Mathematics Learning and Diverse Students

Na'ilah Suad Nasir, Niral Shah, Jose Gutierrez, Kim Seashore, Nicole Louie, & Evra Baldinger
UC Berkeley

Abstract

This literature review synthesizes the research on issues of mathematics teaching, learning, and achievement for students from marginalized groups, including Black students, Latina/o students, English language learners, and poor students. In Part 1, we outline national trends in mathematics achievement and learning for students in these groups. In Part 2, we describe what we know about the extent to which students in these groups are provided access to high-quality mathematics instruction and we detail some of the challenges these students face. In Part 3, we summarize what existing research tells us about effective instruction for equity in mathematics, and the necessary conditions at the district, school, and department levels to support such instruction. We also consider the implications for schools; what can schools do to better support equity in mathematics learning outcomes? Throughout, we will consider the case of one school that developed an equity pedagogy in mathematics, Railside High School, as an example of successful equity pedagogy in mathematics, and as a cautionary illustration of the kinds of institutional and district support required to sustain such pedagogy.

The goal of creating equitable[1] outcomes in mathematics education has been a part of the national agenda since at least the early 1980s, when the report *A Nation at Risk* cautioned that America's economic future depended on the mathematical and scientific literacy of *all* of its citizens (National Commission on Excellence in Education, 1983). However, three decades later, substantial disparities both in resources and in achievement persist, organized along troublingly clear lines of race, ethnicity, and socioeconomic status (SES).

This paper reports on issues of mathematics teaching, learning, and achievement related to students from groups historically marginalized, such as low-SES students, racial/ethnic

[1] Using the word *equity*, we adopt Rochelle Gutiérrez's (2002) definition, which emphasizes "the goal of being unable to predict student patterns (e.g., achievement, participation, the ability to critically analyze data or society) based solely on characteristics such as race, class, ethnicity, sex, beliefs and creeds, and proficiency in the dominant language" (p. 153).

minorities, and English learners.[2] The paper proceeds in four parts. First, we examine national achievement data that reveal disparities in test performance and course-taking patterns. Next, we go beyond the quantitative trends to consider disparities in students' access to opportunities to learn (DiME, 2007) that contribute to persistent inequities. Third, we synthesize what is known about effective mathematics teaching and learning for students from marginalized groups. Finally, we consider implications for institutional policy. As we do so, we use the case of Railside High School as an example of a racially, socioeconomically, and linguistically diverse high school that created an equity pedagogy in mathematics but then struggled to maintain that pedagogy in the face of numerous external pressures coming out of a complex fiscal and policy context. We will begin with a brief profile of Railside's mathematics department.

Railside High School Mathematics

In many ways, Railside is a typical, large, urban, comprehensive high school. It enrolls approximately 1500 students, with a student body that is 92% non-White (54% Latina/o, 21% Black, and 17% Asian and Pacific Islander). Additionally, 45% of the students at Railside are English language learners, and 52% qualify for free or reduced lunch. Railside serves students from exactly those populations about which we are most concerned in this paper.

In the early 1980s, there was nothing exemplary about mathematics instruction at Railside. In fact, in 1986 students told the regional accreditation commission that they "could not learn math" at Railside (Lieberman, 1997, p. 40). Prompted in no small part by this commission's report, the school's mathematics department came together to figure out how to better support

[2] Historically, women have also comprised a group marginalized in mathematics. And while women remain underrepresented in STEM careers (Hyde, et al., 2008), gender gaps in K-12 mathematics course-taking and undergraduate mathematics majors have generally closed (National Center for Science and Engineering Statistics, 2011). Thus, given our space constraints, gender equity is not the focus of this paper.

students, particularly Black and Latina/o students, with whom they had not had much success. The teachers began meeting regularly to develop curriculum and instructional practices that would both maintain a high level of mathematical rigor and be widely accessible to students with a variety of strengths. They enlisted the support of university partners as consultants. They also attended carefully to their hiring practices, with the department playing a central role in hiring new math teachers who were equity-minded. Over time, these efforts produced significant results. Boaler and her colleagues (Boaler, 2008; Boaler & Staples, 2008) compared mathematics teaching and learning at Railside and two other high schools, each of which had fewer poor and minority students, and found that more Railside students were enrolled in advanced mathematics courses (41% were in Calculus or Pre-Calculus, compared to 27% at the other schools). Railside students also had slightly higher scores on the California standards test for algebra (49% of students scored "basic" or better, compared to 41% at the other schools). Additionally, achievement was more equitable at Railside, where there were no achievement gaps by senior year between White, Black, and Latina/o students (though Asian students continued to have significantly higher achievement than all other groups), while gaps between White and Asian students versus Black and Latina/o students persisted at the other schools. We will say more about the pedagogy and practices at Railside that produced these outcomes in later sections, but first we will examine equity outcomes in mathematics nationally; the national trends provide striking contrast to the success at Railside.

PART 1: Trends in achievement

In order to establish the seriousness of inequities in mathematics education, in this section we discuss disparities in national standardized test scores and mathematics course-taking patterns. These disparities, or “gaps,” exist along multiple demographic variables (e.g., race/ethnicity, SES, English proficiency). While the bulk of extant research focuses on racial/ethnic disparities, we also address gaps linked to SES and English proficiency.

One widely-cited measure of mathematics learning is the National Assessment of Educational Progress (NAEP), also known as the “nation’s report card.” For years, NAEP scores have reflected significant “gaps” in achievement based on race (e.g., J. Lee, 2006) and class (e.g., Flores, 2007), regardless of grade level. Most recently, on the 2009 NAEP, 75% of White high school seniors scored at the “Basic” level or better, compared to 36% of Black seniors and 45% of Latina/o seniors (National Center for Education Statistics [NCES], 2011). The gaps are even wider when only higher-level NAEP items are examined (i.e., those items that require multi-step problem solving and constructed responses, as opposed to multiple choice); on these items, 1 in 10 White students was proficient compared with 1 in 30 Latina/o students and 1 in 100 Black students (Haycock, 2001). By the time they finish high school, the average performance of Black and Latina/o students is not significantly different from that of White 8th graders (Haycock, 2001; Lubienski, 2002). Equally striking, on the 2009 NAEP, only 44% of poor students (those who qualified for the National School Lunch Program) scored at the “Basic” level or better, compared to 71% of students from families with higher incomes (NCES, 2011). On the same test, 20% of English learners met or exceeded the “Basic” standard, versus 66% of non-English learners (NCES, 2011).

Other assessments show similar race- and SES-based patterns (e.g., the Trends in International Mathematics and Science Study, Gonzales et al., 2004; and the National Educational Longitudinal Survey, Tate, 1997). Additionally, while child poverty has substantial effects on mathematics achievement independent of race (Payne & Biddle, 1999), race has effects independent of class such that on the 2009 NAEP, White students who were eligible for the National School Lunch Program still scored better, on average, than Black students who were not eligible (58% “Basic” or better vs. 45%, respectively) (NCES, 2011; see also Lubienski, 2002).

