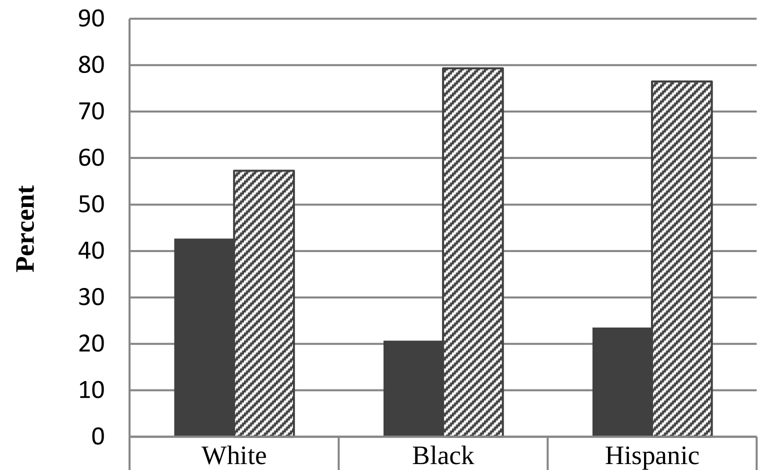


Figure 1.2. 8th Grade Algebra Enrollment by Race/Ethnicity for Students in *Predominantly Hispanic Schools*



	White	Black	Hispanic
Algebra	42.7	20.7	23.5
Lower Than Algebra	57.3	79.3	76.5

I now turn to consider whether and how the racial/ethnic differences observed in algebra enrollment in both integrated and predominantly Hispanic schools are explained by students' academic performance in prior grades. For each school type, I begin with a descriptive look at racial/ethnic differences in academic priors (as well as control variables), and then subsequently move to the results of multi-level random effects logistic regression analyses.

What Happens in Integrated Schools. Table 1.2 displays means on academic background variables as well as measures of social class and other control variables within integrated schools for each racial/ethnic group. Overall, White students have higher values on the academic priors and come from higher social class backgrounds relative to their Black and Hispanic peers. For example, relative to their minority peers, White students score more than a half a standard deviation higher on the standardized math test and about .7 of a standard deviation higher on 7th grade math grade. Lastly, 89% of White students took an honors math class in 7th grade compared to 62% of Black students and 63% of Hispanic students. As for social class background, while 69% of Black students and 84% of Hispanic students are eligible for free or reduced lunch, only 19% of White students are. Similarly, the mean value on the *books at home* variable is 3.3 compared to 2.8 and 2.4 for Black and Hispanic students, respectively. Finally, 41% of Hispanic students are classified as LEP compared to only 3% and 1% of White and Black students, respectively. Comparisons of the two minority groups do not indicate an academic advantage of one group over another as Hispanic students have slightly higher math test scores, Black students have slightly higher math grades and both groups have rates of honors math enrollment that are equivalent. Yet Black students come from higher social class backgrounds than their Hispanic peers. All of these results were statistically significant ($p<.05$).

Table 1.2. Descriptive Statistics: Means and Proportions by Race/Ethnicity for Students in *Integrated Schools*

	White	Black	Hispanic
7th Grade Academic Priors			
Math Test Score (Standardized)	0.73 (0.99)BH	0.03 (0.88)H	0.18 (0.97)B
Math Grade (Standardized)	0.54(0.98) BH	-0.07(0.89) H	-0.15(1.08)B
Honors Math	0.89 BH	0.62	0.63
Controls			
Free/Reduced Lunch	0.19 BH	0.69 H	0.84 B
Books at Home	3.30(0.83) BH	2.80(0.92) H	2.40(0.99) B
Female	0.48 BH	0.56	0.53
LEP	0.03 BH	0.01 H	0.41 B
N (students)	858	973	1294

B indicates that the mean is statistically significantly different than the mean for Black students ($p<.05$). H indicates that the mean is statistically significantly different than the mean for Hispanic students ($p<.05$), standard deviations in parentheses.

I now turn our attention to results of multivariate analyses displayed in Table 1.3. The results from my logistic regression models are presented as odds ratios, which are relative measures of the effect that a one-unit increase of an independent variable has on the odds of enrollment in algebra, holding all other variables in the model constant. Furthermore, when investigating the likelihood of enrollment of one racial/ethnic group relative to the reference group, odds ratios are easily interpretable. For example, if comparing Black students relative to White students, an odds ratio of 1 indicates that the odds of enrollment for Black and White students are the same. An odds ratio greater than 1 indicates that Black students have higher odds than White students, while an odds ratio less than 1 indicates that Black students have lower odds than White students.

Table 1.3. Odds Ratios from Logistic Regression Analyses Predicting Algebra Enrollment among Students in *Integrated Schools*

	Model 1	Model 2	Model 3
Race/Ethnicity (ref=White)			
Hispanic	0.244***	0.580***	0.779
	(0.0235)	(0.0702)	(0.140)
Black	0.238***	0.354***	0.793
	(0.0248)	(0.0411)	(0.134)
7^{th} Grade Academic Priors			
Math grade			3.599***
			(0.330)
Math test			5.704***
			(0.596)
Honors math			12.45***
			(2.861)
Controls			
Free/reduced lunch		0.609***	0.706*
		(0.0602)	(0.102)
Books at home		1.582***	1.340***
		(0.0754)	(0.0913)
Female		0.996	0.826
		(0.0822)	(0.0996)
LEP		0.521***	0.782
		(0.0705)	(0.155)
School size		1.000	1.000*
		(0.000303)	(0.000222)
School % free/reduced lunch		1.013	1.091***
		(0.0177)	(0.0174)
Constant	1.498*	0.279	0.00153***
	(0.245)	(0.262)	(0.00135)

N=3125 students and 5 schools
Standard errors in parentheses; results are from random effects models where students are nested within schools; *** p<0.001, ** p<0.01, * p<0.05

Consistent with Figure 1.1, I see that Black and Hispanic students are statistically significantly less likely to be enrolled in 8^{th} grade algebra relative to White students.

Specifically, Black and Hispanic students, have odds of enrollment that are 0.238 and 0.244 that of White students, respectively. In model 2, I add measures of social class and family background, as well as school characteristics. Not surprisingly, accounting for these measures reduces racial/ethnic disparities in the likelihood of enrolling in algebra. Specifically both the Black and Hispanic odds ratios (relative to Whites) increase with the inclusion of these measures, yet they remain statistically significant. Both free/reduced lunch eligibility and my second SES proxy (i.e. *books at home*) are statistically significant and positively associated with the likelihood of enrollment. On the contrary, being classified as LEP reduces the odds of enrollment in algebra. Neither school size nor the school percentage of students eligible for free/reduced lunch predicts likelihood of enrollment.

Lastly, in my full model I add my three measures of academic background to determine the extent to which racial/ethnic disparities remain net of these key factors. Each measure has a strong and significant effect on likelihood of enrollment. Specifically, a one standard deviation increased in students' math grades results in odds of enrollment that are 3.5 times greater; a one standard deviation increase in 7th grade math test score increases the odds of enrollment by a factor of 6. Furthermore, being in an honors class results in being 12.5 times more likely to be enrolled than not being in an honors class. With the inclusion of these variables, I find that the odds ratios of both Hispanic and Black students relative to their White peers are closer to 1 and no longer statistically significant. This indicates that within integrated schools, when Black and Hispanic youth have comparable levels of academic performance on grades and test scores and similar levels of prior course-taking, their probability of enrolling in 8th grade algebra is statistically equivalent to that of their White peers. Additionally I note that the odds ratios for both Black and Hispanic youth relative to White youth look very similar in this final model. Consistent with my interest in considering potential differences between students from different minority groups, I conducted follow-up tests (i.e., switch the contrast group to Hispanic instead of White) which confirmed that there was not a significant difference in the likelihood of enrollment between Black and Hispanic youth in integrated schools.

What Happens in Predominantly Hispanic Schools. I now turn to examine inequality within predominantly Hispanic schools, which comprise the main school type within this district. In Table 1.4 I display means by racial/ethnic group on the background variables. As is the case in integrated schools, White students are higher on academic background and have higher social class backgrounds than their Black and Hispanic peers. While these mean differences are statistically significant ($p<.05$), I note that they are not as large in magnitude as is evident in integrated schools (as seen in Table 2). For example, White students have math grades that are about a third of a standard deviation higher than those of their minority peers. Also, White students' math test scores are about a quarter of a standard deviation higher than those of their Hispanic peers and almost a half a standard deviation higher than those of their Black peers. Furthermore, a larger percentage of White students took an honors math class in 7th grade compared to their minority peers (67% vs. 41% Black students and 43% Hispanic students). In addition, a large percentage of all students, regardless of race/ethnicity are eligible for free or reduced lunch. However, more than 90% of minority students are eligible while about 82% of White students are. Also, White students have a higher mean on the *books at home* measure at 2.8 compared to Black and Hispanic students at 2.2 and 1.9, respectively. When considering comparisons of the two minority groups, I find that Black students have lower levels of academic performance compared to their Hispanic peers, while the latter group has lower means than the former on proxies for social class background. Finally, as in integrated schools, Hispanic students have the largest proportion of students classified as LEP at 57.5%, while only 2.1% of White students and 2.2% of Black students are classified as such.

Table 1.4. Descriptive Statistics: Means and Proportions by Race/Ethnicity for Students in *Predominantly Hispanic Schools*

	White	Black	Hispanic
7th Grade Academic Priors			
Math Test Score (Standardized)	0.13(0.93) BH	-0.30(0.91) H	-0.10(0.99) B
Math Grade (Standardized)	0.29(0.90) BH	-0.09(0.96) H	-0.02(0.99) B
Honors Math	0.67 BH	0.41	0.43
Controls			
Free/Reduced Lunch	0.82 BH	0.93 H	0.98 B
Books at Home	2.80(0.98) BH	2.20(0.97) H	1.90(0.90) B
Female	0.51	0.52	0.50
LEP	0.02 H	0.02 H	0.58
N (students)	96	958	6310

B indicates that the mean is statistically significantly different than the mean for Black students ($p<.05$). H indicates that the mean is statistically significantly different than the mean for Hispanic students ($p<.05$), standard deviations in parentheses.

I now turn to consider whether the differences in academic background seen in Table 1.4 explain subsequent racial/ethnic disparities in algebra enrollment. Thus in Table 1.5, I present results of logistic regression models predicting likelihood of enrollment of White and Black students relative to Hispanic students since Hispanic students represent the numerical majority in this context. The baseline multi-level model essentially replicates the descriptive results discussed above, but adjusts for clustering within schools. Compared to Hispanic students, White students have a higher likelihood of algebra enrollment; I note however that this difference is not statistically significant. Black students, on the other hand, are statistically significantly less likely to be enrolled compared to their Hispanic peers (OR=0.774).

