encouraged to go into their own communities and find problems worth solving? Could they in some way apprentice with people in the community to learn the mathematical practices involved in the problem and then (with their teachers) build upon this knowledge to learn more formal and abstract ways of representing their solutions?

**LEARNING MATHEMATICS: AFTERSCHOOL PROGRAMS**

Studies on mathematics learning in afterschool settings suggest that some of the constraints normally imposed by teachers and curricula, disappear after the school bell rings. Regardless of whether or not they are on school grounds, afterschool mathematics programs can provide opportunities for greater personalization, collaboration, student talk, manipulatives, multiple representations, connections to the community, positive student identity, and, to a certain extent, more rigorous learning. Similar trends have been found in afterschool science programs led by indigenous peoples in their communities (Honey 2011).

We begin with a bird’s-eye view of national and large afterschool programs and the kinds of associated structures, content, and outcomes that are afforded to mostly low-income youth. From there, we zoom in on smaller programs that specifically connect with the lives of Latino/a and black students.

Large-scale studies and program evaluations illustrate the wide variety in focus, structure, and impact of afterschool mathematics programs (Briggs-Hale et al. 2006; Lauer et al. 2006; Mokros, Kliman, & Freeman 2005; Rothman & Henderson 2011; Welsh et al. 2002). Some programs serve as spaces for students to receive help on homework or tutoring to remediate areas of low proficiency. Others focus on preparing students for standardized tests or improving students’ attitudes toward and engagement in mathematics. Still others offer enrichment programs that can supplement what normally occurs during school hours (Mokros, Kliman, & Freeman 2005). Interestingly, when compared to other countries, the United States tends to offer more programs that focus on remediation than enrichment (Baker et al. 2001). Some afterschool programs occur on school grounds, while others are offered through community-based agencies.

A broad range of afterschool programs targets low-income youth, but the available studies consistently highlight the generally positive nature of such programs on mathematics achievement (Briggs-Hale et al. 2006; Halpern 1999; Klein & Bolus 2002; Lauer et al. 2006; Mokros, Kliman, & Freeman 2005; Rothman & Henderson 2011; Welsh 2002). One meta-analysis of 35 afterschool programs and summer schools found small but statistically significant gains in mathematics for low-achieving students (Lauer et al. 2006). The size of these gains (effect sizes of about 0.13) are meaningful when compared to those of low-achieving students who did not participate in afterschool programs, but they are insufficient to close achievement gaps between low-achieving students and their more advantaged counterparts. Offering the programs after school, during the summer, or on Saturdays does not seem to affect the program impact. However, secondary students seem to benefit more from afterschool mathematics programs than do elementary students (Lauer et al. 2006).

One possible mechanism for the increase in student achievement that is generally tied to afterschool mathematics programs is a sense of personalization. For example, programs that attend to students’ social and academic needs show greater effects than programs focused only on academics (Lauer et al. 2006). Surprisingly, even programs focused on youth development (rather than academics) improve student achievement and engagement (Eccles & Templeton 2002).

In programs focused on tutoring, one proposed mechanism for impact is the tutor-student relationship (Ritter et al. 2009). School-based teachers who work in afterschool programs can convey to students that they are important and belong to the school.

This notion of personalization extends beyond the social nature of learning (motivating students to attend) to include the number of people who can attend to students’ needs. In general, students are much more likely to work in small groups in afterschool mathematics programs than in typical mathematics classrooms and summer schools.
Moreover, programs that use small groups show greater effects than programs with whole-group instruction or a focus on one-on-one tutoring, suggesting that students may benefit from peer interaction. This focus on group work may be possible because many afterschool programs have more adults per student than is typical in mathematics classrooms (Halpern 1999). As such, adults can divide students into small groups and work with them.

A classroom culture that values what we call “horizontal learning” through peer interaction appears to go a long way toward helping students gain mathematical understanding. In contrast to “vertical learning,” where teachers convey information to students, when students can collaborate with one another to solve non-routine problems, they have more opportunities for rigorous mathematics thinking. For example, in a three-year study of how 24 black and Latino/a middle school students developed mathematical reasoning, students in an afterschool program showed increases in the variety and sophistication of reasoning with respect to proofs (Mueller 2009; Mueller & Maher 2009). The teaching and learning in this program included: open-ended, group problem solving; problems with more than one answer; encouraging students to collaborate, share, and support one another’s solutions; the use of manipulatives; and asking students to prove things that could not be proven. This contrasted with the mathematical classrooms in which the students normally participated.

In fact, this afterschool setting offered students a more relaxed environment for testing their ideas and making them public. It was a place where success was measured not by teacher approval but by peers and the reasonableness of one’s argument. Students had opportunities to hear a variety of perspectives from peers, challenge their peers in small groups and whole-class discussions, revisit their learning strategies, and refine their thinking along the way. By expanding upon the arguments of others, students in this program co-constructed proofs with more alternative forms of reasoning than if they had constructed proofs alone. They also developed greater ownership over their justifications.

A review of research on afterschool mathematics programs also suggests that when students work in small groups, they receive feedback more quickly than if they had to wait for the teacher, and they are more likely to be engaged in higher-level problem solving and making connections to the real world (Briggs-Hale et al. 2006). As such, belonging to a community of learners can offer positive results for students who are learning mathematics. Similar results for the positive influences of working in peer groups have been found with African-American students taking college-level courses, both in high schools and colleges (Fullilove & Treisman 1990).