Similar trends exist for K-12 course-taking patterns. By the 8th grade, 49% of Latina/o students and 47% of Black students have taken algebra or pre-algebra, compared with 68% of White students (Flores, 2007). Furthermore, beginning in elementary school and all the way through high school, White students are overrepresented in “gifted,” “honors,” and “advanced placement” programs, while Black and Latina/o students are severely underrepresented (Darling-Hammond, 2010; Oakes, 1990; Tyson, 2006). English learners are also frequently blocked from these tracks (Darling-Hammond, 2010; Olsen, 1997).

Data on students’ identification with and interest in pursuing mathematics are less available than their standardized test scores, but these measures have significant implications for who goes on to study the mathematics that is required for college admissions and later, for STEM careers. Small-scale studies (Boaler & Greeno, 2000) and indirect measures (Catsambis, 1994) suggest that despite achievement gains, girls still have significantly less confidence and attitudes that are less positive about mathematics than boys. Very little data is available for similar comparisons by race, class, or English proficiency.

Despite the persistence of race- and SES-based achievement gaps, there have been marked changes in mathematics achievement since the 1970s. Raw scores have improved for all racial/ethnic groups on a number of measures, including the NAEP (Lubienski, 2002; Tate, 1997). And yet, although racial/ethnic disparities narrowed through the 1970s and 1980s, that trend has reversed over the last two decades; gaps have widened since 1988 (Flores, 2007).

Darling-Hammond (2010) attributes this reversal to the abandonment of policies aimed at equalizing school funding, raising teacher quality, and eliminating child poverty. In comparison, recent research has found that current policies emphasizing standardization and high-stakes accountability (e.g., No Child Left Behind) exacerbate inequity by driving the schools that are least successful to focus on basic skills as a means of test preparation and to push out students who are struggling and in need of support (Haney, 2000; McNeil, 2000; Mintrop, 2003; Pedulla, et al., 2003). This phenomenon disproportionately affects low-SES students and students of color (Haney, 2000; Rustique-Forrester, 2005).

It was in the context of these national patterns of inequity in mathematics education that the Railside teachers came together to look for solutions. To some degree, these national patterns also foreshadow an issue that became an obstacle for Railside teachers in recent years: a national educational policy climate that focuses heavily on standardization, accountability, and scores on high-stakes state exams. Next we examine the structural and systemic forces that serve to maintain the lower levels of achievement in mathematics for students from marginalized groups, low SES students, and students with limited English proficiency.

PART 2: Inequity in Opportunities to Learn Mathematics

The disparities summarized in the preceding section can be interpreted in at least two ways. One possible interpretation is that racial/ethnic minorities, low-SES students, and English learners are somehow either biologically or socially less inclined toward mathematics. Certainly, such biased ideas have historically been supported by social science research (Hernnstein & Murray, 1994; Jensen, 1998; Richards, 1997). However, a wealth of empirical evidence refutes these claims (Gamoran, 2001; Nisbet, 1998).

A better-supported interpretation is that social, political, and economic forces converge in ways that systematically limit the opportunities that students from historically marginalized groups have to learn mathematics. In this section we identify four critical components of access to opportunities to learn mathematics: 1) access to advanced mathematics courses; 2) access to quality mathematics curricula and instruction; 3) access for English learners; and 4) access to productive mathematics identities. We cite research that illuminates ways in which each of these components of access is differentially distributed across racial/ethnic, SES, and language groups. However, since opportunities to learn mathematics are closely linked to opportunities to learn *in general*, we begin by considering school-level factors that disproportionately affect certain students' academic experiences.

The Broader Context of Limited Opportunities to Learn

Opportunities to learn and access to high quality schooling are unequally distributed in American society. Research shows that schools attended by racial/ethnic minorities, low-SES students, and English learners are systematically under-resourced. These schools tend to have fewer well-trained or even credentialed teachers, more dilapidated buildings, less access to basic supplies (such as pencils and paper), less access to technology (e.g., computers and calculators), and fewer advanced and AP courses (Darling-Hammond, 2010; Oakes, 2007; Kozol, 2006 as compared to schools attended by middle and upper class and white students. Within schools, tracking systems maintain differential (and less rigorous) educational experiences for Black and Latina/o students, poor students, and English learners (Oakes, 1985; Darling-Hammond, 2010; Olsen, 1997; Gifford & Valdés, 2006).

Scholars have also identified discipline systems in schools and classrooms as an important factor that impacts the schooling experience of students from marginalized groups (Dance, 2002; Ferguson, 2000; Noguera & Wing, 2006). Discipline systems in schools often operate in ways that disproportionately penalize Black and Latino male students in particular (Ferguson, 2000; Noguera & Wing, 2006); as a result, these students encounter a less friendly school environment and miss class time when they are being punished for infractions for which other students are not punished (Noguera & Wing, 2006). The combination of having less access to rich learning opportunities and being more harshly penalized for minor infractions can leave students feeling less connected to school and less likely to develop identities as competent students (Nasir, Jones, & McLaughlin, 2009; Darling-Hammond, 2010).

Factors Specific to Mathematics Education

Having noted these broader school factors that impact students' opportunities to learn in general, we now turn to four critical access points specific to mathematics education.

Lack of access to advanced mathematics courses[3]

Access to rigorous mathematics courses is perhaps one of the most fundamental gateways to learning opportunities. The practice of "tracking" students into more or less rigorous mathematics pathways has repeatedly been found to unfairly disadvantage Black and Latina/o students, poor students, and English learners (Darling-Hammond, 2010; Oakes, 1985; Olsen, 1997). Tracking occurs when students are placed into particular pathways (e.g., "low-track" or

[3] In this section, we use "advanced mathematics courses" to mean Calculus, Pre-calculus, and Trigonometry and "rigorous" as a descriptor of courses that are high-quality, conceptually oriented, and cognitively demanding. A high-tracked course is not necessarily advanced or rigorous. For example, an Honors Algebra class could be designed to cover a large amount of material very procedurally.

“remedial” versus “college preparatory”) based on factors such as standardized test scores, grades, and teacher recommendations. While tracking is often justified as a way of tailoring instruction to students’ different abilities and needs, it commonly produces classrooms that are highly segregated with respect to race and that reflect structural and personal biases rather than actual differences in students’ abilities. Research has shown that Black and Latina/o students are often assigned to lower tracks than White and Asian students, even when their achievement profiles are similar (Oakes, 2005). Tyson (2006), for example, has found that “gifted” programs consistently under-enroll Black students, even excluding students with higher academic achievement than their White peers at the same school. Once students are tracked into low-track/remedial pathways, it is often difficult for them to “jump” into college preparatory tracks (Darling-Hammond, 2010; Oakes, 1985). Tracking systems thus contribute to the underrepresentation of Black and Latina/o students, poor students, and English learners in college preparatory classes and the overrepresentation of these groups of students in remedial tracks and special education. In contrast, Lee, Croninger, and Smith (1997) have found both higher and more equitably distributed achievement in schools that offer a narrow selection of mostly academic courses, as opposed to schools with more tracks, even when students are ostensibly assigned to tracks based on their own choices.