Table 1.5. Odds Ratios from Logistic Regression Analyses Predicting Algebra Enrollment among Students in *Predominantly Hispanic Schools*

	Model 1	Model 2	Model 3
Race/Ethnicity (ref=Hispanic)			
White	1.314	0.872	0.923
	(0.304)	(0.208)	(0.317)
Black	0.772**	0.575***	0.742*
	(0.0754)	(0.0605)	(0.112)
7th Grade Academic Priors			
Math Grade			2.585***
			(0.168)
Math Test Score			5.659***
			(0.419)
Honors Math			8.242***
			(0.942)
Controls			
Free/Reduced Lunch		0.821	1.092
		(0.136)	(0.267)
Books at Home		1.265***	1.083
		(0.0404)	(0.0498)
Female		0.986	0.988
		(0.0579)	(0.0831)
LEP		0.693***	0.799*
		(0.0446)	(0.0734)
School Size		0.998**	0.998
		(0.000747)	(0.00114)
School % Free/Reduced Lunch		1.141***	1.237***
		(0.0259)	(0.0406)
Constant	0.305***	9.30e-05***	1.92e-08***
	(0.0543)	(0.000174)	(5.64e-08)

N=7364
Standard errors in parentheses. Results are from random effects models where students are nested within schools. *** p<0.001, ** p<0.01, * p<0.05

Model 2 adjusts for social class and family background, as well as school characteristics. The odds ratio for Black students remains statistically significant and actually decreases somewhat, such that Black students are even less likely to enroll in algebra than their Hispanic peers. This appears to be driven by the fact that relative to

Hispanic students, Black students are less likely to be classified as LEP, which significantly reduces the likelihood of enrolling in algebra. The measure of *books at home* is statistically significant and positively associated with likelihood of enrollment in algebra. I also find that school size and school percentage of free and reduced lunch eligible students are both statistically significant predictors of enrollment.

Lastly, in the full model, I add my three key measures of academic background, and find that, similar to the trend for integrated schools, grades, test scores and prior course-taking each positively and significantly predict the likelihood of enrollment. Yet Black students remain significantly disadvantaged relative to their Hispanic peers in the likelihood of 8th grade algebra course-taking (OR=.742). Finally, changing the reference category to White students revealed that Black students were also at a significant disadvantage relative to their White peers in all models. Thus, within the context of predominantly Hispanic schools, Hispanic students have comparable chances of enrolling in 8th grade algebra as their White peers (who comprise a very small fraction of the student body). Yet net of all controls as well as my key measures of prior academic background, Black students in these schools remain significantly less likely to enroll in this course, compared to both their Hispanic peers who comprise the majority of the school population, as well as their White peers.[1]

[1] To test whether race/ethnic gaps in algebra course-taking might vary by gender, in exploratory analyses we also included interactions terms in our models for both integrated and predominantly Hispanic schools. These interactions were not statistically significant and therefore are not included here.

Discussion and Conclusion

Algebra in 8th grade is known as a gatekeeper to many favorable academic outcomes in high school and beyond and as such, there has been a push for earlier access to the course starting in 8th grade. Unfortunately, Black and Hispanic students have not been taking the course at rates similar to their White peers. In this chapter, utilizing data from a racially/ethnically diverse school district, I make a contribution to the limited prior research on the determinants of these disparities by considering more comprehensive measures of academic background than previous studies, and importantly, considering gaps within schools of different racial/ethnic compositions. In addition, I do not limit my analyses to enrollment gaps between White and Black youth, as is common in research studies examining racial/ethnic disparities in advanced course-taking in general, but rather examine both White-Hispanic gaps and Black-Hispanic gaps as well.

Indeed my results reveal important differences in course-taking patterns according to school context. First my descriptive results suggest greater availability of 8th grade algebra courses in integrated schools compared to predominantly Hispanic schools, given the overall higher rates of enrollment in the former (see Table 1.1). Within this predominantly Hispanic district, I note that while the number of racially/ethnically integrated schools is relatively low, they serve students from relatively higher levels of social class background and those with generally higher levels of academic performance.

Within these integrated schools, Black and Hispanic students are underrepresented in 8th grade algebra while their White peers are overrepresented. After adjusting first for differences in social class and family background as well as school characteristics, I found that differences in academic priors, including grades, test scores, and prior course-taking, explained the remaining White advantage in 8th grade algebra. Thus my findings suggest that students from different racial/ethnic groups who are similar in academic (as well as social class) background have equal chances of getting into algebra. In some sense this could be viewed as a favorable result, suggesting that schools are allotting access to this critically important course in a meritocratic manner, admitting those students who have previously demonstrated high levels of math performance. And yet at the same time I caution that this is likely an overly optimistic interpretation, particularly given the large differences by race/ethnicity on 7th grade academic measures as seen in Table 1.2. Clearly, Black and Hispanic youth within integrated schools trail behind their White peers quite dramatically in terms of their 7th grade test scores and grades, and are much less likely to have taken honors math. Thus I argue that there is good reason to examine the role that schools play in contributing to gaps that appear earlier in middle school, as well as even further back into elementary school, as my results support the need to consider how early disparities may shape subsequent patterns of inequality (Lubienski, 2008).

As I consider White-Hispanic gaps within predominantly Hispanic schools, my results confirm findings from other studies that suggest that minority students do not have a course-taking disadvantage relative to Whites in a high minority school (Kelly, 2009). However, I also find that Black students are significantly less likely to enroll in 8th grade algebra relative to both their White and Hispanic peers, a disparity that remains significant net of control variables as well as measure of prior academic background.

This persistent course-taking disadvantage of Black youth within predominantly Hispanic schools, suggests the possibility of a "double-minority" effect. This term is often used to define individuals who belong to two different groups that have lower social status on some dimension, such as belonging to a racial/ethnic minority group as well as being an immigrant or being female (DeJong & Madamba, 2001; Denton & Massey, 1989). For example, research has examined the particular obstacles of Black females or Hispanic first generation immigrants. But instead I suggest a possibly different definition that looks at how an individual may belong to a minority group at the macro/national level as well as belong to a minority group in their local environment. Thus Black students in my sample belonged to a racial/ethnic minority group in the national context, but also occupied a school context that is composed primarily of students from a different racial/ethnic minority group to which they did not belong. This experience is not unique to students in my sample, as many school districts across the US have significant representations of at least two racial/ethnic minority groups (KewalRamani et al., 2007). As such, future research should examine the particular obstacles that may be faced by students that occupy such a double-minority status.

Reflecting on the findings of this study, I argue that there is clear evidence that school racial/ethnic composition has implications for access to 8th grade algebra for minority students, in sometimes unexpected ways. The school district from which my sample comes (large, urban and diverse) is similar to that attended by many minority youth in the US. But, I also recognize that this district may be unique in other ways that limit the applicability of my findings to other districts across the nation. Clearly more research needs to be done that moves beyond traditional Black-White comparisons in order to further understand the complexities behind gaps in access to 8^{th} grade algebra and other advanced math opportunities. This move would respond to the call to expand on current work on achievement gaps between minority students and their White peers through examinations of disparities in access to specific math content (NCTM Research Committee, 2015) and would, thus, broaden the conversation surrounding the racialized opportunities for minority students across different school contexts (Parks & Schmeichel, 2012).

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Analytic Chapter Two:

Straightforward Path, Dead End or Labyrinth: 9th Grade Math Placement for Students Successfully Completing 8th Grade Algebra

Beyond the obstacles relative to equity in access to 8th grade algebra, another pressing cause for concern is the possibility that minority students who successfully complete 8th grade algebra may not be realizing the same favorable math outcomes as their White peers do. Specifically, research suggests that in their transition to high school, unlike their White peers, Black and Hispanic students who are successful completers of this gateway course may not proceed to the next math course in the sequence (i.e., geometry) (Noguera & Wing, 2006; Waterman, 2010). Conversely, there is research to suggest just the opposite, that is, that minority students who are set on an advanced math course-taking trajectory remain on par with or exceed their White peers in advanced math course-taking (Bennett & Lutz, 2009; Bennett & Xie, 2003; Merolla, 2013).

In this analytic chapter, I will address the following research questions:

1. Among students who successfully complete algebra in 8th grade are there racial/ethnic differences in the probability of taking geometry in the 9th grade? If so, to what extent are differences explained by grades in algebra and/or the racial/composition of their high school?
2. Are there differential returns to the grades earned in 8th grade algebra such that Black and Hispanic students' placement in geometry is more dependent on the grades they earned? Does this differ by school racial/ethnic composition?

In this second analytic chapter I contribute to the current literature on advanced math course-taking in a number of ways. First, I add to the existing literature by investigating the 9th grade math placement of minority students and their White peers after they having successfully completed 8th grade algebra. My specific aim is to determine if course placement outcomes result from arguably meritocratic processes, rewarding Black and Hispanic students and their White peers equally through comparable rates of enrollment into geometry after successfully completing algebra in the 8^{th} grade. Second, I utilize data from a large and diverse urban school district with a significant percentage of minority students (60% Hispanic, 20% African American) allowing for an easy in-depth exploration into issues related to race/ethnicity. Lastly, I investigate differences in enrollment across schools by racial/ethnic composition to determine its effect on enrollment patterns.

Background

The transition to high school is a pivotal time in a student's educational experience for a variety of reasons including a possible cut of social ties (Langenkamp, 2011), the loss of middle school teacher mentors and/or relationships (Midgley, Feldlaufer, & Eccles, 1989), and a decline in academic achievement (Langenkamp, 2009). Specifically, as it relates to math course-taking, the transition to high school could also interrupt advanced course-taking trajectories for students who have demonstrated competency in an advanced math course (i.e., algebra) in the 8^{th} grade. Minority students are especially at risk particularly if high school course placement decisions are not based solely on merit in terms of observable indicators of success, but on more subjective (and sometimes biased) determinations of readiness for an advanced 9th grade course such as geometry. For example, Waterman (2010) investigated the high school math course placement of middle school students from the Bay Area who received a grade of at least a B- in an algebra course in the 8th grade and found that almost 45% of those students were retained and re-took algebra in the 9th grade. Furthermore, he also found that retention rates varied by race/ethnicity such that students from underrepresented groups in that area (i.e., Filipino students) were the most likely to be retained compared to their White, Asian and Latino peers.

The Role of High School Counselors

High school counselors play a key role in course placement decisions of students. Particularly as it relates to students entering high school as freshmen, high school counselors often have the ability to determine 9th graders' entire high school math course-taking trajectories with their initial math course placement determination. Decisions made by counselors may be driven by a variety of factors including information about the sending school including its racial/ethnic composition. Perceptions of the academic rigor of the middle school, for example, may shape the placement decisions of school counselors. For example, perceptions that teachers grade minority students on an easier scale or that classes with high numbers of minority students are of lower quality (McKown & Weinstein, 2002) may add to the likelihood that counselors have lower expectations of Black and Hispanic students. This could result in high school counselors either undoing the course placement recommendations made by middle school counselors and teachers or downplaying visible markers of success (e.g. successfully completing the course).

Furthermore, there may be a differential return to the actual grade received in an 8th grade algebra course such that students from minority groups with final grades that are similar to those of their White peers, may not reap the benefits of those grades in the form of 9th grade geometry placement. For example, in a study investigating disparities in the highest math course that students reached by the end of high school, Riegle-Crumb (2006) found that Black male students received lower returns from getting high grades than their White peers did. Specifically, she determined that relative to their White counterparts, Black males who earned an A or B in their 9th grade math course ended up completing less advanced math courses by the time they finished high school.