Beyond greater personalization, dialogue, and student interaction, afterschool programs seem to offer opportunities for students to develop a kind of identity around mathematics, addressing the call from the Common Core State Standards that students create a mathematics “character.” In the study of students developing reasoning, one outcome was that students in the afterschool mathematics program later reported feeling more confident in asking questions, completing homework, and challenging the mathematical justifications of others (Mueller 2009; Mueller & Maher 2009). This sense of confidence can go a long way toward individuals’ seeing themselves as mathematical people and in persisting in solving difficult mathematics problems. In fact, some research indicates that a student’s identity within mathematics depends less on cognitive abilities and more on the kind of person the student wants to become. The form of mathematics presented to students and the kinds of community in which they are learning influences whether or not they want to become or eventually see themselves as mathematics people (Boaler & Greeno 2000).

When students work in small groups, they receive feedback more quickly than if they had to wait for the teacher, and they are more likely to be engaged in higher-level problem solving and making connections to the real world.
Afterschool programs can also provide a powerful space for students to take on a different identity than they might otherwise in their mathematics classroom. One study of Patti, a third-grade black student in an afterschool, all-girls mathematics club, showed that while her mathematics classroom tended to dismiss or reject her cultural and linguistic tendencies, the club provided a space for her to express herself and do mathematics her way (Jones 2003). An analysis of observations of the mathematics club and mathematics lessons in the school, along with interviews with teachers and students over one year, suggests that part of Patti’s success in developing a mathematical identity was due to the personal relationship she developed with the club leader, a working-class white woman with cultural ties to rural Appalachia. This relationship was strikingly different from the relationship Patti had with her classroom teacher.

Within school, Patti, like many of her classmates, felt disconnected and passive. She was expected to behave and act in particular ways in order to be seen as a successful student, to do mathematics that was not connected to her personal life, and to memorize facts. In contrast, the club met once a week for 75 to 120 minutes and focused on such things as playing mathematical games (e.g., SET), identifying relationships between photography and geometrical shapes, discussing mathematics in everyday life, and taking field trips. In addition, the club invited students to be active in the room and build on the work of others. The leader of the club also worked hard to position students as competent by pointing out each member’s strengths to them individually and to the group. No student achievement data were collected, but at the end of the year, Patti claimed that she “loves mathematics.” This study, conducted with third graders, echoes studies that have associated personalization, collaboration, and manipulatives with positive outcomes for secondary students.

One multisite, afterschool research project focusing on the relationship among culture, language, and mathematics is particularly pertinent for our concerns for Latino/a youth. Situated in the Center for Mathematics Education of Latinos/Latinas, a Center for Teaching and Learning funded by the National Science Foundation, the project conducted a number of research studies at afterschool programs in the Southwest and the Midwest that sought to connect teachers, Latino/a students, and community members in doing mathematics.

At one site, Mexican middle school students and their parents did mathematics together in what was called a tertulia or mathematics circle (similar to a book discussion group). Several aspects characterized the tertulia: it was systematic; students did not attend for accreditation or promotion; attendance was voluntary; and the structure was relatively flexible and adapted to the unique situation of the participants (Menéndez & Civil 2008; Civil & Planas 2010; Diez-Palomar, Menéndez, & Civil 2011). Over two-and-one-half years and forty-two 90-minute sessions, the tertulia covered algebraic reasoning, statistics, geometry, and fractions. Typically a session would begin with mathematical learning in small groups, sometimes using manipulatives or contextualized problems, and then shift to a discussion about mathematics education. Several facilitators, including mathematics professors and undergraduate research assistants, worked with the small groups and asked participants to explain their thinking before sharing their solutions with the whole group. Because of the flexible nature of the tertulia, parents and students could suggest what kinds of mathematics they wanted to learn—whether to better understand a concept, help a child with homework, or build upon knowledge they possessed from their jobs or activities.

This format also enabled parents and students to reflect on their own mathematics learning and to comment on the instruction students were receiving in school. One complaint by parents was that schools rejected the algorithms and forms of mathematics that students or parents had learned in Mexico, thereby ignoring the “funds of knowledge” that students’ homes offered. To a certain extent, this underscores the results from other research that some Latino/a and low-income students are asked to park their identity at the door in order to participate in the mathematics classroom (Zevenbergen 2000; Gutiérrez 2002a, b). The emphasis on voluntary attendance and adapting to the unique needs of participants seems to go hand in hand with participants being intrinsically motivated to attend the sessions and engage fully in them. This study, though not reporting outcomes for participants, highlights the role of manipulatives, small groups,
and personalization, as well as maintaining a sense of cultural identity while doing mathematics.

Research at another site in this study underscores the opportunities that afterschool mathematics programs have to help students connect with their personal lives and their communities (Civil 2002). The study followed 18 third-grade and sixth-grade Mexican students at a school serving 91 percent Latino/a students, 98 percent of whom qualify for free and reduced lunch and 26 percent classified as still in the process of learning English (Diez-Palomar, Simic, & Varley 2008; Diez-Palomar, Varley, & Simic 2006; Turner, Gutierrez, & Diez-Palomar 2011). The program was non-remedial, had curricular flexibility, and focused on students’ lives. Some of the contexts for learning mathematics came from a panaderia (bakery), an auto shop that converted cars into “low riders,” a nearby park that had burned down, and a dulcería that sold candies and piñatas.

