

Teaching and Learning Mathematics for Social Justice in an Urban, Latino School

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This article reports on a 2-year study about teaching and learning mathematics for social justice in an urban, Latino classroom and about the role of an NCTM *Standards*-based curriculum. I was the teacher in the study and moved with the class from seventh to eighth grade. Using qualitative, practitioner-research methodology, I learned that students began to *read the world* (understand complex issues involving justice and equity) using mathematics, to develop mathematical power, and to change their orientation toward mathematics. A series of real-world projects was fundamental to this change, but the *Standards*-based curriculum was also important; such curricula can *theoretically* promote equity, but certain conditions may need to exist. Social justice pedagogy broadens the concept of equity work in mathematics classrooms and may help promote a more just society.

Key Words: Attitudes; Beliefs; Critical theory; Equity/diversity; Middle grades, 5–8; Qualitative methods; Race/ethnicity/SES; Social and cultural issues

With every single thing about math that I learned came something else. Sometimes I learned more of other things instead of math. I learned to think of fairness, injustices and so forth everywhere I see numbers distorted in the world. Now my mind is opened to so many new things. I'm more independent and aware. I have learned to be strong in every way you can think of it. (Lupe, Grade 8)

Lupe wrote the above after almost 2 years in a mathematics class where a principal focus was on *teaching and learning mathematics for social justice*. But what does it mean to teach and learn mathematics for social justice? How might this take shape in the classroom? What is the relationship to a curriculum based on the National Council of Teachers of Mathematics [NCTM] *Principles and Standards for School Mathematics* (2000)? In this article I address these questions and describe a research project in which I was a middle-school mathematics teacher in an urban, Latino school. I have two purposes here: (a) to uncover and concretize components of teaching and learning mathematics for social justice and (b) to understand the relationship of a *Standards*-based curriculum to that process. I situate this

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study alongside NCTM's positions on equity and extend them, and I examine students' learning from the perspective of teaching for social justice and through the lens of the vision for school mathematics described in the NCTM's *Standards*. I also discuss students' changed dispositions toward mathematics and raise further research questions.

NCTM published the initial *Curriculum and Evaluation Standards for School Mathematics* over 10 years ago (NCTM, 1989) and declared equity to be an aim of mathematics education reform. The authors specified certain "new societal goals for education" (p. 3) and incorporated equity into the goal of *opportunity for all*. Although the *Curriculum Standards* did not explicitly define equity, it stated, "the social injustices of past schooling practices can no longer be tolerated. . . . Creating a just society in which women and various ethnic minorities enjoy equal opportunities and equitable treatment is no longer an issue" (p. 4). The authors also took a strong position against tracking: "we believe that current tracking procedures often are inequitable, and we challenge all to develop instructional activities and programs to address this issue directly" (p. 253). The *Curriculum Standards* embraced democratic citizenship with mathematical literacy as a key component.

One can, however, critique the *Curriculum Standards*' equity framework because the document was also largely about U.S. economic competitiveness and workforce preparation in a global context. One of the new societal goals of the *Curriculum Standards* (NCTM, 1989) was to develop "mathematically literate workers" (p. 3), situating equity within the context of economic productivity: "the educational system of the industrial age does not meet the economic needs of today" (p. 3) and "equity has become an *economic necessity*" (p. 4, my emphasis). It is not surprising that the document reflects multiple perspectives on equity, because it was developed and written by consensus. But to discuss equity from the perspective of U.S. economic competition is to diminish its moral imperative and urgency.

In the revised *Principles and Standards* (NCTM, 2000), equity had a more prominent focus and was not tied to economics. Of the six unifying principles in the document, equity is the first, thus demonstrating a deeper concern than in the original document. The revision reiterates the strong stand against tracking and other forms of differential curriculum and insists that all students have access to high-quality curriculum and technology and to highly qualified teachers with adequate resources and subject-matter knowledge. The point is made clearly that uniformly high expectations of students and strong supports are necessary to achieve equity. However, the document does not address what else might be necessary to attain equity, nor does it propose how to transform inequitable mathematics classrooms into equitable ones.