Students, Their Parents and Agency

Students' retention in algebra (or placement in a course below algebra) in 9th grade could also be due to a lack of agency by students and their parents. Specifically, the economic, social and cultural capital of minority students and their parents may not be sufficient enough to provide them with the knowledge base required to navigate school course-taking decisions (Noguera & Wing, 2006). So while a Black or Hispanic student entering the 9th grade having already completed algebra in the 8th grade may decide that she should repeat the course simply because she believes she is not ready to move on to geometry, her White peer, who is well versed in the benefits of continuing on with advanced math course-taking, would likely continue on that course-taking trajectory.

White parents, unlike some parents of Black and Hispanic students, often serve as advocates for their students' educational opportunities. Research on the lack of agency of working class parents relative to middle class parents attributes the former's lack of agency in their children's course-taking decisions on their trust in the educational system. For example, Lareau (2000), in her study of working and middle class parents, found that working class parents tend to trust the judgment of teachers, counselor and administrators due to their belief that they were more qualified to make educational decisions for their children. Consequently, decisions made about course placement are usually left up to those school officials. Given the established correlation between race/ethnicity and social class background such that individuals from minority groups are overrepresented in lower social class brackets, it is likely that many Black and Hispanic parents also hold this view on educational decision making. The lack of agency of minority parents, specifically those from lower-SES households, further exacerbates the issue of misplacement of students in math courses in high schools, since decisions made by counselors and teachers often go unchallenged.

Data and Methods

For this chapter I utilize the same district data as that used in the first analytic chapter. I base the analyses for this study on 2,245 students who successfully completed algebra when they were 8th graders attending a predominantly Hispanic or integrated middle school during the 2010-2011 or 2011-2012 school years. I limit my sample to students who transition to either a predominantly Hispanic or integrated high school, as these are the two main school types by racial/ethnic composition. A student is considered as passing algebra if he or she earns a final grade of at least 70% as indicated on their academic transcript and also corresponds with the district's minimum requirement for successful completion of a course. As in the first analytic chapter, I also limit my sample to students identified as White, Black or Hispanic by the school district.

The dependent variable for this study is *geometry enrollment,* where 1 represents enrollment in geometry (or above) in the 9th grade and 0 represents enrollment in a course lower than geometry (e.g. Algebra). In the district represented in this analysis, geometry normally follows Algebra I in the math sequence. My measure of geometry enrollment comes from students' high school transcripts which indicate the course taken in 9th grade.

The key independent variable in this study is *algebra grade* which is a continuous variable indicating students' grade in 8th grade algebra. I also include 2 measures of social class background, *free/reduced lunch*, which is coded 1 if students were eligible for free or reduced lunch and 0 otherwise, and *books at home,* which is an ordinal variable created from a survey question asking students to estimate the number of books they have in their home, where 1 indicates the lowest response of "Few (0 to 10)" and 4 represented the highest response of "Enough to fill several bookcases (more than 100)".

I also include a number of controls in my study. These include *female*, where 1 represents females and 0 represents males and *LEP* status, coded 1 if the student was categorized as Limited English Proficient on their middle school transcript and 0, otherwise. There is great consistency in the type of school students in my sample attend as middle and high schoolers, but I include a control to account for those whose school type switched in their transition to high school.   Values on this dichotomous control variable are 1 for high schools that are predominantly Hispanic and 0 for those that are integrated. I also control on *school size* and *school free/reduced lunch* which capture the size and percentage of students eligible for free/reduced lunch for each high school, respectively. Finally, my multivariate analyses include *cohort* which captures the two different cohorts of high school students from which my data comes.

The purpose of this study is to investigate the likelihood of enrollment in geometry in 9th grade for Black and Hispanic students relative to their White peers (and each other), net of their grades in their 8th grade algebra class as well as the type of middle school attended. I investigate the possible contribution of school racial/ethnic composition on racial/ethnic differences on the probability of geometry enrollment by conducting analyses within high schools classified as “integrated” and “predominantly Hispanic”. As in the first analytic chapter, I define an integrated high school as one where each racial/ethnic group makes up at least 20% but no more than 60% of the school and a predominantly Hispanic high school as one that is more than 60% Hispanic. My sample includes data from 6 integrated high schools (n=982 students) and 21 predominantly Hispanic high schools (n=1403 students). My analyses include descriptive statistics about the characteristics of 8th grade algebra takers who attend these two school types, as well as two-level, multivariate logistic cross-classified random effects models predicting geometry enrollment, where students are nested within both their middle and high schools.

Results

Descriptive Results

Comparing 8th Grade Algebra Takers in Integrated and Predominantly Hispanic High Schools. To give a sense of the characteristics of 8th graders who took algebra by race/ethnicity by the type of high school they attended, Tables 2.1 and 2.2 provide some descriptive statistics on algebra grade and my control variables. I note that as indicated in the table, all the differences discussed below are statistically significant. Both tables show that within both high school types the vast majority of students successfully completed algebra in the 8th grade, although a larger percentage (98%) of those attending integrated high schools did so compared to 92% of students attending predominantly Hispanic high schools. Table 2.1 reveals that among students who attend integrated high schools White students received higher grades in algebra compared to their minority peers. Specifically, the mean algebra grade for White students is about 3 percentage points higher than those for Black and Hispanic students. Furthermore, delving deeper into algebra grade by grade categories I find that over 40% of White students received an A while only about 21% of Blacks and 26% of Hispanics earned the same. Furthermore, Black and Hispanic students earn more B's and C's than their White counterparts do. On the other hand, among students in predominantly Hispanic high schools there are no racial/ethnic differences on algebra grade received and no overrepresentation of any racial/ethnic group relative to each other in terms of letter grade distribution.

Turning my attention to the control variables, I find that among students in both integrated and predominantly Hispanic high schools, a larger proportion of Hispanic algebra takers was classified as LEP compared to their White and Black peers but that proportion was larger in predominantly Hispanic high schools than in integrated high schools (.498 in predominantly Hispanic schools vs .310 in integrated schools). On the two measures of social class background, I see similar patterns by race/ethnicity within each school type such that White students are the most advantaged, followed by Black students, then Hispanic students. Comparing the two school types, I find that a much larger proportion of each racial/ethnic group is eligible for free/reduced lunch within predominantly Hispanic schools than in integrated schools. For example, while only about 11% of White algebra takers in integrated schools are eligible, 5 times as many of their counterparts in predominantly Hispanic schools are eligible. Similarly, the percentage of Black and Hispanic students eligible for free or reduced lunch in predominantly Hispanic schools is more than 20 percentage points higher than the respective percentages in integrated schools.

Table 2.1. Descriptive Statistics: Means and SDs on Academic and Social Class Background Variables Among 8th Grade Algebra Takers: *Integrated High Schools*

	White	Black	Hispanic
Algebra Grade			
Categorical			
A	0.419^{BH}	0.206	0.259
B	0.428^{BH}	0.554	0.523
C	0.133^{BH}	0.216	0.190
<C	0.021	0.025	0.029
Continuous	$87.21\ (7.04)^{BH}$	84.46 (6.42)	84.71 (7.27)
Controls			
Female	0.504	0.608	0.526
LEP	0.007^{H}	0.010^{H}	0.310
Free/Reduced Lunch	0.107^{BH}	0.583^{H}	0.747
Books at Home	$3.39(0.76)^{BH}$	$3.00(0.75)^{H}$	2.72(0.97)
N (students)	n=430	n=204	n=348

B indicates that the mean is statistically significantly different than the mean for Black students (p<.05). H indicates that the mean is statistically significantly different than the mean for Hispanic students (p<.05), standard deviations in parentheses.

Table 2.2. Descriptive Statistics: Means and SDs on Academic and Social Class Background Variables Among 8th Grade Algebra Takers: *Predominantly Hispanic High Schools*

	White	Black	Hispanic
Algebra Grade			
Categorical			
A	0.184	0.099	0.162
B	0.500	0.462	0.451
C	0.237	0.341	0.311
<C	0.079	0.099	0.077
Continuous	82.48 (7.45)	80.02 (8.25)	81.52(8.27)
Controls			
Female	0.447	0.505	0.491
LEP	0.026^{H}	0.022^{H}	0.498
Free/Reduced Lunch	0.526^{BH}	0.835^{H}	0.954
Books at Home	$3.37(0.91)^{BH}$	$2.54(0.98)^{H}$	2.06(0.94)
N (students)	n=38	n=91	n=1274

B indicates that the mean is statistically significantly different than the mean for Black students (p<.05). H indicates that the mean is statistically significantly different than the mean for Hispanic students (p<.05), standard deviations in parentheses.

Geometry Enrollment in Integrated vs. Predominantly Hispanic High Schools. Before discussing the results of my multivariate analyses predicting geometry enrollment by school type, I present the racial/ethnic breakdown of the percentage of 8th graders in my sample who enroll in geometry as a 9th grader within integrated and predominantly Hispanic high schools (see Figures 2.1 and 2.2). In integrated high schools, there is a non-statistically significant difference in the percentage of each racial/ethnic group that goes on to take geometry in 9th grade after passing algebra. As a matter of fact, the vast majority (at least 94%) of each racial/ethnic group who passes algebra is placed in geometry as a 9th grader. Similarly, in predominantly Hispanic schools, most students (at least 90%) regardless of race/ethnicity are placed in geometry.

While 100% of White students go on to take geometry and only 90% of their minority peers do, that difference is also not statistically significant.