Using video and audio recorders, participants observed and interviewed community members multiple times about their work and how/when they used mathematics. Then the students posed questions they wanted to answer from these contexts (e.g., how to enlarge a sketch to fit a car hood). This form of “community mathematization”—where participants collaboratively use mathematics to make sense of the world—takes problems from authentic settings in the school and community where students have personal connections. Because students are familiar with the settings, they approach problems more confidently, sometimes reenacting the practices they had witnessed by those they had interviewed.

Students who participated in this afterschool club showed increased engagement in mathematics activities; this is especially the case for those who otherwise were quiet or disruptive in mathematics classrooms that required English communication. This echoes research that afterschool settings can offer a space to construct a different identity than might otherwise occur in a school mathematics classroom. After participating in the mathematics club where group work was the norm and horizontal learning was encouraged, students were more likely to use a range of strategies to explain a mathematical operation. They also showed a greater tendency to use Spanish and work with Spanish-speaking peers during mathematics activities, suggesting that they combined identities of being Mexican with being a mathematician. However, because community members sometimes used technologies or outside sources to deal with mathematical tasks (e.g., sending their drawings to a copy center to enlarge them), some mathematical concepts remained hidden in the practice and did not translate easily to the problems that students posed. On the other hand, the club facilitators also posed problems that ignored the authentic contexts of the community in order to help students translate their understandings to more formal and abstract mathematics. Even so, the organic nature of the project made it difficult for the facilitators to anticipate mathematical connections that would arise for students.

Still another site in this larger study suggests a positive connection between participation in an afterschool mathematics program and students’ increased participation in their regular mathematics classrooms (Khisty & Willey 2011). Low-income Latino/a students in third through fifth grade who participated over a three-year period in a bilingual mathematics club had opportunities to choose and create mathematical tasks, become the authorities on problem situations, and solve problems in ways that made sense to them, using their preferred methods. Initially, students in the afterschool program were unwilling to communicate their thinking verbally or through models and drawings, but over time they learned to take more risks than in their mathematics classrooms. They also learned to ask more questions, give longer responses, use more tools to represent their thinking, and work better with others. Students also developed more positive identities around mathematics (Dominguez 2011). Undergraduate and graduate students attributed differences in the kinds of participation styles and confidence that students developed to the structure of teaching and learning facilitated. In the words of one student:

Instead of—you can’t get up on your feet in the normal class, like you have to stay with the person you are working with. You can’t
go around and check what they’re doing to see if you or your answer . . . to see if whoever you are working with . . . to see if you got the answer right with another pair. But when you’re at the afterschool, you can move around and ask them, “Oh, what did you get? Because I got this.” And then we look at each other’s work, and we see if one of us got it wrong. And it’s kind of better than in class.

This notion—greater movement, working with peers, benefitting from the perspectives of others and building upon their ideas—is reminiscent of the work conducted with black youth in developing their reasoning abilities. It also contrasts with the kinds of teaching and learning that are typically experienced by low-income black and Latino/a youth.

Of all the approaches reviewed here, afterschool mathematics is clearly the most common. In fact, a study of 41 countries found more than one-third of all seventh and eighth graders engage in some type of out-of-school education, including cram sessions and tutoring (Baker et al. 2001). And of those who do, 4 out of 10 participate in mathematics-related activities. However, the same study found the strongest gains in mathematics achievement in nations that invest in programs focused on enrichment (e.g., South Korea, Romania) as opposed to remediation (e.g., the United States). Even so, there are tensions in the literature related to a growing overemphasis on academic gains when afterschool programs historically have served students’ social and “developmental play” needs (Halpern 2002).

Although much of the research on learning mathematics in afterschool settings points to the benefit of breaking with school traditions and supporting students in more personalized ways, some limitations in the research are worth noting. For example, few evaluation studies report the number of students dropping out of the program. As such, effects could be inflated, with the most academically motivated students staying in the program (Fashola 2002). In addition, although reports generally highlight the more personal nature of adults in these settings, some research suggests that, because of low pay and high turnover, adults in these settings may be less likely to possess deep content knowledge or familiarity with today’s mathematics curricula, especially reform-oriented formats (Halpern 1999; Mokros, Kliman, & Freeman 2005). If that is the case, recruiting better qualified staff should increase mathematical gains associated with these programs. Several successful programs targeting Latino/a youth have been run by mathematics professors, graduate assistants, undergraduate assistants, or a combination of the three.

SUMMARY

Much of the research on afterschool mathematics programs has been conducted at the middle school level. Presumably, this is a time when students are being tracked into courses that will either prepare them for college or not, and high school may be too late to significantly affect a student’s identity in mathematics or a curricular pathway. Many program evaluations were not rigorous and apparently biased toward finding positive effects, even small ones or those not directly related to achievement gains. And many of the studies collapsed students into “urban,” “at risk,” or “low-achieving” categories that made it difficult to know if students were black/Latino/a as opposed to white. To develop a solid base of evidence for student-centered learning, further research is needed to better understand the mechanisms involved in offering benefits to black and Latino/a youth, particularly through afterschool programs. For example, how do high school students feel about learning mathematics after the school day ends? What kinds of experiences do they encounter? Are their identities in afterschool programs as flexible as those of the middle school students, able to adopt a

Developing students’ confidence, enlarging their repertoire of mathematical strategies, and building a mathematical identity that builds upon one’s culture or community may be as important as increasing scores on standardized tests.
different persona than that which they embody in the school mathematics classroom? These studies seem to suggest that how students feel about themselves while doing mathematics is critical to whether or not they engage fully in mathematical activities.