Lack of access to quality mathematics curriculum

Opportunities to learn are also fundamentally related to access to high-quality mathematics curriculum, that is, access to rich and challenging content and activities. Leading national standards documents and mathematics education scholars emphasize the importance of student-centered, conceptually oriented and problem-solving focused approaches to mathematics pedagogy (e.g., Boaler & Greeno, 2000; "Principles and Standards," National Council of Teachers of Mathematics [NCTM], 2000; Schoenfeld, 2002). But many schools that serve students from historically marginalized groups do not offer such instruction, instead "teaching to the test"—focusing on remediation and basic skills over conceptual learning—in an attempt to increase student scores on state-mandated standardized assessments (e.g., Davis & Martin, 2008; Darling-Hammond, 2010; Lipman, 2002; McNeil, 2000). While the development of basic skills is an important aspect of mathematical learning, narrow emphasis on such skills severely curtails students' opportunities to learn rich mathematics.

Even in the presence of reform-based approaches, students can be differently positioned to take advantage of rich mathematical content. For example, Lubienski (2000) has documented differences between lower and higher SES students' experiences with a problem-based mathematics curriculum, finding that higher SES students were more likely to have developed the skills and dispositions to productively engage with open-ended problems, while lower SES students were less able to engage more conceptual problems, so that disparities in learning remained. This disparity was most likely due to their lack of prior exposure to the kinds of discourse patterns required in these curricula.

Lack of access for English learners

Issues of language in mathematics education hold implications for mathematics learners both at a structural level and at the level of everyday classroom instruction. From a structural standpoint, some argue that English fluency[4] has had an undue impact on the placement of English learners in low-level mathematics courses (Secada, 1991, 1996). That is, by using English fluency as a measure of mathematical competence, educators may incorrectly place a

[4] We use the terms "fluency" and "proficiency" interchangeably for the purpose of this report.

student in a low tracked class. In some cases, the student may have already studied the content of the class in her/his home country (Gutierrez, 2002). This problem may stem from the assessments being used for placement, as such assessments are typically written in English. Some scholars propose that such assessments should be coupled with other measures (e.g., oral interviews or translated written assessments) that may afford students better opportunities to demonstrate their mathematical knowledge (e.g., by speaking or writing in their home language) (Moschkovich, 1999; Solano-Flores, 2010).

Aside from students' access to advanced mathematics courses, English language barriers are also consequential for teaching and learning in classrooms. Reforms that followed the National Council of Teachers of Mathematics' *Standards* (1989, 2000) have worked to propagate views of mathematics learning as a social process of sense-making and classroom discourse. Prior research has focused on English learners' struggles in comprehending written mathematical texts or word problems (e.g., Dale & Cuevas, 1987; Rubenstein, 1996). More recent research has sought to move beyond emphasis on vocabulary development, instead focusing on the ways in which students use multiple languages in oral communication with other students as they make sense of mathematical ideas (e.g., Moschkovich, 2010).

Historically, English learners' opportunities to learn mathematics have been limited by English-only policies (Olsen, 1997). Numerous scholars have found that students often switch into their dominant languages to engage with higher-level mathematical concepts (Gutstein, et al., 1997; Khisty, 1995; Moschkovich, 1999). These findings suggest that forcing students to communicate in English only may obstruct access to students' full range of cognitive resources and limit their access to rich mathematical content.

While prohibitions on classroom use of languages other than English are no longer common, English learners' opportunities to engage with rich mathematics continue to be limited by efforts to accommodate their needs that are primarily superficial. Research shows that mere translation of mathematical terminology from English into Spanish, for example, is insufficient for learning (Khisty, 1995). Instead, it is optimal when English learners experience mathematical explanations in their dominant language, a decidedly non-trivial pedagogical challenge even for bilingual content-area teachers (Ron, 1999). Nevertheless, as Gutierrez's (2002) study of a school that was successful in enrolling large numbers of Latina/o students in AP Calculus shows, it is possible to create productive learning environments even when teachers are not fluent in students' home languages.

Lack of access to productive math identities

From lack of rich, challenging curriculum to support to English language obstacles, we have identified thus far a number of barriers that limit students' opportunities to learn mathematics. However, not all such obstacles are material in nature. Content learning is recognized as requiring access to a vision of oneself as a future capable doer of the given discipline (Wenger, 1998). The availability of productive math identities bears heavily on whether and how students engage with mathematics in school (Nasir, 2002; Martin, 2000; de Abreu, 1995; Sfard & Prusak, 2005). We conclude this section with a treatment of some of the factors that mediate students' access to productive identities in mathematics.

Research on stereotype threat provides evidence that stereotypes can depress the performance in testing situations of students who perceive themselves as belonging to groups that are the subject of negative stereotypes (Steele, 1998; Steele & Aronson, 1995). In one study that focused on the effects of the racial narrative, "Asians are good at math," researchers found that White males who were made aware of this narrative prior to testing performed significantly worse on a mathematics assessment than White males in a control group (Aronson et al., 1999). The fact that queuing a stereotype can affect even members of a historically dominant group speaks to the power of such narratives.

The power of stereotypes is particularly striking when one considers the prevalence of racial stereotypes about who can be good at math. Survey data suggest that while both elementary and middle school students are aware of the “Asians are good at math” stereotype, as well as the stereotype that Black and Latina/o students are *not* good at math, older students are more likely to endorse these narratives (Nasir, O’Connor, & Wischnia, in progress). Although to date little research exists on how these stereotypes impact student learning, there is evidence at the high school level that they do come up in everyday classroom discourse among Black males, and that this does influence their perceptions of which groups of students can and cannot succeed in mathematics (Nasir & Shah, 2011; Nasir, 2011). Similar narratives about boys being better than girls at math have also been shown to be salient to students (Cvencek, Meltzoff, & Greenwald, 2011).

In addition to racial and gender narratives, the presence (or absence) of positive role models also affects students’ access to productive identities in mathematics. In her research on Black women who succeeded in mathematics, Moody (2004) found that one commonality among her study participants was that they relied on what they call reinforcing agents, namely individuals in their lives who told them they belonged in mathematics and who encouraged them to persevere. These reinforcing agents gave study participants a vision of themselves as successful doers of mathematics. Making available such identities has been one objective of the ethnomathematics movement, which has sought to challenge the notion that mathematics originated only from European geographies (de Abreu & Cline, 2003). By tracing the roots of mathematics to Africa and other non-European locales, this research tradition has attempted to make "ownership" of mathematical knowledge more accessible to non-White students, thereby increasing their access to productive mathematical identities.

In sum, we have discussed several barriers that differentially limit students' opportunities to learn mathematics, including lack of access to advanced math courses, lack of access to high-quality curriculum, lack of access for English learners, and lack of access to productive mathematical identities. Taken together, these issues present formidable, systemic challenges faced by many mathematics students from historically marginalized groups. This examination of the striking paucity of opportunities to learn for Black and Latina/o students, poor students, and English learners puts the achievement gaps in Part 1 into clearer relief. Next, we explore what the research tells us about approaches that have effectively fostered equity despite the challenges we have described. As we do so, we turn to a deeper description of the practices and pedagogies that fostered equitable outcomes at Railside.