Figure 2.1. Geometry Enrollment by Race/Ethnicity among Students in Integrated High Schools

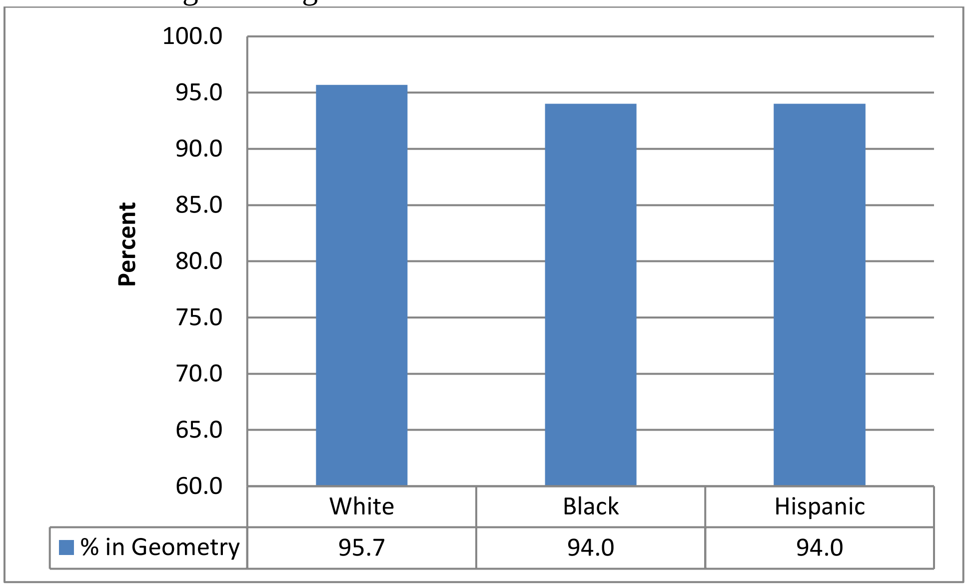
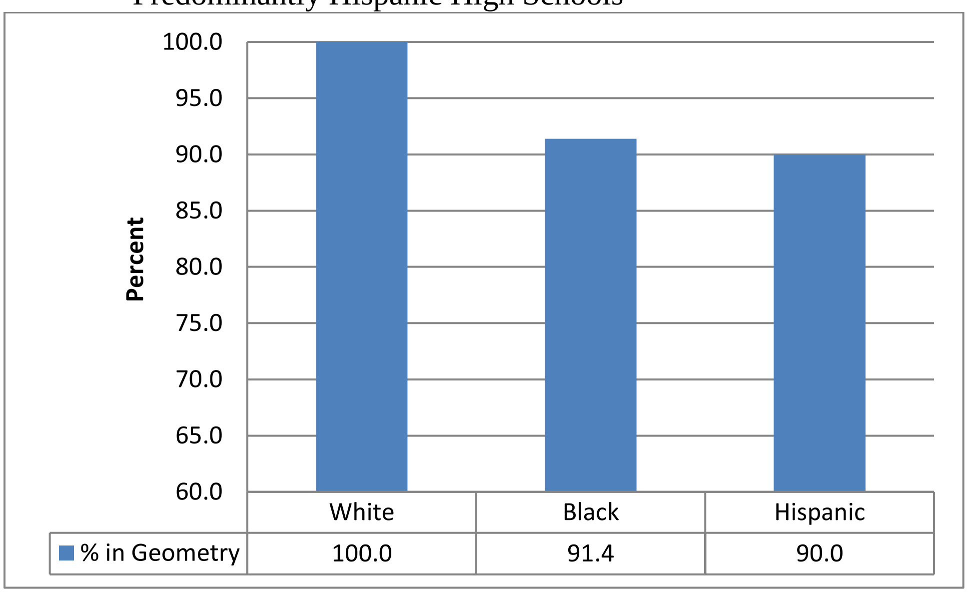


Figure 2.2. Geometry Enrollment by Race/Ethnicity among Students in Predominantly Hispanic High Schools



Predicting Geometry Enrollment: Integrated High Schools. In Table 2.3, I turn my attention to the results of regression analyses predicting geometry enrollment in integrated high schools. For these analyses, White students serve as the reference group. The baseline model reveals no racial/ethnic disparities in geometry enrollment between White students and their minority peers. In model 2, I add all of my student level controls and school level controls (except predominantly Hispanic middle school). The only student level variable that is statistically significant is free or reduced lunch eligibility which reduces the likelihood of enrollment in geometry. Both high school size and percent free and reduced lunch have statistically significant effects on likelihood of enrollment where larger school sizes increase likelihood of enrollment and increases in the school percentage of students eligible for free or reduced lunch reduces the likelihood of enrollment.

In models 3 and 4, I investigate the effect of the grade earned in algebra on likelihood of geometry enrollment and if any differential returns are evident for minority students relative to their White peers. In model 3 I find that algebra grade positively predicts the likelihood of enrollment in geometry. I also find that with the addition of algebra grades earned, Hispanic students appear to be more likely than their White peers to be enrolled in geometry. Furthermore, in model 4, I interact being Black and being Hispanic with algebra grade and find that these interactions are not statistically significant. Therefore, relative to their White peers, Black and Hispanic students receive the same returns from their algebra grades as far as their likelihood of enrolling in geometry.

Table 2.3. Odds Ratios from Cross-Classified Logistic Regression Analyses Predicting Geometry Enrollment: Integrated High Schools

VARIABLES	model 1	model 2	model 3	model 4
Race/Ethnicity (ref=White)				
black	0.703	1.035	1.247	413.1
	(0.272)	(0.466)	(0.570)	(2,445)
Hispanic	0.849	2.197	3.142*	0.983
	(0.297)	(1.100)	(1.681)	(5.225)
Key Independent Variable				
algebra grade			1.220***	1.233***
			(0.036)	(0.054)
Controls				
cohort		1.152	1.071	1.068
		(0.368)	(0.364)	(0.366)
female		1.405	1.031	1.036
		(0.433)	(0.338)	(0.341)
LEP		0.480	0.348~	0.338~
		(0.241)	(0.192)	(0.189)
books at home		0.822	0.748	0.742
		(0.162)	(0.161)	(0.163)
free/reduced lunch		0.431*	0.432*	0.459~
		(0.180)	(0.185)	(0.198)
predominantly Hispanic middle school		0.463~	0.396*	0.383*
		(0.198)	(0.177)	(0.172)
size of high school		1.001**	1.001***	1.001***
		(0.000)	(0.000)	(0.000)
% free/reduced lunch of high school		0.001~	0.000**	0.000**
		(0.005)	(0.000)	(0.000)
Interactions				
blackXalgebra grade				0.931
				(0.068)
HispanicXalgebra grade				1.014
				(0.067)
Constant	21.70***	54.24***	0.000***	0.000***
	(7.059)	(60.530)	(0.000)	(0.000)
Number of MS groups			17	
Number of HS groups			6	

N=955; SE Eform in parentheses

*** p<0.001, ** p<0.01, * p<0.05, ~ p<0.10

Predicting Geometry Enrollment: Predominantly Hispanic High Schools. I now examine if racial/ethnic disparities in the likelihood of geometry enrollment exist among students who attend predominantly Hispanic high schools in Table 2.4. For these multivariate analyses Hispanic students serve as the reference group since they make up the numerical majority in this case. Also, comparisons are only made between Hispanic and Black students since all of the White students in this sample who transition to a predominantly Hispanic high school go on to take geometry. As in integrated high schools, the baseline model of Table 2.4 also reveals no disparity between Hispanic and Black students in likelihood of geometry enrollment. In model 2, I find that being classified as LEP reduces the likelihood of enrolling in geometry. As in integrated schools, model 3 shows that the likelihood of geometry enrollment increases as algebra grades increase but there are no differential returns to algebra grade by race/ethnicity as seen in model 4.

Table 2.4. Odds Ratios from Cross-Classified Logistic Regression Analyses Predicting Geometry Enrollment: Predominantly Hispanic High Schools

VARIABLES	model 1	model 2	model 3	model 4
Race/Ethnicity (ref=Hispanic)				
black	1.272	1.074	1.134	142.6
	(0.547)	(0.485)	(0.538)	(801.2)
Key Independent Variable				
algebra grade			1.175***	1.180***
			(0.023)	(0.024)
Controls				
cohort		0.989	0.989	0.993
		(0.205)	(0.218)	(0.219)
female		1.158	0.889	0.892
		(0.232)	(0.189)	(0.190)
LEP		0.591*	0.626*	0.628*
		(0.130)	(0.144)	(0.145)
books at home		1.054	1.037	1.042
		(0.117)	(0.122)	(0.122)
free/reduced lunch		2.179~	2.552*	2.566*
		(0.919)	(1.134)	(1.134)
predominantly Hispanic middle school		0.976	0.655	0.678
		(0.891)	(0.572)	(0.587)
size of high school		1.000	1.000	1.000
		(0.000)	(0.000)	(0.000)
% free/reduced lunch of high school		0.0248	0.124	0.119
		(0.058)	(0.314)	(0.301)
Interactions				
blackXalgebra grade				0.940
				(0.067)
Constant	12.27***	155.900**	0.000***	0.000***
	(3.672)	(303.400)	(0.000)	(0.000)
Number of MS groups		20		
Number of HS groups		21		

N=1,289; SE Eform in parentheses

*** p<0.001, ** p<0.01, * p<0.05, ~ p<0.10

Discussion and Conclusion

Prior research suggests the possibility that Black and Hispanic students who successfully complete algebra in the 8^{th} grade may not advance to geometry in the 9^{th} grade in comparable rates as their White peers. In this study, I explore this issue by examining geometry placement of the middle school students from my first analytic chapter who go on to attend either a predominantly Hispanic or integrated high school. As in my previous analytic chapter, I consider the possibility of gaps in enrollment between White students and their minority peers as well as those between minority groups. I also investigate if there are differential returns in the probability of geometry enrollment by race/ethnicity and the grades students receive in their 8^{th} grade algebra course.

My descriptive analyses reveal mixed findings in my comparisons of racial/ethnic groups across school types. For example, when considering students' final grades, I find that more than 92% of students in my sample pass the course regardless of the type of middle school they attend. However, examining the grade distribution by race/ethnicity within school type reveals some differences. In integrated schools, White students have higher algebra grades than their Black and Hispanic peers. In predominantly Hispanic middle schools, however, I find no differences in algebra grades earned by racial/ethnic group. When considering student math course placement in 9^{th} grade, I find that the vast majority go on to take geometry (94% of students from integrated middle schools and 90% of students from predominantly Hispanic schools).

My regression analyses reveal no differences in the probability of enrollment in geometry for successful completers of 8^{th} grade algebra regardless of whether they attend a predominantly Hispanic or integrated high school. This is true in baseline models and net of student background, grades, as well as school characteristics. Essentially, in this school district, students in my sample who enter the advanced math course-taking pipeline by enrolling in and passing algebra in 8^{th} grade continue on in that pipeline in their transition to high school. These analyses further show that schools appear to employ an unbiased meritocratic process in placing students in geometry, such that students of all race/ethnicities are rewarded comparably by the grades they receive in the course.

While these findings are encouraging, such that students who gain access to and successfully complete algebra, move on to take geometry, they are limited to course placement in students' 9^{th} grade year and do not extend to the rest of high school. What happens beyond 9^{th} grade is not known. Racial/ethnic patterns of math course-taking in this district may remain similar or diverge as students progress through high school (Merolla, 2013; Conger, Long, & Iatarola, 2009; Kelly, 2009). Furthermore, we should also recall from findings from my first analytic chapter that racial/ethnic gaps in academic background exist before students' 8^{th} grade year and these gaps potentially exclude many minority youth from taking the gatekeeper course in 8^{th} grade that would position them to take geometry in 9^{th}. So continued efforts should be made to address those achievement gaps, recognizing that doing so may result in more equitable math trajectories for students of all racial/ethnic groups.

Analytic Chapter Three:

Perceptions of Equity in the Classroom: How Teacher Practices Shape Students' Achievement in Math

Beyond examining issues of equity related to access to certain math courses it is also necessary to examine student experiences within courses and the extent to which those experiences are equitable. Key contributors to the experiences of students within classes are teachers themselves. Recent educational reforms have focused heavily on teachers and their effectiveness as a means to ensure equitable educational opportunities for all students, particularly those from traditionally marginalized groups. Research has highlighted, for example, how teachers' lack of subject matter expertise and experience can negatively impact students' achievement, with strong implications for minority students in particular who are disproportionately more likely than their White peers to be taught by those with the weakest credentials and background (Darling-Hammond, 2000; Hill, Rowan & Ball, 2005; Lankford, Loeb & Wyckoff, 2002; Clotfelder, Ladd & Vigdor, 2007).