The research points to a general trend among afterschool mathematics programs toward offering opportunities for personalization and other student-centered approaches, yet only smaller, qualitative studies offer voices of black and Latino/a students or their parents. And where student perspectives are available, they are mainly those of younger students. Do the same forms of personalization, collaboration, and connection to one’s culture and community apply to older students? Does horizontal learning show the same kinds of benefits? How might the content of a high school mathematics curriculum influence an afterschool program’s attempts to facilitate mathematical “play” or enrichment?

The research also seems to suggest important effects in terms of motivating students who might not otherwise engage in mathematics classrooms. Developing students’ confidence, enlarging their repertoire of mathematical strategies, and building a mathematical identity that builds upon one’s culture or community may be as important as increasing scores on standardized tests.

Several questions arise. How might everyday mathematics teachers, as opposed to professors, better incorporate community-based projects in ways that attend to the authentic nature of a community setting?

How might community agencies, as opposed to college-based researchers, leverage their resources to help provide these kinds of opportunities to more students over a longer period of time?

Can the notion of multi-generational tertulias be applied in more settings, giving parents and students more opportunities to do mathematics and reflect on their learning? Might these mathematical circles also help students better negotiate schooling? Can these community-based mathematics circles be applied in society to include not only parents and students but community members as well, especially those who might have some mathematical expertise? Might they include mathematics teachers’ in ways that can help foster more positive adult-student relationships? Can they include teachers in ways that support teachers professional development on student-centered learning and transfer to the classroom?

LEARNING MATHEMATICS AND SOCIAL JUSTICE

One way researchers and teachers try to engage Latino/a and black adolescents who may not identify with mathematics is to begin with things that matter to them (e.g., Berry 2005, 2008; Stinson 2006, 2010). Teaching mathematics for social justice is very much like culturally relevant pedagogy, a widely embraced strategy in mathematics education in that it seeks to connect with students’ out-of-school knowledge. However, teaching mathematics for social justice differs from other approaches (Leonard et al. 2010) in that students use mathematics as an analytic tool for developing an understanding and awareness of injustices in society, their place within history, and their ability to make changes in society (Frankenstein 1994, 2005; Freire 1970; Gutstein 2003, 2006).

For example, students might examine the areas and percentages of different countries on a world map to see how some countries are represented as larger or smaller than their actual land mass warrants (Gutstein 2001). Or they might survey the community on experiences with the police to calculate the likelihood that a police officer will pull over a brown or black person, versus a white person, when driving a car in a given neighborhood (Gutstein 2006). More than using mathematics as a tool for understanding social injustices that may relate to their lives, the goal is for students to also develop mathematical arguments, accompanied by representations of data that can help convince others of an action (e.g., getting a police department to rethink how it profiles drivers).

If this strategy is done correctly, students can learn mathematics by examining social and economic issues that affect their lives. In one study, elementary students received disposable cameras and took pictures of sites in their neighborhoods that were of interest to them (Leonard & Guha 2002). The students
then developed mathematics word problems based on their pictures. These held meaning for students because the contexts were familiar. Also, students had control of the kinds of questions they could ask and were personally invested in the outcomes (Martin 2006; Mukhopadhyay & Greer 2001).

Although this form of learning may sound more like what you might see in a social studies classroom, mathematics teachers have tried and succeeded with a surprising number of topics. Examples include: calculus (Staples 2005); proportional reasoning (Brantlinger 2005; Turner & Strawhun 2005; Gutstein 2003, 2006); geometry (Brantlinger 2005; Gutstein 2003); measurement (Brantlinger 2005; Turner & Strawhun 2005; Gutstein 2003); estimation (Brantlinger 2005); percentages (Diez-Palomar, Varley, & Simic 2006; Frankenstein 1990, 1995); operations with fractions (Turner & Strawhun 2005); and statistics (Gutstein 2003, 2006). Even so, in most of these studies, teachers are reporting on their own practices; few are rigorous empirical research projects with the appropriate resources to carry out adequate data collection and analysis.

Research has promoted the theory of connecting social justice issues with mathematics for some time (Frankenstein 1989, 1990; Borba & Skovsmose 1997). Yet empirical research on teaching mathematics for social justice is thin. In part, this is due to the fact that mathematics education has only recently begun to embrace issues of identity and power (Gutiérrez 2010). Also, such teaching presents additional challenges for teachers to carry out (Bartell forthcoming). In fact, it is difficult to determine the number of teachers who are implementing social justice mathematics in their classrooms: Many teachers lack the time or expertise to publish their strategies, or they simply do not think of their work as teaching mathematics for social justice because they might not create whole projects or units that embed social justice issues (Gregson forthcoming). That said, the radicalmath.org website, created in 2007 by a Brooklyn public school teacher, is dedicated to educating the public, offering resources for teaching mathematics for social justice and promoting an annual conference on the topic (Osler 2007). Of the formal studies that exist on the topic, two separate researchers and their associates, Eric Gutstein and Erin Turner, have written about their experiences. As such, we draw heavily on their work.