PART 3: Effective Approaches to Foster Equity[5]

There is no panacea to make mathematics education effective for all students, let alone students whose needs have frequently remained unmet. However some promising directions for improving mathematics teaching and learning are being explored, tested, and refined (Confrey, 2011) Here we describe what is known to date about approaches to mathematics education that

[5] The literature pertaining to this area is sparse, yet in this section we attempt to summarize the research that is available. As such, the reader should note that these studies at times lack clear outcome measures. Rather than report on specific results from individual studies, we instead highlight promising directions for research focusing on equity-driven pedagogy. Given the paucity of large-scale studies in this particular area, it is difficult to anticipate what methods will work where and with whom, given that many of these components are contextual (i.e., variation across student populations, teachers, contexts, etc.).

produce positive outcomes for a diverse range of students. We find that these approaches tend to include the following characteristics: high-quality curriculum, classroom practices to foster equity, connecting to students' cultural and real-world experiences and organizing for equity. Of course, in reviewing this literature we recognize that positive outcomes are not simply the result of equitable pedagogical practices, high quality curriculum, or supportive school or district structures, but rather occur when all of these are working symbiotically (Schoenfeld, 2002). As we discuss each characteristic, we reflect on the strategies and structures utilized at Railside.

High Quality Curricula

The features of high quality curricula that have been shown to be effective in supporting the mathematics learning of students from marginalized groups include: cognitively demanding tasks that emphasize conceptual understanding and mathematical reasoning (Silver & Stein, 1996), problems grounded in familiar contexts (Boaler, 2002a), and bridges between students' informal knowledge and understanding of mathematical situations and the formal language of mathematics (Davis et. al., 2007).

One example of a project that highlights the importance of high-quality curriculum is the Quantitative Understanding: Amplifying student Achievement and Reasoning (QUASAR) Project. The QUASAR project, an instructional intervention supported by on-going professional development, investigated learning gains that resulted from use of mathematical tasks that "involve multiple connected representations and allow multiple solution strategies" (Silver & Stein, 1996, p. 486) Silver and Stein's (1996) results showed substantial learning gains for Black students, White students, and English learners in comparison to classrooms using more simple tasks employing single strategies or representations. These gains were measured both in terms of students' performance on open-ended problem solving tasks and their NAEP scores. Other studies also indicate that curricula that emphasize complex mathematical tasks are indeed beneficial for all students (Boaler, 2002b; Schoenfeld, 2002; Tarr et. al, 2008).

Another aspect of curricula that support diverse learners is grounding mathematical ideas in contexts familiar to students (Boaler, 2008 Davis, West, et. al., 2007). Such contexts help students leverage their everyday, out-of-school experiences for in-school learning, and motivate students by communicating the power of mathematics in their worlds. In her seminal study involving two schools attempting to implement reform-based instruction, Boaler (2008) found greater gains in a school in which the mathematical tasks were closely tied to experiences in the students' lives. Similarly, one of the central tenets of the Algebra Project (Davis, et al., 2007) curriculum is engaging students in shared experiences that serve to bring them into the language and culture of mathematics. Their work shows that such experiences help students to connect their own ways of reasoning and explaining to the formal structures of mathematical discourse.

Likewise, the teachers at Railside devoted considerable time and energy to developing and enacting a curriculum that challenged students to engage with complex mathematical ideas. They worked together to plan activities and lessons that they called "group-worthy" -- employing mathematical tasks that foster deep engagement with challenging mathematical problems and rich mathematical discussions among students. They continually revised these lessons together, sharing ideas and strategies for optimal implementation, as well as analyzing failures and potential pitfalls. Over the course of several years, each teacher had compiled a large binder with these co-written and revised activities, which they used as the basis for their activities in the classroom.

Classroom Practices that Support Equity

Equally important to the content of the curriculum are classroom practices that enable students to engage with the curriculum and create mathematical meaning from it. Powerful practices include those that foster student-centered discourse, student exploration of mathematical ideas, and on-going feedback (Davis, et. al., 2007; Boaler, 2002b; Fullilove & Treisman, 1990). Studies indicate that supporting students in working productively in small groups to discuss their understanding and provide help to their peers leads to increased performance (Webb & Farivar, 1994; Boaler & Staples, 2008; Silver & Stein, 1996; Fullilove & Treisman,1990).

Researchers stress the importance of the role of teachers in fostering and facilitating productive student discourse as well as the importance of "group-worthy" tasks (Cohen & Lotan, 1997; Boaler & Staples, 2008). Changing participation structures from lecture or teacher-centered discourse to student-centered discourse may result in discomfort for some students and, if not sufficiently supported, can lead to a lack of positive results (Lubienski, 2000). However, as Webb and Farivar (1994) demonstrated with sixth-grade students, supporting students in learning how to talk with and help each other and providing sufficient feedback on individual work results in significant gains for Black and Latina/o students.

Issues of unequal status in classrooms can create inequitable learning in the context of group work (Cohen & Lotan, 1997). Cohen and Lotan (1997) have identified two practices that can address issues of differential status: broadening the meaning of "smart" by reorganizing curriculum and instruction around multiple ways of representing and interpreting mathematics, and assigning competence to low-status students by publicly recognizing these students' mathematical ideas and contributions. Boaler and Staples (2008) studied the effects of these classroom practices in mathematics classrooms at Railside High School, documenting their positive effects on both mathematics achievement and the development of positive mathematical identities. They found that the teachers at Railside regularly assigned competence to students who did not see themselves as "smart" in mathematics, and found ways to support those students in finding new ways to be smart, for instance, by asking productive questions. Railside teachers also developed shared ways of supporting students to talk mathematically and to work together on complex tasks. They found that giving students more challenging material was a critical aspect of supporting higher levels of achievement.

Connecting to Students' Cultural and Real-World Experiences

In addition to high-quality curriculum and classroom practices that support equity, an important component of creating a classroom context that best supports the learning of students from historically marginalized groups is connecting to students' cultural or real-world experiences. Learning is an inherently cultural endeavor (C. Lee, 2007; Nasir, 2011). The research literature in mathematics education identifies two potential ways that math classrooms can connect to students' cultural worlds. The first is through activities that are "culturally congruent," that is, activities and content that draw on students' knowledge base and experiences outside of school. For instance, Gonzalez, Moll, and Amanti (2005) design classroom activities that build on expertise in Latina/o students' homes and communities. They incorporate families and community members into the life of the classroom, and encourage teachers to connect with families to better understand and utilize the cultural funds of knowledge of students and their communities. Similarly, Civil (2007) and Moses & Cobb (2000) have designed mathematics lessons that build on the cultural knowledge of students and families, for instance by creating lessons that draw on community-based gardening knowledge or knowledge about the subway system.

The second way of connecting with students' worlds that the research literature has identified is to take social justice approaches to mathematics teaching (Brantlinger, 2007; Gutstein, 2003). Social justice approaches use factual, rather than fictional, problems and data and encourage students to use mathematics to reflect on social issues that are relevant to them and to their communities (e.g., differences in interest rates for home loans in poor versus wealthy neighborhoods). These approaches view critical perspectives on power and inequality in society as important aspects of mathematical literacy (Gutstien, 2003; 2005). Researchers have found that social justice approaches to mathematics can be engaging for students, particularly students from historically marginalized communities (Gutstien, 2005). However, scholars caution that teachers should be mindful of the challenges inherent in creating lessons and activities that are mathematically rich and that address important social issues (Brantlinger, 2007). While these projects serve largely as "existence proofs," that culturally congruent and social justice approaches can illuminate new directions in mathematics instruction for students from historically marginalized groups, there has yet to be systematic research published on the learning outcomes afforded by these approaches.