Beyond a focus on teachers' skills and knowledge, other research has considered teachers' views and attitudes towards their students as another possible source of educational inequality between student groups. Specifically, the presence of teacher bias, especially against females and minority students, appears to be a topic of renewed interest, as a recent body of research has found new evidence of the presence of racial/ethnic and gender bias, and further documented its negative impact on student outcomes (Gilliam, Maupin, Reyes, Accavitti & Shic, 2016; Robinson-Cimpian, Lubienski, Ganley & Copur-Gencturk, 2014; Papageorge, Gershenson & Kang, 2016). This body of research highlights how bias may be particularly pronounced in math classrooms, where stereotypes regarding the presumed superiority of White males remain stubbornly resilient.

However, while the extant literature has provided important evidence that teachers may (intentionally or not) contribute to the creation and maintenance of inequality, little attention has been given by quantitative researchers to the potentially positive effects of teacher beliefs and behaviors that are equitable in nature. Thus, in this analytic chapter I make a new contribution to the literature by specifically examining what I refer to as an equity focus, that is, the extent to which math teachers create an inclusive and positive classroom environment for all students. In doing so, I focus on whether and how such a teacher focus can positively impact students, particularly minority students who have historically been subjected to bias and stereotypes in math classrooms. In addition, rather than relying on teachers' reports of their classroom practices, I argue that it is students' perceptions of their teachers' behavior and attitudes that may be more consequential, and thus rely on students' reports of the extent to which their teachers are equitable. Utilizing national data I will address the following research questions:

1. Which students report having an equitable teacher? (e.g., what student characteristics are associated with higher ratings of their teachers?) Who are the teachers that students perceive as being equitable (e.g., what teacher characteristics are associated with higher ratings by students?)

2. What are the consequences of having an equitable teacher? (e.g., does having an equitable teacher result in an increase in math test scores?) Does this differ by students' race/ethnicity?

Background

Research on Teacher Equity

As the above discussion makes clear, bias in the math classroom continues to exist, with real consequences for students' outcomes. Yet there is much less empirical research that examines the existence and likely positive effects of more equitable teacher attitudes and behaviors. Specifically, I argue that we should conceptualize an equitable classroom focus as more than just a classroom where teacher bias is absent, and instead examine the presence and the impact of teacher attitudes and behaviors that actively promote feelings of inclusion and support among all students. A few qualitative studies offer some key insights into the power of teachers who create an inclusive learning environment based on high expectations for all students (e.g., Boaler, 2006; Gutstein, 2003). For example, Boaler and Staples (2008) investigated the teaching practices of 8 math teachers who had inclusive classroom environments and found that those teachers employed practices such as the "multiple ability treatment" such that high expectations were had for all students with the belief that there were many different pathways to learning. Furthermore, the classroom culture required that students value and respect one another's ideas and points of view.

While the aforementioned study does not consider race/ethnicity in the classroom, other studies have emphasized the impact that race/ethnicity has in the classroom learning environment. A focused attention on race/ethnicity is a response to a historical use of negative stereotypes in assessments of minority students' academic ability, especially in mathematics. These negative stereotypes, which often lead to lowered expectations by teachers, are most pronounced among Black and Hispanic students in lower level math courses, where they represent the vast majority of students in such classes (Oakes, 2005). Therefore, the types of classroom environments that include deliberate attention to issues of race/ethnicity and culture that students bring to the classroom can counteract such negative stereotypes and serve as mechanisms through which learning can occur (Ladson-Billings, 2009). Teachers who use this type of pedagogy do so under the premise that every student is capable of learning and that traditional classroom environments neglect to realize the unique cultural capital that each student brings to the classroom (Gutierrez, 2013). These studies highlight how individual teachers create learning spaces that are not only void of gender and racial/ethnic biases, but are empowering spaces where students perceive that they are capable of learning and are expected to excel by their teachers. Such studies also suggest that students respond to this positive environment by performing at or surpassing their teachers' level of expectation and by developing more positive attitudes about mathematics in general (Jamar & Pitts, 2005).

Building on such research, I suggest that more large-scale quantitative studies are needed to further unpack the potential for an equitable focus by teachers in the classroom to promote positive educational experiences and learning for students. Furthermore, another important consideration needs to be made. Teacher behaviors may not always translate in the way they were intended. Thus, students' perceptions of those behaviors are likely more consequential for student learning.

Students' Perceptions of Teacher Practices and Beliefs

Howard (2001) argues that students are the invisible participants in schooling whose voices are often ignored but should be heard. Surprisingly, there are very few research studies that examine student perceptions of their teachers' equitable behaviors and the majority of those that do examine this do so with a qualitative lens. For example, Howard (2001) investigated the perceptions of 8 African American 5^{th} grade students in an urban elementary school of their math teacher and found that they perceived their teachers as being caring, fostering a comfortable school environment, and making learning fun. Howard argues that these characteristics were all translated by students as components of an inclusive learning environment that ultimately impacted their academic performance/engagement. Similarly, Irizarry (2007), interviewed Latino students regarding their perceptions of their teachers and found that students found that their teachers not only respected their culture, but also found ways to connect their culture with class activities. As in the previous study, this teacher and the resulting classroom environment fostered a desire to engage more academically.

While informative, these studies do not explicitly examine the role that teachers' equitable practices have on student outcomes, beyond actual engagement in class. Sleeter (2012) further comments on this void in the literature citing that many research studies do a good job of pointing out those teacher practices that are equitable (culturally relevant), but do not adequately tie those equitable practices to student learning. This study, therefore, which quantitatively investigates the impact of students' perceptions of equitable teaching practices on math achievement scores, makes a valuable contribution to the gaps in literature.

Considering Course Context

Research on ability grouping in schools reveal a number of patterns that suggest that course level may be an important factor to consider when examining teachers' equitable practices and their students' perceptions of such practices. Oakes (2005) explored the classroom environments of students within low, average and high tracked classes and found stark differences in teacher expectations, pedagogical choices, and student attitudes. For instance, students in lower tracked classes, who were mostly Black and Hispanic, were taught by teachers who had very low expectations for their success who had a huge focus on discipline and maintaining authority. This type of classroom environment included teachers' pedagogical choices which were often based on tasks that lacked rigor. Students in these classrooms were perceived negatively by their teachers, resulting in a general feeling of inferiority and low expectations for their academic trajectories. Students in higher tracked classes, on the other hand, had classroom experiences that were more positive and inclusive with teacher expectations that were generally very high and course work that was very rigorous. Teachers of high tracked students spoke often of a classroom structure that was very informal, where students respected and valued each other's ideas. As a result, students perceived themselves very positively and had high academic aspirations. Students in average tracked classes, interestingly, had experiences that were not extremely negative or positive, but about halfway between those of students in low and high tracked classes on most indicators.

It stands to reason that teachers' equitable practices should be ideally present across all course levels if we desire to positively impact academic achievement for all students. However, given what we know about differences in classroom climate by course level, students at the lower end, who are mostly minority youth, may be in most need of, and may be the most receptive to, such practices. Yet positive classroom environments might be more important in counteracting negative stereotypes that may be the most salient in advanced math classes, where Black and Hispanic students are most under-represented. Thus my study will consider whether and how the impact of perceptions of equitable teacher practice differs by the course context.

Data and Methods

For this analytic chapter I utilize data for 9th graders from the High School Longitudinal Study of 2009 (HSLS: 2009) (Ingels et al., 2011). HSLS: 2009 is a nationally representative dataset collected by the National Center for Educational Statistics (NCES) that includes data for approximately 25,000 students beginning with 9th graders in the fall semester of 2009. The dataset includes responses to items from student questionnaires, as well as those from school administrator, teacher and parent questionnaires. The first follow-up of data collection occurred during the spring semester of students' junior year. I limit my sample to 14,864 White, Black and Hispanic 9th graders who also participated in the first follow-up who were not missing on the dependent variable. Of this sample, about 69% are White, 12% are Black, and 19% are Hispanic.

Key Independent Variable

My key independent variable, referred to as *teacher equity*, is a composite variable derived from four survey items from the base year student questionnaire that capture students' perceptions of their math teachers' engagement in equitable behaviors in the classroom. The individual items, rated on a 4 point Likert scale (1=strongly disagree-4=strongly agree), ask students their level of agreement with the following statements about their math teacher: treats students with respect, treats every student fairly, thinks all students can be successful and treats some kids better than others (reverse coded). Students' responses across these questions are averaged; the alpha reliability coefficient for these items is 0.9850.

Dependent Variable

The dependent variable for this study is students' 11th grade math test scores. It represents the math IRT scale score from a standardized test administered by NCES that includes 118 items. The score is an estimate of the total number of items of those 118 that students would have answered correctly if they had answered all of the questions. To capture change in test scores I control on students' scores on the NCES administered math test in 9th grade.

Controls

I control on a number of additional student and teacher variables. Student demographic variables include *female*, coded 1 for females and 0 for males and a continuous standardized measure of students' socioeconomic status (*SES*) constructed by NCES and composed of parent education, occupation and family income. Student academic background variables include *math grade* which is a continuous variable derived from a question on the student questionnaire asking students to report the grade they received in their 8th grade math class, and *course level* which represents the level of students' 9th grade math class where 1=a course below algebra (e.g., pre-algebra), 2=algebra and 3=a course above algebra (e.g., geometry). In this sample, approximately 6% of students are in a course below algebra, while 59% are in algebra and 35% are in a course above algebra. Teacher controls came from teacher questionnaires and include *math certification status*, coded 1 if teachers report being math certified and 0, otherwise, and a continuous measure of *years of experience* teaching high school math.

Plan of Analyses

I begin my analyses by providing descriptive statistics to indicate how perceptions of teacher equity vary by both student and teacher characteristics, thus addressing my first research question. I then turn my attention to fixed effects linear regression analyses[2] predicting 11th grade math test scores by racial/ethnic group to address my second research question. I base all of my analyses, on the longitudinal analytic weight provided by HSLS: 2009.

[2] Fixed effects models were chosen due to the small number of students clustered within the same school.

Results

Descriptive Analyses

In Table 3.1, I present n's, means and standard deviations of teacher equity by student gender, race/ethnicity, and math course level. All of the findings discussed hereafter are statistically significant. Overall, given that the teacher equity variable is constructed from survey items ranging from 1 (strongly disagree) to 4 (strongly agree), students in this sample have mean perceptions of their teachers that suggest agreement that they are equitable. Considering student gender, females appear to rate their teachers higher than their male counterparts do but this difference is not statistically significant ($p>.05$). Looking at differences in perceptions by race/ethnicity, I find that White and Hispanic students rate their teachers similarly, however, Black students rate their teachers higher than their White and Hispanic peers do. Turning my attention to differences in teacher equity by the level of their 9th grade math course, I find that teacher ratings for students in the below and algebra categories are not statistically significantly different from one another, however, both are lower than those of their peers in the above algebra category. Effect sizes indicate that these differences are about one fifth of a standard deviation in magnitude.