To illustrate, Beatriz Strawhun, a middle school mathematics teacher, worked with Turner, a college professor, to plan a six-week unit that asked students to investigate overcrowding in their middle school (Turner & Strawhun 2005). The sixth graders, predominately working-class blacks, Dominicans, and Puertoriqueños/as, expressed concern that their school, located on the fifth floor of the building, was overcrowded compared with the magnet middle school housed one floor below and serving wealthier students. After observing the implementation of the unit and related classroom discussions, the teacher and the researcher found that “as students posed problems that mattered to them, their desire to understand and affect the overcrowding increased their engagement in mathematics, and thereby enhanced the learning that occurred.” To address their own concerns about relative space, students learned ratios and proportions while practicing skills of measurement and operations on fractions. As Angel, a sixth grader in the social justice unit, noted:

> It was easier to do the math this way, instead of just learning it straight, like solving a problem, because we would actually, like, really get into it, and that made it easier. . . . Like the facts [about the school], they made you want to find out the answer. Like we wanted to know (Turner & Strawhun 2005).

The Latino/a and black students who comprised this class were motivated and engaged in solving their problem.

Turner’s students also developed a strong sense of community, taking greater risks and using one another as resources to build their solutions. Together, they constructed an understanding of the concept of ratio. The class planned to present their data to the school board and request help in improving the overcrowding situation in their school. Lianna wanted to strengthen her argument before going before the school board. In her own words, she wanted to “use more specifics so people will listen” (Turner & Strawhun 2005). When comparing the amount of space within their school to the magnet
school, Lianna did not simply calculate the square footage of the hallways for both schools. She viewed the work that a classmate was doing, comparing the amount of square footage to the number of students. She was intrigued:

“How did you do that?” she asked. “We already found out the [hallway] area of [the magnet school], and I want to see how much [space] they will each get. You found out how much each person will get in [our school], and I want to do the same thing in [the magnet school]. But I don’t know how to do it” (Turner & Strawhun 2005).

After asking for the relevant information (the number of students and total square footage), the other student, Thomas, explained to Lianna how to determine the ratio. She, in turn, presented it to the school board. By the end of the project, the class demonstrated their increased understanding of measurement, operations with fractions, and proportional reasoning as they struggled with the issue of overcrowding in their school.

Similar findings arise from the work of Gutstein, a college professor and researcher who spent one hour a day over two years teaching predominately low-income Latino/a youth in a Chicago public middle school (Gutstein 2003, 2005, 2006). In his classroom, he spent 80 to 85 percent of his time using a reform-based mathematics curriculum (Mathematics in Context), but he supplemented it with social justice projects. His goal was for his 18 students to use math to understand and change the world around them while learning and demonstrating an understanding of mathematics in the traditional schooling environment. From the point of view of Maria, one of his students, learning mathematics was more interesting in his classroom because it related to her life:

What made this experience different than other classrooms was a number of factors. First, the issues were applicable to real life, and many were personally relevant to us at more than one level. As low-income, Latino, immigrant children, some of the issues were directly linked to our own neighborhood, while others were issues of social justice on a global level (Gutstein 2006).

The engagement reported by Maria was reflective of the general class as well.

In addition, there is evidence that working from social justice contexts can benefit students mathematically. After being in Gutstein’s class for one year, students were better able to articulate their mathematical reasoning. They also passed district standardized exams for their grade level, scored better than their district peers on tests of standardized mathematics achievement, and scored well on entrance exams for competitive high schools.

Another benefit of a social justice approach is the development of a stronger sense of community in the classroom, which makes students more comfortable engaging in difficult conversations about previously taboo topics (Gutstein 2006). In addition, students become more likely to believe they can make a difference in their own lives as well as in the lives of others (Gutstein 2006; Turner & Strawhun 2005). For example, students developed more sophisticated understandings of broader social issues (e.g., using data to learn that banks were not necessarily racist, even if they tended not to loan money to blacks). From the point of view of one of Gutstein’s students:

I like the way you taught math using real life issues. That is interesting because we had never done anything like that. It got everyone thinking for themselves. It made some people come up with powerful things to say about the math involving those problems. . . . [W]e thought beyond candy, music, and soda, and it brought out another side of us. . . . All my views have changed. The world before wasn’t very interesting to me because I wasn’t aware of all the issues that were happening. Now, math made everyone interested in the real world because it’s something that catches everyone’s attention (Gutstein 2006).

Longitudinal data point to more than the immediate gains of mathematical participation, persistence with challenging concepts, and mastery of content. Learning mathematics for social justice may also raise the bar on students’ expectations for the mathematics classroom. Adrián, a former classmate of Maria, notes that after experiencing social justice
mathematics, he disengaged with mathematics when he returned to traditional instruction:

My transition to high school was difficult: It was back to the old textbook method and tedious drills. There wasn’t enough time for any critical thinking or application. My interest in mathematics decreased and my frustration grew. . . . In retrospect, the period when I learned to read and write the world with mathematics was the only time I had an interest in mathematics (Gutstein 2006).