Researchers have also argued for the importance of students' developing *disciplinary identities* (or disciplinary dispositions) that support their mathematics learning (Boaler & Greeno, 2000; Nasir, 2002). Researchers define mathematical identity as the ways in which students feel that they belong in the math classroom community and can be competent learners of mathematics. Thus, the development of students' mathematics identities may be strengthened by classroom practices that both foster successful learning (Nasir, 2002) and build a sense of community among the students.

While Railside teachers did not use explicitly social justice or culturally congruent approaches, they did actively work to build close-knit classroom communities and to create a positive classroom culture of support and encouragement. They also found ways to support students in developing identities of competence, assigning competence as a regular part of classroom practice and supporting students in coming to think of themselves as mathematics learners.

Organizing for Equity

Studies of schools and districts that serve students from historically marginalized groups consistently point to the importance of organizing for equity at the institutional level. Features of this organization include a shared mission, mission-aligned curriculum and instruction, and attention to cultivating and maintaining supportive, professional communities.

Shared mission. An explicit commitment to improving learning outcomes for students of color specifically characterizes many of the schools (Morris, 2004; Valenzuela, 1999; Walker, 1996) and mathematics departments (Boaler, 2008; Gutiérrez, 1999, 2000) that succeed with these students. While such a commitment does not guarantee more equitable outcomes *per se* (Horn, 2007), it is important to counter the prevalent and often defeatist conceptions of these students as deprived or somehow deficient. Teachers at Railside developed a shared mission that was built upon working to teach complex mathematics to students from marginalized groups, thus providing these students with the academic, social, and personal resources necessary for them to continue on to college. At Railside, this shared mission was made explicit and reiterated as teachers worked together daily (Little & Horn, 2007).

Curriculum and instruction. In previous sections, we have discussed the negative consequences of tracking, which disproportionately fall on students from historically marginalized groups. Research has repeatedly shown the benefits of schools with less course differentiation (i.e., schools that are de-tracked), in terms of student achievement on standardized tests, enrollment in advanced mathematics courses, and their development of positive mathematical identities (Boaler, 2002b; Burris, Heubert, & Levin, 2006; Lee, Croninger, & Smith, 1997). At Railside, all 9th grade mathematics classes were de-tracked, with all 9th graders taking Algebra. Additionally, mathematics was taught in 90-minute “condensed block” periods with most full courses being taught in a single semester. This system allowed teachers time to take on long and challenging group problems with students and also allowed students to retake math classes if they failed, while still being able to continue on to higher mathematics before graduation.

Professional community. Research suggests that investment in sustained professional development and teacher-led collaboration is a necessary component of efforts to improve learning outcomes for students from historically marginalized groups; when this investment has been lacking, which it all too often is, curricular and other reforms have not been effective (Cohen, 1990; Spillane, 1999; Tyack & Cuban, 1995). In contrast, schools and districts that support ongoing professional learning produce and sustain equitable learning environments and outcomes for students (Balfanz & Byrnes, 2006; Darling-Hammond, 2010; McLaughlin & Talbert, 2006). The mathematics department at Railside exemplifies this point. Over a twenty-year period beginning in the mid-1990s, the department’s rotating leadership consistently prioritized designating time for teachers to refine their curriculum collectively, work through classroom challenges as they arose, and develop shared understandings of equity in mathematics education, activities that were essential to the successes they achieved (Horn, 2005; Little & Horn, 2007).

In this section, we described several components of successful mathematics teaching for equity, and highlighted the ways that these components were taken up in the work at Railside High School. We must also note the importance of the school, district, and policy context in supporting such work at the classroom level. We have already discussed the importance of practices at the school level, such as a commitment to de-tracking that is necessary for the kind of equity work that occurred at Railside. However, there must also be support at the district level for the kinds of curricular and pedagogical approaches that we have described here to be effective. That said, such support may be increasingly difficult to find, particularly in urban districts which are under the threat of sanctions under federal education policy.

In fact, at Railside High School since 2007, mathematics teachers have been under increasing pressure to shift to practices more aligned with high stakes standardized exams, as the district has faced increasing scrutiny under No Child Left Behind, and under a new superintendent who does not share the Railside teachers' vision of equity pedagogy. The district mandated that rather than draw on the curriculum they had produced together and were working to tailor to their students, mathematics teachers use the district-adopted textbook—despite the fact that several of the teachers had participated in writing the textbook. Additionally, the district shifted from the block schedule to a regular 7-period day, which made it impossible for the teachers to continue to implement the problem-based curriculum that they had been working for years to perfect. To make matters worse, a district-wide budget crisis resulted in increased class sizes and a shift in school assignment procedures. Consequently, with a larger influx of students, Railside enrolled fewer students who had been successful educationally, which led to larger classes of more needy students. This combination of a lack of support for their work, and a new context within which the practices they had developed together were impossible to sustain, several of the core mathematics teachers at Railside left the school, and the remaining teachers say that they are unable to continue the work that they had done for over a decade; they report that they are just biding their time until retirement (Louie, 2011).

This course of events at Railside points to the importance of support at multiple levels for equity pedagogy in mathematics, and the challenge of enacting such a pedagogy in a time of high-stakes accountability and standardization.

PART 4: Implications for Schools & Directions for Future Research

This literature review demonstrates that mathematics teaching, learning, and achievement for students from marginalized groups is contingent upon both systemic and pedagogical factors. We maintain that the achievement gaps in mathematics education that we describe at the opening of this report are the result of social, political, and economic forces converging in ways that systematically delimit the opportunities that students from historically marginalized groups have to learn mathematics. We identify four critical components that serve to differentially restrict opportunities to learn mathematics for students from marginalized groups: 1) access to advanced mathematics courses; 2) access to quality mathematics curricula and instruction; 3) access for English learners; and 4) access to productive mathematics identities. In light of these systemic challenges, we also summarize what existing research tells us about effective classroom instruction for equity in mathematics, and the necessary conditions at the district, school, and department levels to support such instruction. Specifically, we found that effective approaches tend to include the following characteristics: high-quality curriculum, classroom practices to foster equity, connecting to students' cultural and real-world experiences and organizing for equity.

Following the case of Railside High School, we illustrate how these various systemic and pedagogical factors interact so as to impact student outcomes and teachers' dispositions, explaining how a once highly effective, equity-driven mathematics department was ultimately "derailed" by inefficacious state mandates. Although Railside is a single case study involving one mathematics department, we believe that it is characteristic of the types of challenges faced by many teachers serving marginalized youth. Taken together, this review and the lessons learned from Railside lead us to a discussion of future research directions and policy considerations, at both the structural and pedagogical level.