Table 3.1. Descriptive Statistics on Teacher Equity, by Student Characteristics and Course Level

	N	Mean	SD
Gender			
Female	7413	3.184	0.596
Male	7451	3.170	0.619
Race/Ethnicity			
White	10253	3.176^{B}	0.607
Black	1766	3.199^{H}	0.636
Hispanic	2845	3.167	0.592
Course Level			
Below Algebra	844	3.100^{AB}	0.608
Algebra	8833	3.145^{AB}	0.614
Above Algebra	5187	3.244	0.590

B and H indicate means statistically significantly different from that for Black and Hispanic students, respectively.
AB indicates a mean statistically significantly different from that for students in a course above Algebra.

In table 3.2, I present descriptive statistics on teacher equity by teacher gender, race/ethnicity, math certification status and years of experience. Since the unit of analysis is students, n's reflect the number of students who have a teacher with the corresponding characteristic.[3] For instance, 6875 students have a 9th grade math teacher who is female compared to 4560 students who have a teacher who is male. As in my discussion of findings from table 3.1, all mean differences discussed below are statistically significant. Both teacher gender and race/ethnicity are included in my descriptive analyses, but due to more than 30% of my sample who are missing on these characteristics, I exclude them from later regression analyses. Considering teacher gender, students rate their male

[3] In HSLS:09 there is no teacher ID variable, however, due to the low numbers of students clustered within schools it is unlikely that the same teacher would be represented more than once; thus, student n's closely resemble teacher n's.

teachers as being slightly more equitable than their female teachers, however, this difference is very small with an effect size of 0.03. But when looking at teacher race/ethnicity, I find that White, Black and Hispanic teachers are rated similarly and all about ¼ of a standard deviation higher than Asian teachers. Looking at differences by math certification status, I find that teachers who do not hold a regular math certification are rated slightly higher than their peers with a math certification (3.214 not math certified vs. 3.184 math certified), however, the effect size of 0.05 indicates that this difference is very small. Lastly, teachers new to the profession (i.e., those with at most 5 years of experience) are rated higher than their peers with more than 5 years of experience, but the small effect size (0.05) indicates that these differences are small in magnitude.

Table 3.2. Descriptive Statistics on Teacher Equity, by Teacher Characteristics

	N	Mean	SD
Gender			
Female	6875	3.181*	0.623
Male	4560	3.202	0.579
Race/Ethnicity			
White	10220	3.195^{A}	0.597
Black	358	3.184^{A}	0.644
Hispanic	419	3.148^{A}	0.615
Asian	245	3.040	0.695
Math Certification			
Certified	8979	3.184**	0.607
Not certified	2395	3.214	0.599
Years of Experience			
≤5 (beginner)	4605	3.210^{IA}	0.597
6 to 15 (intermediate)	4121	3.181	0.617
>15 (advanced)	2679	3.174	0.595

**p<.01, *p<.05

A indicates a mean that is statistically significantly different from those of students with Asian teachers.
I and A indicate means that are statistically significantly different from those of students with teachers in the intermediate and advanced categories, respectively.

Regression Analyses

In tables 3.3-3.6, I present coefficients from fixed effects linear regression models predicting 11th grade math test scores for each racial/ethnic group. For each racial/ethnic group, I present 5 models. In the baseline model I include just teacher equity as a predictor in order to determine if there is a statistically significant association between teacher equity and 11th grade math test score. In model 2, I introduce 9th grade math test score which allows me to determine the effect of teacher equity on 11th grade math test scores net of students' baseline scores. In the next 2 models, I introduce student demographic, student academic background and teacher controls, in order to explain away any statistically significant effects of teacher equity on the outcome from model 2. In the final model, I investigate the possible differential effect that teacher equity may have on the outcome by the level of the math course that students are in, by introducing interactions terms between course level and teacher equity.

In table 3.3 I present findings for White students. The baseline model reveals a statistically significant association between teacher equity and math test score. Specifically, for every 1 unit increase in teacher equity, the math test scores of White students increase by about 2.5 points. Once I account for the effect of students' 9th grade math test score, the effect of teacher equity reduces to 0.606. This effect is completely explained by student demographic and academic background.

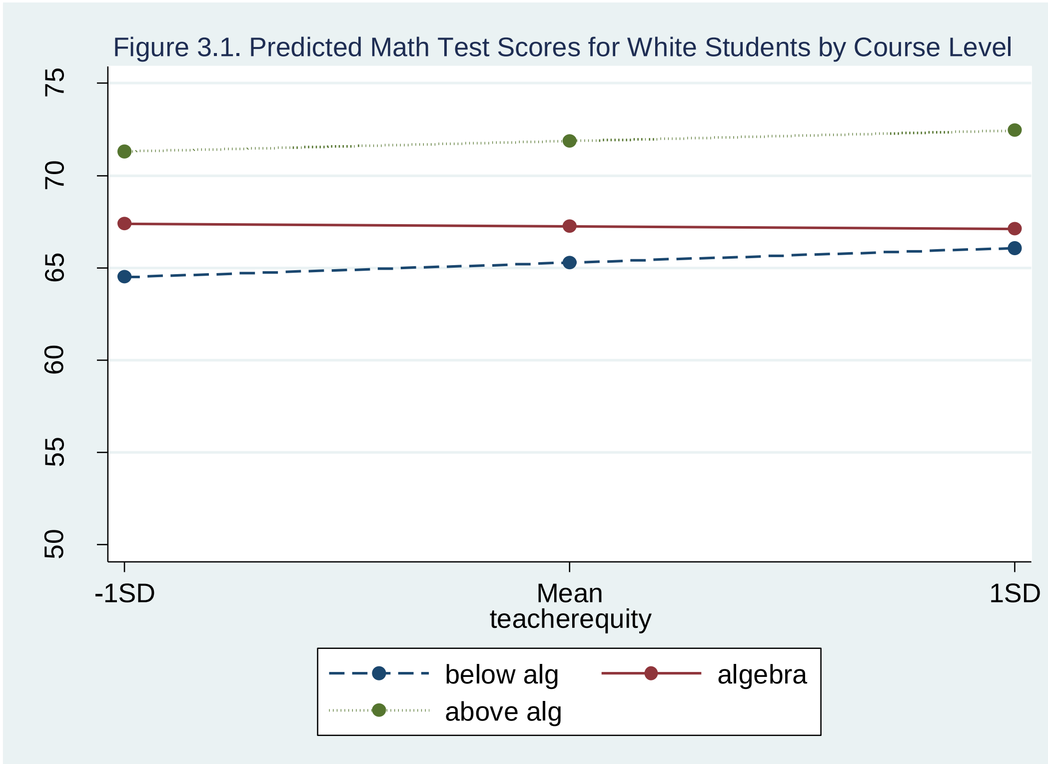
Other results from the full model indicate that net of other controls White females have lower math test scores than their male counterparts do and as SES increases so do students' test scores. Furthermore, relative to students in algebra, students in a course below algebra have lower math test scores and students in a course above algebra have higher math test scores. Students' 9th grade math test score and self-reported math grade are both positive predictors of 11th grade math test scores of White students. The two teacher characteristics also positively predict math test score for Whites, but these effects are small and of borderline significance.

Table 3.3. Fixed Effects Linear Regression Models Predicting 11th Grade Math Test Score: White Students

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
teacher equity	2.526***	0.606**	0.246	0.282	-0.213
	(0.322)	(0.235)	(0.226)	(0.226)	(0.292)
Student Characteristics					
female			-0.924***	-0.925***	-0.918***
			(0.263)	(0.263)	(0.263)
SES			1.521***	1.517***	1.512***
			(0.221)	(0.221)	(0.221)
Course Level (ref=algebra)					
below algebra			-2.053**	-2.020**	-6.858*
			(0.668)	(0.668)	(3.211)
above algebra			4.724***	4.643***	0.935
			(0.335)	(0.336)	(1.546)
9th grade math test score		1.139***	0.908***	0.905***	0.903***
		(0.0132)	(0.0154)	(0.0154)	(0.0154)
math grade			3.079***	3.077***	3.093***
			(0.163)	(0.163)	(0.163)
Teacher Characteristics					
math certification				0.873~	0.854~
				(0.509)	(0.509)
years of experience				0.0400~	0.0401~
				(0.0215)	(0.0215)
Course levelXteacher equity (ref=algebra)					
below algebraXteacher equity					1.534
					(1.000)
above algebraXteacher equity					1.157*
					(0.470)
Constant	60.94***	19.26***	15.90***	14.76***	16.34***
	(1.041)	(0.897)	(0.984)	(1.086)	(1.235)
R-squared	0.258	0.610	0.642	0.643	0.643

N=9,099; Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, ~ p<0.10

Investigating whether the effect of teacher equity on math test score depends on the course level of students in model 5, I find a statistically significant interaction between being in a course above algebra and teacher equity. In other words, relative to their peers in algebra, students in advanced classes benefit more from having an equitable teacher. In figure 3.1, I illustrate this finding using a graph of predicted math test scores of students by math course level for values of teacher equity that are at the mean, as well as 1 standard deviation below and above the mean. As can be seen in the figure, however, this increase for White students in the advanced classes is very, very small, as increasing from 1SD below to 1SD below on teacher equity only increases their predicted math test score two points, which is equivalent to 0.06 of a standard deviation increase on test score. Additionally, while it appears that those in low level classes also have a slight increase in test score relative to their peers in algebra as teacher equity increases, this is not statistically significant.



In table 3.4 I present findings for Black students. Like with their White peers, for Black students the baseline model reveals a positive and statistically significant association between teacher equity and math test scores but the magnitude is greater for Black students than it is for White students. Specifically a 1 unit increase on students' perception of their math teacher being equitable results in a 3.2 point increase on math test scores (compared to 2.5 for White students). Considering the effect of Black students' previous math test scores in model 2 results in a reduction of the effect of teacher equity on 11th grade math test scores to 1.67. This effect drops by about .2 of a point and remains statistically significant once all remaining controls are included in models 3 and 4, indicating that teacher equity still positively predicts math test scores of Black students net of student and teacher characteristics.

From the full model (model 5) I find that unlike their White peers, neither gender nor SES predict math test scores. Furthermore, students in advanced courses have higher math test scores than those in algebra. As with White students, math test score in 9^{th} grade is a significant predictor of 11^{th} grade math test score. Of the two teacher characteristics, only years of experience of teachers predict math test score but this effect is small.