The main contribution of teaching mathematics for social justice is that it can supplement typical mathematics curricula with topics that may be more interesting for students, increasing their engagement in mathematics. Moreover, because this approach often embeds work in the students’ local contexts, it can present problems without simple solutions and motivate students to want to understand challenging concepts (Gutstein 2006; Peterson 2005; Turner & Strawhun 2005).

Even so, this type of teaching is complex. Some of the challenges include: getting to know the students well enough to develop social justice projects that are meaningful to individuals; balancing the demands for rigorous mathematics with sufficient detail to a social justice issue; avoiding overly influencing students with the teacher’s point of view; finding time in the curriculum to fit in social justice projects; and helping students develop a sense of agency rather than despair around injustice (Bartell forthcoming; Frankenstein 1995; Freedman 2007; Gregson forthcoming; Gutstein 2006). Even mathematics teachers who work in schools with a social justice theme report these challenges.

**SUMMARY**

By starting with contexts that are familiar to students and appealing to their sense of fairness, teaching mathematics with social justice issues can motivate students to learn the mathematical skills necessary to solve complex problems. When presented with social justice issues, it is difficult for individuals to be indifferent; most people want to take a stand on a controversial topic. The approach appears to be especially effective at engaging students who have lost interest in mathematics, a large percentage of whom are Latino/a or black. By connecting mathematics to the world outside of school, teaching mathematics for social justice also has a way of illustrating for students that mathematics will be part of their lives after schooling.

Student voices are prominent in this line of research. They offer a consistent and convincing perspective that when learning is grounded in issues that deeply affect their lives or their communities, mathematical skills and concepts take on more meaning. The consequences for getting a “wrong answer” or having unconvincing data for an argument mean more than a poor grade. On the other hand, much of the work reported with students is anecdotal and may be influenced by students’ desires to please teachers who have chosen such methods.

The connection to social and moral development seems fairly clear, as students report being better able to understand broader social issues and articulate their stances with peers. This maturity may help position them to be more engaged citizens. Less obvious are the academic outcomes or the mechanisms by which they occur. Does learning mathematics in a social justice context offer something unique that is not present in other kinds of
meaningful contexts for students? With the exception of a few teachers reflecting on their own classrooms, none of the research focuses on high school learners. More rigorous research designs and analyses are needed to capture the kinds of learning opportunities that are afforded to students.

Some questions that come to mind if we are to take seriously a social justice framework for teaching mathematics are: How can teachers effectively and efficiently develop the knowledge of a social justice issue? Might they team up with community members who have such expertise? What might learning look like if community centers engaged schools with using mathematics to help them address some of the injustices that black and brown youth face? Could partnership projects focus on difficult social issues (e.g., violence, poverty, immigration) that would benefit society as well as student learning? Could extensive and sustained student-centered learning serve to create a generation of citizens who engage regularly with social issues?
IMPLICATIONS FOR TEACHING AND LEARNING

We began with the image of a large number of Americans who neither perform well in mathematics classrooms nor view themselves as “math people.” From there, we argued that too many of those individuals are Latino/a and black adolescents whom the institution of schooling has failed. Surveying research to understand how education in alternative contexts and modes could better support their engagement and learning, we were struck by commonalities across fields as different as out-of-school mathematics learning, ethnomathematics, adults learning mathematics, afterschool mathematics programs, and learning mathematics through social justice issues. We report on the commonalities in the form of recommendations to teachers, policymakers, and funders.

BUILD UPON FAMILIAR CONTEXTS AND THE PERSONAL AND CULTURAL EXPERIENCES OF LEARNERS

Schools tend to ignore or even reject the familiar contexts and personal and cultural experiences of learners. Any connection to the real world tends to come from word problems developed by textbook publishers or teachers; it is not clear that learners find these meaningful. Student-centered learning for Latino/a and black adolescents would seek to build upon their experiences in ways that help position individuals as “experts” with something to share. Some examples that learners could be encouraged to draw upon while engaging in mathematics might include known games, algorithms from other countries, and hobbies or community practices. It is worth noting that in programs that have built upon familiar contexts and cultural experiences, typically members of the communities have been facilitators who took the time to get to know students in deeper ways. Rather than relying upon stereotypes or their own impressions, educators would need to create space and time for learners to inform them about which contexts are familiar and which cultural experiences are meaningful. Joint community walks, projects that allow for students to apply their lives, and more personal conversations with students can help create more student-centered learning experiences for black and Latino/a adolescents.

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NURTURE CONFIDENCE AND A MATHEMATICAL IDENTITY IN LEARNERS

Secondary mathematics classrooms tend to focus on mastering predetermined content, with little attention to students’ social or emotional development. Yet black and Latino/a adolescents, like others, seem to reap the benefits of programs that attend to both their academic and social needs. Almost at the flip of a switch, they can turn from passive, disruptive, disengaged students into learners who are full of...
energy, offer creative strategies, and have a desire to discuss mathematics with others. In fact, learners show greater confidence and abilities to not only arrive at an answer but also reflect on how reasonable that answer is when they have opportunities to: be active in a learning space; use their home languages; build upon familiar contexts and personal and cultural experiences; use mathematics to analyze injustices in society; and apply strategies that make sense to them. However, learners need help translating their everyday knowledge into more abstract forms of mathematical modeling and representation. Manipulatives and community members, especially ones from a familiar context, can serve as useful tools to make this translation.