Policy and Practice Implications

Structural Level

Our review revealed that structural barriers to access to quality instruction in mathematics played a significant role in perpetuating achievement gaps based on race/ethnicity, social class, and English proficiency. Thus, one set of implications from the research literature involves working to both remove these structural barriers and support students in overcoming them. An obvious implication from the research on equitable mathematics instruction is to create alternatives to systems of tracking which, especially at the high school level, create unequal opportunities to learn, and exacerbate learning gaps. Prior studies have shown that one alternative to tracking is to create rigorous heterogenous classes, where students are supporting in learning complex mathematics. Importantly, however, this structural change must go hand-in hand with pedagogical and curricular changes that support *all* students in learning math.

Developing teaching practices that disrupt inequities requires that teachers engage in a shared vision around equity, and that they communicate with one another, and work together to support change and to learn new ways of approaching their teaching, as well as new ways of viewing their students. However, these strong communities don't sprout up spontaneously—they must be consciously created. At the policy level, schools and districts must structure teacher's work lives in ways that foster collaboration, and perhaps build in apprenticeship and hiring practices that further encourage the development of teacher professional communities designed to disrupt inequity.

A final important implication at the structural level is that support for reaching equity goals my be present at both school and district levels. When teachers feel unsupported in doing equity work, and when the district and school-level administrators don't support their teaching practices, equity pedagogy in mathematics is near impossible to sustain.

Pedagogical Level

Our review of the research literature identified several components of instruction that have implications for enacting teaching that disrupts inequity. Students need to have access to a high-quality curriculum—one that engages them in curriculum that engages students in complex thinking and problem solving. This likely has two important effects; it engages students in complex mathematics thinking and supports their mastery of important mathematical concepts, and it helps to reframe their identity so that they come to see themselves as "smart" in mathematics. It is important to note, however, that teachers must have access to training that supports their ability to implement such a curriculum.

A curriculum that provides students to access to complex mathematical ideas is most effective when paired with classroom practices that foster access and a range of ways to bring intellectual strengths to the endeavor of learning mathematics. That is, practices and activities that build on students' strengths and ways of knowing, and that connect to their experiences and identities outside of the classroom.

Implications for Future Research

While there is a sizable research literature on equity and mathematics teaching and learning in general, we found that much of this research simply described the nature and extent of achievement gaps. There was less research on curricular and pedagogical approaches intended to disrupt these inequalities. And existing studies on pedagogy, curriculum, and practices that create equitable outcomes tended to be case studies and/or descriptions of particular approaches; there was a paucity of studies that compared different approaches to teaching mathematics in systematic ways. Additionally, very few studies included rigorous outcome measures, for instance changes in course-taking patterns, or measures of math learning. The field would benefit from such well-designed, outcomes-based research.

Additionally, there is a shortage of research on the nature of the relationship between the practice of teaching (including learning outcomes) and the school, district, and education policy context. More research is needed to better understand the various factors at these broader levels that support or inhibit the disruption in inequality in access to mathematics.

In conclusion, we hope that this report has highlighted both the critical insights from the body of research on equity and mathematics teaching, and has offered some insight on potential fruitful directions for future research. It is time for the discussion on equity in mathematics education to move beyond simply describing inequities in outcomes; we must move towards both a political commitment and the development of a knowledge-base on how to create classrooms, schools, and educational policies that support greater equity. Creating such classrooms will require that we address political, social, and pedagogical issues in schools, and ultimately, involve directly attending to issues of race, social class, language, and power in schools.

References

Aronson, J., Lustina, M. J., Good, C., & Keough, K. (1999). When White men can't do math: Necessary and sufficient factors in stereotype threat. *Journal of Experimental Social Psychology, 35*, 29–46.

Balfanz, R., & Byrnes, V. (2006). Closing the mathematics achievement gap in high-poverty middle schools: Enablers and constraints. *Journal of Education for Students Placed at Risk*, *11*(2), 143–159.

Boaler, J. (2002a). Learning from Teaching: Exploring the Relationship between Reform Curriculum and Equity. *Journal for Research in Mathematics Education*, *33*(4), 239-258.

Boaler, J. (2002b). *Experiencing school mathematics: Traditional and reform approaches to teaching and their impact on student learning*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Boaler, J. (2008). Promoting 'relational equity' and high mathematics achievement through an innovative mixed-ability approach. *British Educational Research Journal, 34*(2), 167-194.

Boaler, J., & Greeno, J. G. (2000). Identity, agency, and knowing in mathematics worlds. In J. Boaler (Ed.), *Multiple perspectives on mathematics teaching and learning*. Westport, CT: Ablex Publishing.

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of Railside School. *The Teachers College Record, 110*(3), 608–645.

Brantlinger, A. (2007). *Geometries of inequality: Teaching and researching critical mathematics in a low-income urban high school.* Unpublished Dissertation, Northwestern University.

Brenner, M. E. (1998). Adding cognition to the formula for culturally relevant instruction in mathematics. *Anthropology & education quarterly, 29(2),* 214–244.
Burris, C. C., Heubert, J. P., & Levin, H. M. (2006). Accelerating Mathematics Achievement Using Heterogeneous Grouping. *American Educational Research Journal, 43*(1), 137-154.
Catsambis, S. (1994). The path to math: Gender and racial-ethnic differences in mathematics participation from middle school to high school. *Sociology of Education, 67(3),* 199-215.
Civil, M. (2007). Building on community knowledge: An avenue to equity in mathematics education. In N. Nasir & P. Cobb (Eds.), *Improving access to mathematics: Diversity and equity in the classroom* (pp. 105-117). New York: Teachers College Press.
Cohen, D. K. (1990). A revolution in one classroom: The case of Mrs. Oublier. *Educational Evaluation and Policy Analysis, 12*(3), 311-329.
Cohen, E., & Lotan, R. (Eds.). (1997). *Working for equity in heterogeneous classrooms: Sociological theory in practice*. New York: Teachers College Press.
Cvencek, D., Meltzoff, A., & Greenwald, A. (2011). *Math-Gender stereotypes in elementary school children.* Child Development, 82(3), 766-779.
Dale, T. C. & Cuevas, G. J. (1987). Integrating language and mathematics learning. In Crandall, J. (Eds.), *ESL through Content Area Instruction: Mathematics, Science, and Social Studies,* (pp. 9–54). Englewood Cliffs, N.J.: Prentice Hall.
Dance, L.J. (2002). *Tough fronts: The impact of street culture on schooling*. NY: Routledge.
Darling-Hammond, L. (2010). *The flat world and education: How America's commitment to equity will determine our future*. New York: Teachers College Press.
Davis, F. E., West, M. M., Greeno, J. G., Gresalfi, M., & Martin, H. T., with R. Moses & M. Currell. (2007). Transactions of mathematical knowledge in the Algebra Project. In N. Nasir & P. Cobb (Eds.), *Improving access to mathematics: Diversity and equity in the classroom* (pp. 69-88). New York: Teachers College Press.
Davis, J., & Martin, D. B. (2008). Racism, assessment, and instructional practices: Implications for mathematics teachers of African American Students. *Journal of Urban Mathematics Education*, *1*(1), 10-34.
De Abreu, G. (1995). Understanding how children experience the relationship between home and school mathematics. *Mind, Culture, and Activity*, 2(2), 119-142.
De Abreu, G., & Cline, T. (2003). Schooled mathematics and cultural knowledge. *Pedagogy, Culture and Society*, *11*(1), 11-30.
Diversity in Mathematics Education Center for Learning and Teaching. (2007). Culture, race, power, and mathematics education. In F. Lester (Ed.), *Second handbook of research on mathematics teaching and learning*. Charlotte, NC: Information Age Publishing.
Ferguson, A. A. (2000). *Bad boys: Public schools in the making of Black masculinity*. Ann Arbor, MI: University of Michigan Press.
Flores, A. (2007). Examining disparities in mathematics education: Achievement gap or opportunity gap? *The High School Journal, 91*(1), 29-42.
Fullilove, R. E., & Treisman, P. U. (1990). Mathematics Achievement Among African American Undergraduates at the University of California, Berkeley: An Evaluation of the Mathematics Workshop Program. *The Journal of Negro Education, 59*(3), 463-478.
Gifford, B. R., & Valdés, G. (2006). The linguistic isolation of Hispanic students in California's public schools: The challenge of reintegration. *Yearbook of the National Soceity for the Study of Education, 105*(2), 155-172.