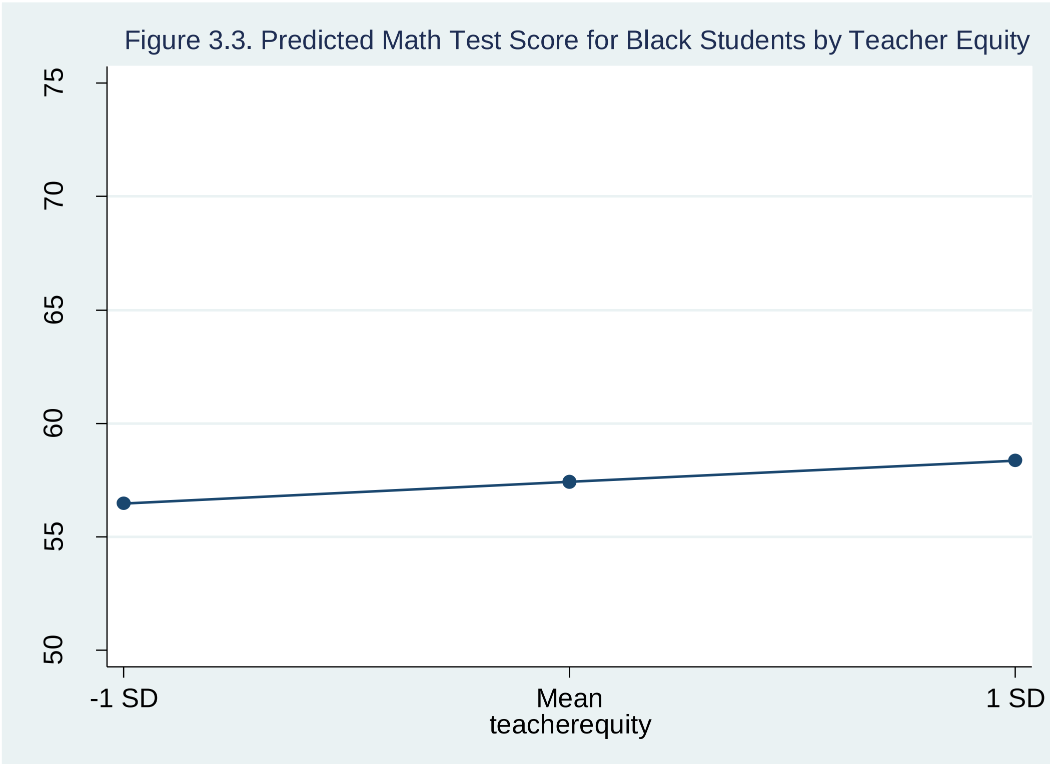
In model 5 I find that the effect of teacher equity on math test score does not differ by student course level as the interactions between teacher equity and below algebra and above algebra, respectively are not statistically significant. This indicates that perceiving a math teacher as being equitable has equal benefit for Black students regardless of the level of the math course that they are in. In figure 3.2, I show the predicted math test scores for Black students at values of teacher equity that are at 1 standard deviation below the mean, the mean, and 1 standard deviation above the mean. The graph shows that predicted scores for Black students increase from about 56 points to 58 points indicating an increase of .12 of a standard deviation, which is twice the magnitude of the effect I find for White students in advanced classes.

Table 3.4. Fixed Effects Linear Regression Models Predicting 11th Grade Math Test Score: Black Students

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
teacher equity	3.203***	1.678**	1.433*	1.475*	1.557*
	(0.711)	(0.622)	(0.629)	(0.627)	(0.747)
Student Characteristics					
female			1.115	1.112	1.079
			(0.833)	(0.830)	(0.831)
SES			1.137~	0.947	0.994
			(0.663)	(0.663)	(0.663)
Course Level (ref=algebra)					
below algebra			-0.668	-1.123	9.421
			(1.642)	(1.656)	(7.054)
above algebra			2.611*	2.455*	-0.399
			(1.104)	(1.102)	(5.043)
9th grade math test score		0.781***	0.735***	0.719***	0.727***
		(0.0440)	(0.0477)	(0.0477)	(0.0480)
math grade			0.405	0.234	0.145
			(0.466)	(0.467)	(0.470)
Teacher Characteristics					
math certification				1.640	1.718
				(1.351)	(1.351)
years of experience				0.190**	0.194**
				(0.0710)	(0.0712)
Course levelXteacher equity (ref=algebra)					-3.454
below algebraXteacher equity					(2.241)
					0.886
above algebraXteacher equity					(1.534)
Constant	47.20***	25.54***	25.47***	23.51***	23.20***
	(2.288)	(2.328)	(2.682)	(2.841)	(3.074)
R-squared	0.548	0.661	0.665	0.669	0.670

N=1,520; Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, ~ p<0.10



In table 3.5, I present coefficients for Hispanic students. The baseline model reveals a statistically significant association of teacher equity and math test score similar to those of White students, such that as Hispanic students' perception of their teachers being equitable increases by 1 unit, their math test scores increase by about 2 points. However, once I account for students' prior math test scores, teacher equity no longer has a statistically significant effect on the math test scores of Hispanic students. Net of student and teacher characteristics, teacher equity appears to have a negative effect on math test scores but these findings are not statistically significant.

Other findings from the full model indicate that, similar to their White peers, Hispanic females have lower math test scores than their male counterparts. Similar to the models for White and Black students, 9th grade math test score positively predicts 11th grade math test score. As with White students, students in courses below algebra have lower math test scores than their peers in algebra and students in advanced courses have higher math scores than their peers in lower classes. Also, math grades are a positive predictor of math test scores for Hispanic students.

My investigation into whether the effect of teacher equity on math test score for Hispanic students depends on the level of their 9th grade math course (model 5) reveals a statistically significant interaction effect for students in both the below and above algebra groups relative to those in the algebra group. These effects suggest that students in a course below algebra receive more benefit from having an equitable teacher than students in algebra, while their peers in advanced courses receive less benefit. To further investigate this statistically significant interaction effect, in figure 3.3, I illustrate the predicted math test scores for Hispanic students at each course level as teacher equity increases. The graph shows that while the math test scores of students in algebra appear to remain flat as teacher equity increases from 1standard deviation below the mean to 1standard deviation above the mean, the math test scores of Hispanic students in courses below algebra increase substantially while those of students in courses above algebra very slightly decrease. Specifically, Hispanic students in advanced courses realize a drop in math test scores of about 1/5 of a standard deviation in magnitude as teacher equity increases from 1 standard deviation below to 1 standard deviation above the mean. On the other hand, Hispanic students in low level math courses who rate their teachers at 1standard deviation below the mean have math test scores that trail their peers in algebra and advanced math by 7 and 11 points, respectively. Yet as teacher equity increases, the scores of those in low level math courses increase substantially, such that there is no gap in test scores by 9th grade course type for those at 1 standard deviation above the mean on teacher equity. This change in math test score is indicative of about ½ of a standard deviation increase, which is higher than the magnitude of increases I find for White students in advanced classes and Black students.

Table 3.5. Fixed Effects Linear Regression Models Predicting 11th Grade Math Test Score: Hispanic Students

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5
teacher equity	2.189**	0.0134	-0.320	-0.276	0.382
	(0.694)	(0.543)	(0.534)	(0.537)	(0.672)
Student Characteristics					
female			-1.641**	-1.624**	-1.603**
			(0.616)	(0.617)	(0.614)
SES			0.0461	-0.00301	0.0630
			(0.568)	(0.568)	(0.567)
Course Level (ref=algebra)					
below algebra			-2.996*	-3.039*	-22.92**
			(1.503)	(1.503)	(7.422)
above algebra			2.507**	2.451**	12.45**
			(0.787)	(0.791)	(3.787)
9th grade math test score		1.055***	0.922***	0.919***	0.921***
		(0.0314)	(0.0349)	(0.0350)	(0.0348)
math grade			2.366***	2.330***	2.333***
			(0.340)	(0.340)	(0.339)
Teacher Characteristics					
math certification				1.177	1.374
				(1.037)	(1.033)
years of experience				0.0670	0.0632
				(0.0548)	(0.0545)
Course levelXteacher equity (ref=algebra)					
below algebraXteacher equity					6.409**
					(2.334)
above algebraXteacher equity					-3.123**
					(1.157)
Constant	55.33***	22.51***	20.03***	18.53***	16.30***
	(2.220)	(1.980)	(2.227)	(2.402)	(2.709)
R-squared	0.343	0.605	0.622	0.623	0.627

N=2,414; Standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05, ~ p<0.10

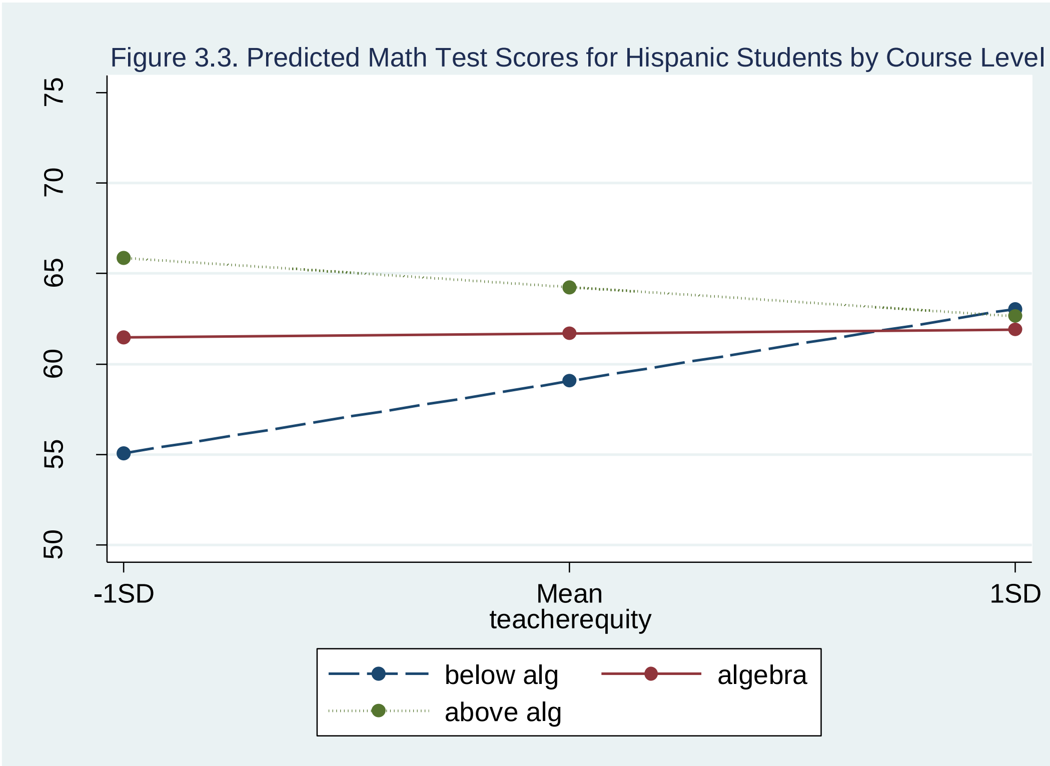


Figure 3.3. Predicted Math Test Scores for Hispanic Students by Course Level
75
70
65
60
55
50
-1SD
Mean
1SD
teacherequity
below alg
algebra
above alg

Discussion and Conclusion

Teachers and the classroom environment that they create are important components of issues of equity, particularly in math. We know that teacher attitudes and behaviors towards students can have lasting effects on student attitudes and achievement. A prominent theme, particularly in recent research, is the impact on students of teacher bias or negative attitudes (Gilliam et al., 2016; Robinson-Cimpian, et al., 2014; Papageorge, Gershenson & Kang, 2016). Yet extant literature, particularly quantitative literature, tells us little about how the existence of more positive and inclusive teacher beliefs and practices, as perceived by students themselves, may affect student achievement.