Findings across the research areas suggest that an individual’s identity is tied to the practices he/she has created, regardless of whether the learner is a member of a landless peasant movement, a parent who wants to help a child with homework, or a teenager who wants to do things her own way. Incorporating the history of mathematics and the views of community members can go a long way toward helping students see that mathematics is not a singular entity, that many cultures have created (and are still creating) it, and that we can combine our personal identities with mathematical ones. Creating opportunities for students to have a stronger voice in the kinds of mathematics being studied and the forms of interaction in a learning environment can also help black and Latino/a learners see themselves as “math people.” And when they see themselves as such, they are more likely to persist in solving difficult problems or addressing novel situations.

**USE AUTHENTIC PROBLEMS AND OTHER LEARNERS TO INCREASE MATHEMATICAL RIGOR**

For decades, mathematics problems have tended to be of the kind: “Here is an example where I have worked out a solution, now you do 30 of them.” In fact, these are not problems but mere exercises. The teacher and the students both know there is only one right answer, and probably only one sanctioned way of representing the solution. In fact, the latest push—for failing schools to better prepare students for standardized exams—almost ensures that Latino/a and black youth will continue to get this form of instruction. **In contrast, problems in the real world involve many overlapping variables and are not so clear cut.** They require learners to decide what information is pertinent to the problem at hand, what strategy might best fit the situation, whether an exact answer or a good approximation is warranted, and how best to test that strategy in practice with others. Almost never is there one right answer, with a predetermined set of procedures to be followed.

By beginning with problems that are grounded in Latino/a and black students’ interests in the world, we increase the chances that they will be engaged in higher-order thinking. **Such problems invite learners to bring previously acquired knowledge to the table to help in deciding how best to develop a solution.** This may be especially true for broader social issues that affect black and Latino/a adolescents, such as social injustices that motivate them to find answers to their questions.

The potential for higher-order learning is further pronounced when individuals work with peers in horizontal learning structures. Just as in real life, where collaboration often requires greater levels of energy and attention to detail, so, too, can small-group problem sessions require more of learners. If structured around an authentic, open-ended problem, Latino/a and black adolescents can benefit from working in small groups. They can hear a variety of perspectives and strategies, refine their thinking, and represent and justify their ideas to others. In doing so, they are more likely to persist in a trajectory from novice to apprentice to expert.

**LEVERAGE COMMUNITY MEMBERS TO ADD PERSONALIZATION AND CHALLENGE STATIC NOTIONS OF “NOVICE” AND “EXPERT”**

Schools operate under the idea that one mathematics teacher can effectively support 25 to 30 students with largely whole-class instruction. This organization presumes the teacher needs few opportunities to
understand deeply what individual students know or can do—both before they walk into the classroom and after they walk out of it. However, even when teachers choose to work in small groups, they and their students generally benefit more when they have time to check in with one another about the status of their work, their growth, and their misconceptions. We take our lead from projects that had favorable facilitator-to-student ratios and suggest asking community elders to work in schools.

By bringing in elders who may be unfamiliar with today’s mathematics curriculum, classroom manipulatives, or mathematical technology to teach mathematics (e.g., Geometer’s Sketchpad), notions of authority shift. Adolescent learners can “teach” peers and adults about things with which they are familiar, and also learn from/with individuals who have a lifetime knowledge of the real world and how mathematics may relate to it. This blurring of who is novice and who is expert can go a long way toward developing meaningful personal relationships, while offering opportunities for students to try on different identities.

We have offered some of the ways that teachers might adopt strategies found in out-of-school settings. However, the point of placing students at the center of learning is not to take all of the components of learning that have occurred outside of school hours and squeeze them into mathematics classrooms.

Schools, as institutions, are constrained, among other things, by their organizational structures, goals, and teacher credentialing processes. One of the greatest tensions for secondary mathematics teachers is attending to issues of depth versus breadth: Do I move on with tomorrow’s topic if not everyone understands today’s, or do I sacrifice time on the next topic in order to develop greater understanding of this one?

Teachers and schools organize their work (and subsequent student learning) based upon how much of a prescribed curriculum can be covered in the amount of time that is available during the school day. In the case of today’s schooling, whole-class delivery, standardized assessments, and multiple sections of the same course offer few options for mathematics teachers other than to either move on with the whole class or keep the whole class focused on the topic for a longer period.

In contrast, the interdisciplinary nature of life, the desires of individuals and communities, and the assessment of (and consequences for) successful problem solving all drive a very different process in learning outside of school or in situations that interface with social and community issues. To create more opportunities for student-centered learning, we must think differently about the enterprise of education—where and when it happens, and who benefits from its forms.

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Although the research gives us a starting point for building student-centered approaches to improving mathematics learning for Latino/a and black youth, there is much we cannot learn from the literature. First, little empirical research centers directly on the learning of U.S. Latino/a and black adolescents. This is particularly true for the topics of ethnomathematics and adults learning mathematics. As such, it is difficult to know how applicable the research findings might be for such populations. Moreover, even research focused on black or Latino/a adolescents does not necessarily ask for the learner’s perspective. Thus, some “findings” may be biased by researchers, many of whom are not black or Latino/a themselves.