Gonzales, P., Guzmán, J. C., Partelow, L., Pahlke, E., Jocelyn, L., Kastberg, D., et al. (2004). *Highlights from the Trends in International Mathematics and Science Study (TIMSS) 2003*.

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

Gutierrez, R. (1999). Advancing urban Latina/o youth in mathematics: Lessons from an effective high school mathematics department. *The Urban Review, 31*(3), 263–281.

Gutierrez, R. (2000). Advancing African-American, urban youth in mathematics: Unpacking the success of one math department. *American Journal of Education, 109*(1), 63-111.

Gutierrez, R. (2002). Beyond Essentialism: The complexity of language in teaching mathematics to latina/o students. *American Educational Research Journal, 39*, 1047-1088.

Gutstein, E. (2003). Teaching and Learning Mathematics for Social Justice in an Urban, Latino School. *Journal for Research in Mathematics Education, 34*(1), 37-73.

Gutstein, E. (2005). *Reading and writing the world with mathematics: Toward a pedagogy for social justice*. NY: Routledge.

Gutstein, E., Lipman, P., Hernandez, P., & de los Reyes, R. (1997). Culturally Relevant Mathematics Teaching in a Mexican American Context. *Journal for Research in Mathematics Education, 28*(6), 709-737.

Haney, W. (2000). The myth of the Texas Miracle in education. *Education Policy Analysis Archives, 8*(41).

Haycock, K. (2001). Closing the achievement gap. *Educational Leadership, 58*(6), 6-11.

Heckman, J. J., & LaFontaine, P. A. (2010). The American high school graduation rate: Trends and levels. *Review of Economics and Statistics, 92*(2), 244-262.

Herrnstein, R. J., & Murray, C. (1994). *The bell curve: Intelligence and class structure in American life*. New York: Simon & Schuster Inc.

Horn, I. S. (2005). Learning on the job: A situated account of teacher learning in high school mathematics departments. *Cognition and Instruction, 23*(2), 207-236.

Horn, I. S. (2007). Fast kids, slow kids, lazy kids: Framing the mismatch problem in mathematics teachers' conversations. *Journal of the Learning Sciences, 16*(1), 37–79.

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Gender similarities characterize math performance. *Science, 321*(July 2008), 494-495.

Jensen, A. R. (1998). *The g factor: The science of mental ability*. Westport, CT: Praeger.

Keller, J. (2007). Stereotype threat in classroom settings: The interactive effect of domain identification, task difficulty and stereotype threat on female students' maths performance. *British Journal of Educational Psychology, 77*(2), 323–338.

Khisty, L. L. (1995). Making inequality: Issues of language and meanings in mathematics.

Kozol, J. (2005). *The shame of the nation: The restoration of apartheid schooling in America.* New York: Crown.

Lee, C. (2007). *Cultural literacy and learning: Taking bloom in the midst of the whirlwind.* New York: Teachers College Press.

Lee, J. (2002). Racial and ethnic achievement gap trends: Reversing the progress toward equity? *Educational Researcher, 31*(1), 3-12.

Lee, J. (2006). *Tracking achievement gaps and assessing the impact of NCLB on the gaps: An in-depth look into national and state reading and math outcome trends*. Cambridge, MA: The Civil Rights Project at Harvard University.

Lee, V. E., & Smith, J. B. (1996). Collective responsibility for learning and its effects on gains in achievement for early secondary school students. *American Journal of Education*, *104*(2), 103–147.

Lee, V. E., Croninger, R. G., & Smith, J. B. (1997). Course-Taking, Equity, and Mathematics Learning: Testing the Constrained Curriculum Hypothesis in U.S. Secondary Schools. *Educational Evaluation and Policy Analysis*, *19*(2), 99-121.

Lee, V. E., Smith, J. B., & Croninger, R. G. (1997). How high school organization influences the equitable distribution of learning in mathematics and science. *Sociology of Education*, *70*(2), 128–150.

Lieberman, J. C. (1997). Enabling professionalism in high school mathematics departments: The role of generative community. *Unpublished doctoral dissertation*. Stanford University.

Lipman, P. (2002). Making the global city, making inequality: The political economy and cultural politics of Chicago school policy. *American Educational Research Journal*, *39*(2), 379-419.

Little, J. W., & Horn, I. S. (2007). 'Normalizing' problems of practice: Converting routine conversation into a resource for learning in professional communities. In L. Stoll & K. Seashore Louis (Eds.), *Professional learning communities: Divergence, detail, difficulties* (pp. 79-92). Buckingham, GBR: Open University Press.

Louie, N. (2011). *Shot through the heart: Successful mathematics teachers' instructional and emotional responses to district accountability policies.* Paper presented at the Annual Meeting of the American Educational Research Association.

Lubienski, S. T. (2000). Problem solving as a means toward mathematics for all: An exploratory look through a class lens. *Journal for Research in Mathematics Education, 31*(4), 454-482.

Lubienski, S. T. (2002). A closer look at black-white mathematics gaps: Intersections of race and SES in NAEP achievement and instructional practices data. *Journal of Negro Education, 71*(4), 269-287.

Martin, D. B. (2000). *Mathematics success and failure among African-American youth: The roles of sociohistorical context, community forces, school influence, and individual agency*. Mahwah, NJ: Erlbaum.

Martin, D. B. (2006). Mathematics learning and participation as racialized forms of experience: African American parents speak on the struggle for mathematics literacy. *Mathematical Thinking and Learning*, *8*(3), 197-229.

McLaughlin, M., & Talbert, J. (2006). *Building school-based teacher learning communities: Professional strategies to improve student achievement*. New York, NY: Teachers College Press.

McNeil, L. (2000). Creating new inequalities: Contradictions of reform. *Phi Delta Kappa International*, *81*(10), 728-734.

Mintrop, H. (2003). The limits of sanctions in low-performing schools: A study of Maryland and Kentucky schools on probation. *Education Policy Analysis Archives, 11*(3).

Moody, V. R. (2004). Sociocultural orientations and the mathematical success of African American students. *Journal of Educational Research, 97*(3), 135-146.