In this analytic chapter, I contribute to this void in the literature by first exploring the characteristics of students that are associated with higher perceptions of teacher equity. In my descriptive analyses, I find that female students generally rate their teachers higher than their male counterparts do. Analyses by race/ethnicity show that Black students view their teachers' more favorably than their White and Hispanic peers do as far as their equitable beliefs and practices. Lastly, when exploring perceptions of teacher equity by math course level, students in advanced math courses rate their teachers highest compared to their peers who are in algebra course or courses below algebra.

I also explore the characteristics of teachers that students perceive to be equitable. My descriptive analyses indicate that male and non-Asian teachers are rated higher than their female peers and Asian teachers, respectively. Also, high school math teachers without a regular math certification were rated higher than their peers holding a math certification. Lastly, beginning teachers were perceived to be more equitable than teachers with more than 5 years of teaching experience.

To determine if and how these perceptions affect student math test scores with particular attention to possible differing patterns by students' race/ethnicity, I engaged in a series of regression analyses. These analyses reveal similarities and differences by racial/ethnic group. The main similarity is that teacher equity positively predicts math test scores in some way for White, Black and Hispanic students. In other words, as students' perceptions of their teacher being equitable increases, so do their math test scores. However, once I account for students' prior math test scores in 9th grade, the effect of teacher equity on math test scores for White students is reduced by 75%, those of Black students are reduced by 50%, and those for Hispanic students are reduced completely. Introducing additional student controls explains away the remaining effect of teacher equity for White students, however, for Black students there remains a persistent effect of having an equitable teacher on math test scores, net of student and teacher controls. Taken together, unlike their White and Hispanic peers, Black students appear to benefit from having an equitable teacher even after I consider their social class and academic backgrounds as well as the characteristics of their teachers.

Another key finding of my regression analyses is the differential effect of having an equitable math teacher by the level of the math course that students are in. For White students, those in an advanced 9th grade math course benefit very slightly from having an equitable teacher whereas peers in algebra and below algebra do not. Given the very small magnitude of this increase, it is difficult to speculate the reasons behind it.

Analyses for Black students reveal no differential effect of having an equitable teacher by course level. In other words, Black students in all course levels receive the same benefit in increase in math test scores as their perceptions of their teacher being equitable increase. Some prior research has shown that having a teacher who fostered a classroom environment where all students were deemed capable of achieving is related to an increase in student engagement and achievement for Black youth (Sandilos, Rimm Kaufman, & Cohen, 2016; Ladson-Billings, 2009; Howard, 2001). The findings in this study further support the notion that for Black students who perceive their teachers to be inclusive, regardless of the level of the math course that they are in, the harmful effect of prevalent negative stereotypes about their academic ability can be reversed.

Contrary to both their White and Black peers, Hispanic students in courses below algebra receive a great benefit (i.e., their math scores increase as teacher equity increases) from having an equitable teacher. What is particularly encouraging is that gaps in predicted math test scores for Hispanic students completely close once perceptions of teacher equity reach 1 standard deviation above the mean. We do need to pay more attention to Hispanic students in advanced math classes who realize a small drop in math test scores as perceptions of teacher equity increase. While this decrease is not nearly as large in magnitude as the increase of their peers in below algebra courses, it is still worthy of further investigation. These differing patterns may be indicative of the heterogeneity of Hispanic youth not currently being captured in the analyses. Students from immigrant and language-minority populations are generally more likely to be in lower level courses, compared to their Hispanic peers who are native born English speakers and who are more likely to be in advanced courses (Callahan, 2005). Some research has found that students from the former group are perhaps more sensitive to teacher messages about their ability than their peers in the latter group (Stanton-Salazar & Dornbusch, 1995) thus providing a possible explanation for the increase in test scores observed for students in the low group.

Limitations and Future Directions

As mentioned previously, it is important to consider students' perceptions of their teachers' equitable practices, as what student perceive may be more consequential than what teachers believe they are doing to promote equity. However, it would be useful to know what specific teacher practices in the classroom that students perceive as equitable, which I was not able to measure. Furthermore, this study was limited in its ability to explore the potential role of teacher gender and race/ethnicity due to the very high rates of missing data on these characteristics. Some research on student-teacher matching (Gershenshon, Holt & Papageorge, 2015; Dee, 2005) indicates that having a teacher of the same race or gender might impact student learning outcomes. Future research could consider how matching might affect student perceptions of their teachers' equitable practice, as well as shape how such perceptions impact their achievement.

Conclusion

Equity in math education has been, and continues to be, on the forefront of discussions among all stakeholders in the educational process. Central to these discussions is the role that schools and teachers play in exacerbating or eliminating inequitable experiences between groups of students. As stated previously, educational researchers play a key role in such discussions. Research studies in math education that investigate issues of equity often do so from two alternative standpoints. The first of these examines existing gaps between groups of students, usually between students from underprivileged groups relative to their peers in more privileged groups. The second focuses less on gaps between groups and more on student experiences across various contexts and a consideration of within group heterogeneity and comparisons. I argue that both perspectives on math education research are needed to gain a comprehensive understanding of inequities that exist as well as ways to address those inequities. In this dissertation study, I contribute to the conversation on equity in math with three analytic studies that support both points of view in different ways, thus providing further evidence for the legitimacy of each.

In the first analytic chapter, I explore inequality in access to the gatekeeper course, 8th grade algebra among students in a large, urban and diverse school district. Findings from this chapter support the notion that investigations of gaps are indeed necessary as descriptive results expose persistent academic disparities between Black and Hispanic students relative to their White peers as early as the 7th grade. These gaps hinder Black and Hispanic students from taking 8th grade algebra, consequently limiting their math course taking trajectories. Key to my analyses is the role that school context, specifically school racial/ethnic composition, plays in impacting racial/ethnic disparities in students' likelihood of enrolling in 8th grade algebra. I further explore these disparities looking both at disparities between Black and Hispanic students relative to White students as well as between Black and Hispanic students relative to each other.

Considering school racial/ethnic composition and comparisons between minority groups, revealed interesting patterns of enrollment inequality that could not have been discovered using more conventional racial/ethnic comparisons and without consideration of school context. Thus, these findings support the notion that math education research should consider student experiences in different contexts and go beyond traditional comparisons of minority students and their White peers. Furthermore, when considering the role of schools in exacerbating or eliminating inequalities, this analytic chapter supports the idea that schools may in fact be contributing to racial/ethnic gaps specifically relative to course-taking but this depends on the racial/ethnic composition of schools. Black and Hispanic students in more integrated school settings seem to fare better as far as actual algebra enrollment proportions and their predicted probability of enrollment relative to their counterparts in predominantly Hispanic schools.

In the second analytic chapter, I expand on the first analytic chapter by investigating whether students who successfully complete algebra go on to take the next course in the math sequence (i.e., geometry) as 9th graders in high school. Findings from this chapter suggest that once students gain access to algebra in 8th grade, most continue on an advanced math course-taking trajectory by enrolling in geometry in the 9th grade. This pattern holds for all racial/ethnic groups regardless of the racial/ethnic composition of students' middle and high school. While all students gain similar returns in course placement for having similar grades, differences in academic priors between minority students and their White peers persist such that the algebra grades of the latter group surpasses those of the former within more integrated school settings.

As in the first analytic chapter, I consider school racial/ethnic composition as well as comparisons between minority groups in this analytic chapter. Doing so also allowed me to fully explore inequality in math course placement in the transition to high school across school contexts. While findings were consistent for both school types, they nevertheless provide insight into pinpointing where along students' educational timeline focus should be made in order to interrupt patterns of inequality. Therefore, in this analytic chapter, as in the first analytic chapter, opportunity gaps are explored but within different contexts. Furthermore, findings from this analytic chapter, which highlight seemingly meritocratic processes for placing students in classes, support the notion that schools serve as a means of, at the very least, preventing racial/ethnic opportunity gaps from widening.

In the third analytic chapter, I shift my focus away from a singular high-minority school district to utilize national data to analyze students' experiences within math classrooms. Specifically, I investigate students' perceptions of their teachers' equitable practices, considering how such perceptions vary with characteristics of students as well as the characteristics of teachers. Furthermore, for students from different racial/ethnic groups, I explore the extent to which perceptions of teacher equity predict students' math test scores and consider whether this varies by course context. Findings from this chapter indicate that females, Black students and students in an advanced math class rate their teachers higher on the equity scale relative to their respective peers. Furthermore, male teachers, non-Asian teachers, those who do not hold a high school math certification and those who are in the first few years of teaching receive the highest equity ratings from students relative to their peers in their respective groups. Considering whether 9th graders' perceptions of their teacher being equitable predicts students' math test scores as juniors, I find varied patterns by racial/ethnic groups. Specifically, net of student, teacher and school characteristics, White students who are in advanced classes, all Black students regardless of course level, and Hispanic students in the lowest level math classes realize an increase in math test scores from having an equitable teacher.

My analyses and findings from this analytic chapter contribute to the debate surrounding the role of math education research in a number of ways. First, the analyses deviate from examining gaps between racial/ethnic groups, and instead focus on achievement differences within groups. Doing so, as pointed out previously, revealed very different patterns by racial/ethnic group of the effect of having an equitable teacher on math test scores specifically relative to students' course level. Second, I rely on students' perceptions of their teachers' equitable practices instead of teacher reports. I argue that how students perceive their teachers' practices may be more indicative of their teachers' actual practices versus teachers' self-report of those practices. In essence, students in this analytic chapter have more of a voice in the expressing what teacher qualities and practices that they deem to be equitable, and in some instances beneficial to their math achievement. In this analytic chapter, I certainly support the notion of having math education research that addresses issues of equity by examining differences within instead of between student groups and I further explore the idea of the effect of teacher practices by examining those positive teacher behaviors that influence student achievement.

Limitations

While this dissertation highlights key areas within math education that we need to pay attention to if we want to adequately address issues of equity, it has its limitations. First, given that research has pointed to the possible diverging effects of males and females within the same racial/ethnic group, I expected that I would also find results by race/ethnicity that differed by gender. However, in these three analytic studies, I explored but did not find any evidence to support that. Second, while my use of district data in the first and second analytic chapter allowed me to gain closer access to the racial/ethnic patterns of math course taking within a specific school district that is similar demographically to school districts that many minority students attend, results cannot be generalized to other areas. There may be unique characteristics of this school district which contribute to the course-taking patterns that I find and thus may not be factors in other school districts. Lastly, my use of national data in the third analytic chapter posed its own difficulties. Specifically, student samples were at most 20 students per school, making it difficult to discuss broader aspect of schools themselves by racial/ethnic group. More national datasets with larger samples of students per school would help to address this issue.

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