If the research reviewed is not always specific to Latino/a and black youth, how might our conclusions significantly improve learning conditions for those adolescents? In some ways, our recommendations can be viewed as simply “good teaching”—that is, good for all students and not particular to black or Latino/a youth. However, we return to the history of mathematics teaching and learning for marginalized students and highlight the fact that black and Latino/a adolescents tend to have low-quality mathematics and teachers who see their failure as related to student motivation or family background. Perhaps more important for the development of a strong and positive identity around mathematics, blacks and Latinos/as rarely have opportunities to bring their culture, language, previous experiences, or sense of justice to the mathematics classroom. As such, incorporating out-of-school experiences can help them maintain a sense of self that is whole, rather than requiring them to “park their identity at the door.” Furthermore, having Latino/a and black youth bring their lives and a sense of social justice into the learning of mathematics may also enrich learning for white and Asian students who may be unaware of the contributions of Latinos/as or blacks or who may hold stereotypes about who is capable of doing mathematics.

Although we highlight some interesting activities taking place in out-of-school contexts, much of the work in community-based organizations and settings is not documented in the literature because such programs do not require formal evaluations or because community members are busy engaging in the work, leaving little time to write about it. As such, we have little understanding of efforts that are more organic or that involve volunteers from the community. These programs fly under the radar of research. In addition, programs serving undocumented students (e.g., Latino/a immigrants) or students who are seen as vulnerable according to the guidelines of Human Subject Review Boards (e.g., low-income students, homeless individuals) may have a harder time getting permission from participants or their families to study the structure or outcomes of their programs. Furthermore, these populations may be less likely to voice their opinions to researchers, not wanting to call attention to themselves or their families. Greater care and trust need to develop across schools, neighborhoods, and community-based institutions (e.g., churches, Boys & Girls Clubs) so that the rich knowledge that they possess about learners can be tapped. In addition to helping adolescents develop socially, explicit connections need to be made with doing mathematics so that people of all ages view this social activity as normal and enjoyable.

Overall, there is a lack of longitudinal data. Few studies report on more than three years of work with learners. Most of the studies that follow participants for more than one year are working with fewer than 20 students. As such, it is hard to know how different programs and experiences influence students over the long term—either with respect to how they view themselves or how well they can do mathematics.
Perhaps the positive effects we see on engagement and mathematics achievement through afterschool programs, using social justice issues, or justifying their answer to peers quickly wear off in less learner-centered environments. Or positive effects might blossom later in life as adolescents mature or graduate from compulsory education that constrains their ways of interacting.

From looking outside of school to understand how people use and learn mathematics, there is still very much we do not know. Many forms of mathematics are simply not well studied or are somewhat hidden by the technology employed (e.g., video gaming). Some of the most interesting research we found (e.g., community-based mathematics discussion groups) was conducted by skilled mathematics professors and their college students as research assistants in settings with fairly favorable facilitator-to-learner ratios. It remains to be seen whether such efforts can be carried out with less formally educated facilitators, with high school aged students, or without the resources of a research grant. The same could be said of teaching mathematics for social justice or teaching. Most of the teachers applying this approach are full-time college faculty members who choose to teach one public school mathematics class a day for research purposes. Generally, they are not juggling several sections of mathematics with 200 students or more—or feeling pressure to “teach to the tests” like full-time teachers who serve black and Latino/a youth. And teachers who seem to be applying principles of personalization effectively, while helping students transition between everyday life and the symbolic forms of mathematics valued in society, have been well supported to develop their expertise.

Pedagogical approaches that build upon the history of mathematics or students’ cultures require a high level of cultural proficiency and a very broad understanding of mathematics—historically, culturally, and practically. We need to take the most successful projects and scale them up, following them for longer periods, so more black and Latino/a adolescents can benefit. For approaches and projects that offer promise, we need to develop more rigorous assessments, invite students of varying ages, and cover a broader range of mathematical topics in order to better understand which formats best serve which purposes.

If we are to take seriously the idea of placing black and Latino/a students at the center of learning, we must engage the broader public in the endeavor, especially community-based organizations that have vested interests in supporting youth. We might also take our guidance from countries like Cuba that have embedded the notion of education as a social responsibility of all citizens, where widespread literacy has become a national goal. In much of Cuba, the walls separating communities, businesses, schools, adults, children, learners, and educators do not exist or are much more permeable than in the United States. Spain is another country that offers a way of thinking about learning centered on students. Using a model called comunidades de aprendizaje (learning communities), hundreds of Barcelona schools leverage community resources, technology, schools, and modes of regular and intergenerational dialogue to translate abandoned and low-income neighborhoods into vibrant places with increased mathematics achievements for youth, greater ownership and strong community, and lifelong learning opportunities for adults. We need to explore countries like these that have taken a strong, comprehensive stand on learning.

Comunidades de Aprendizaje5
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Descriptions of the variety, complexity, and personal meaning involved when people use and create mathematics to solve everyday problems outside of school hours point to the outdated mode of thinking in today’s mathematics classroom, where the emphasis is on working alone, ignoring the contexts in which mathematical problems arise, and privileging the use of symbolic representations before they have any significance to learners. What remains to be seen is whether, as a nation, we have the courage to build on this knowledge base to make important decisions about how we will move forward in this enterprise we call mathematics education.