Morris, J. E. (2004). Can anything good come from Nazareth? Race, class, and African American schooling and community in the urban south and midwest. *American Educational Research Journal, 41*(1), 69.

Moschkovich, J. N. (1999). Understanding the Needs of Latino Students in Reform-Oriented Mathematics Classrooms. In NCTM's *Changing the Faces of Mathematics: Perspectives on Latinos*, (ch. 1, pp. 5-12). NCTM.

Moschkovich, J. N. (Ed.). (2010). *Language and mathematics education: Multiple perspectives and directions for research*. Charlotte, NC: Information Age Publishing.

Moses, R. P., & Cobb, C. E. (2000). *Radical equations: Mathematics literacy and civil rights*. Boston: Beacon.

Nasir, N. (2002). Identity, goals, and learning: Mathematics in cultural practice. *Mathematical Thinking and Learning, 4*(2&3), 213-248.

Nasir, N. (2011). *Racialized identities: Race and achievement among African American youth*. Palo Alto: Stanford.

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

Nasir, N., O'Connor, K., & Wischnia, S. (in progress). *Knowing about racial stereotypes versus believing them.* Unpublished manuscript.

Nasir, N. S., & Shah, N. (2011). On defense: African American males making sense of racialized narratives in mathematics education. *Journal of African American Males in Education*, *2*(1), 24-45.

Nasir, N. S., Hand, V., & Taylor, E. V. (2008). Culture and mathematics in school: Boundaries between "cultural" and "omain" knowledge in the mathematics classroom and beyond. *Review of Research in Education, 32*(1), 187-240.

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

National Center for Education Statistics. (2011). *NAEP Data Explorer*. Washington, DC: US Department of Education, Institute of Education Sciences.

National Center for Science and Engineering Statistics. (2011). *Women, minorities, and persons with disabilities in science and engineering: 2011*. Arlington, VA: National Science Foundation.

National Commission on Excellence in Education. (1983). *A nation at risk: The imperative for educational reform*. Washington, DC: US Government Printing Office.

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

Noguera, P., & Wing, J. Y. (Eds.). (2006). *Unfinished business: Closing the racial achievement gap in our schools*. San Francisco: Jossey-Bass.

Oakes, J. (1985). *Keeping track: How schools structure inequality*. New Haven: Yale University Press.

Oakes, J. (2005). *Keeping track: How schools structure inequality*. New Haven: Yale. 2nd edition.

Oakes, J. (1990). Opportunities, achievement, and choice: Women and minority students in science and mathematics. *Review of Research in Education, 16*, 153-222.

Oakes, J., Wells, A. S., & Jones, M. (1997). Detracking: The social construction of ability, cultural politics, and resistance to reform. *Teachers College Record*, *98*(3), 482-510.

Olsen, L. (1997). *Made in America: Immigrant students in our public schools*. New York: New Press.

Payne, K. J., & Biddle, B. J. (1999). Poor school funding, child poverty, and mathematics achievement. *Educational Researcher*, *28*(6), 4-13.

Pedulla, J. J., Abrams, L. M., Madaus, G. F., Russell, M. K., Ramos, M. A., & Miao, J. (2003). *Perceived effects of state-mandated testing programs on teaching and learning: Findings from a national survey of teachers*. Chestnut Hill, MA: National Board on Educational Testing and Public Policy.

Richards, G. (1997). *'Race', racism, & psychology*. NY: Routledge.

Rubenstein, R. (1996). Strategies to support the learning of the language of mathematics. In Elliott, P. (Ed.), *Communication in mathematics, K–12 and beyond, 1996 Yearbook of the National Council of Teachers of Mathematics*, (pp. 214–18). Reston, Va.: National Council of Teachers of Mathematics.

Rustique-Forrester, E. (2005). Accountability and the pressures to exclude: A cautionary tale from England. *Education Policy Analysis Archives, 13*(26), 1-39.

Schoenfeld, A. H. (2002). Making Mathematics Work for All Children: Issues of Standards, Testing, and Equity. Educational Researcher, 31(1), 13-25.

Secada, W. G. (1991). Degree of bilingualism and arithmetic problem solving in Hispanic first graders. *The Elementary School Journal*, *92*(2), 213-231.

Secada, W. G. (1996). Urban students acquiring English and learning mathematics in the context of reform. *Urban Education*, *30*(4), 422-48.

Sfard, A., & Prusak, A. (2005). Telling identities: In search of an analytic tool for investigating learning as culturally-shaped activity. *Educational Researcher*, 34(4), 14-22.

Silver, E. A., & Stein, M. K. (1996). The Quasar project: the "revolution of the possible" in mathematics instructional reform in urban middle schools. *Urban Education*, 30(4), 476-521.

Solano-Flores, G. (2010). Function and form in research on language and mathematics education. In J. N. Moschkovich (Ed.), *Language and mathematics education: Multiple perspectives and directions for research*. Charlotte, NC: Information Age Publishing.

Spade, J. Z., Columbia, L., Vanfossen, B. E. (1997). Tracking in mathematics and science: Courses and course-selection procedures. *Sociology of Education*, *70*(2), 108-127.

Spillane, J. P. (1999). External reform initiatives and teachers' efforts to reconstruct their practice: The mediating role of teachers' zones of enactment. *Journal of Curriculum Studies, 31*(2), 143-175.

Steele, C. (1998). Stereotyping and its threats are real. *American Psychologist*, 53(6), 680-681.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69*(5), 797-811.

Steele, C. M. & Aronson, J. (1998) Stereotype threat and the test performance of academically successful African Americans. In C. Jencks & M. Phillips (Eds.), *The Black-White test score gap.* Washington DC: Brookings Institution Press.

Tarr, J. E., Reys, R. E., Reys, B. J., Chavez, O., Shih, J., & Osterlind, S. J. (2008). The impact of middle-grades mathematics curricula and the classroom learning environment on student achievement. *Journal for Research in Mathematics Education, 39(*3), 247-280.

Tate, W. F. (1997). Race-ethnicity, SES, gender, and language proficiency trends in mathematics achievement: An update. *Journal for Research in Mathematics Education, 28*(6), 652-679.

Tyack, D., & Cuban, L. (1995). *Tinkering toward utopia*. Cambridge, MA: Harvard University Press.

Tyson, K. (2006). The making of a burden: Tracing the development of a "Burden of Acting White" in schools. In E. M. Horvat & C. O'Connor's (Eds.) *Beyond acting white: Reframing the debate on black student achievement*. Lanham, MD: Rowman & Littlefield.

Valenzuela, A. (1999). *Subtractive schooling: U.S.-Mexican youth and the politics of caring*. Albany: State University of New York Press.

Walker, V. S. (1996). *Their highest potential: An African American school community in the segregated South*. Chapel Hill: University of North Carolina Press.

Webb, N. M., & Farivar, S. (1994). Promoting Helping Behavior in Cooperative Small Groups in Middle School Mathematics. American Educational Research Journal, 31(2), 369-395.

Wenger, E. (1998). *Communities of practice: Learning, meaning and identity*. Cambridge, UK: Cambridge University Press.