In his analysis of the 1989 *Curriculum Standards*, Apple (1992) raised several issues. He acknowledged the *Curriculum Standards*' primary intent—literacy for democratic citizenship—but pointed out that the intentions of its creators do not determine how others might use it. Apple placed the document within its socio-

political context, that of unequal relations of power in society, and questioned whether literacy in the *Curriculum Standards* meant *functional literacy* (i.e., being able to read and do mathematics) or *critical literacy* (i.e., approaching knowledge critically, seeing social events in the interrelationships of their historical and political contexts, and acting in one's own interest as a conscious agent in and on the world [Freire, 1992; Macedo, 1994]). Apple raised questions of how to achieve the principal purpose outlined and implied in *both Standards* documents—a just society—and what are the specific roles that mathematics education can play in reaching that goal. Apple is not alone in raising these questions. Both Secada (1996) and Tate (1996) ask whether the *Curriculum Standards* might in fact exacerbate existing inequalities because students in schools with more opportunity to learn—more resources, more access to better qualified teachers and better curricula—might benefit more from the document than students in poorer communities and schools (Oakes, 1985, 1990).

Clearly these are complicated questions, and neither the *Standards* documents nor any other such document has the sole responsibility for answering them. But the documents further the struggle for equity by openly discussing these issues. Over the past 15 years, many mathematics educators have worked for equity in various theoretic and programmatic ways (e.g., Campbell, 1996; Frankenstein, 1995; Gutiérrez, in press; Khisty, 1995; Moses & Cobb, 2001; Secada, 1991, 1996; Silver, Smith, & Nelson, 1995; Tate, 1995; Weissglass, 2000). Unfortunately, we are not much closer to achieving full equity in mathematics (nor anywhere else in society), despite important advances such as the reduction (but not elimination) of gender disparities. Some may argue about the size of, and trends in, the gaps, but the travesty of unequal experiences, opportunities, and outcomes between rich and poor and between whites and students of color is unarguable—equity is not here.

Although mathematics educators have worked in various ways to promote equity, little literature exists that documents efforts to teach mathematics as a specific tool for equity and social justice. Important exceptions do exist, notably Frankenstein's work (1987, 1989, 1991, 1995, 1997) and that of Skovsmose (1994a, 1994b). But how might teaching mathematics for social justice take shape in practice, and how might it advance the struggle for equity? One way to address this is to consider what teaching for social justice might mean in *any* context, independent of a specific discipline.

TEACHING FOR SOCIAL JUSTICE

An important principle of a social justice pedagogy is that students themselves are ultimately part of the solution to injustice, both as youth and as they grow into adulthood. To play this role, they need to understand more deeply the conditions of their lives and the sociopolitical dynamics of their world. Thus, teachers could pose questions to students to help them address and understand these issues. For example: Why are there so many gangs in your neighborhood, and why are so many bright and talented students dropping out and joining them? Why is the complexion

of your neighborhood changing, and what's behind those changes? As students begin to address questions that have meaning in their lives, they begin to understand the forces and institutions that shape their world and to pose their own questions. These processes of helping students understand, formulate, and address questions and develop analyses of their society are critical components of teaching for social justice and may be encapsulated as "developing sociopolitical consciousness" or *conscientização*, as Freire (1992) called it. Without these tools, students cannot work for equity and social justice.

There is nothing unusual about wanting students to be socially aware. But although necessary, this may be insufficient for students to become actively involved in rectifying social inequalities. Freire (Freire & Macedo, 1987) spoke of *writing* the world (and not just understanding it), which meant, for him, to remedy unjust situations. To write the world, students also need a sense of *agency*, that is, a belief in themselves as people who can make a difference in the world, as ones who are makers of history. Educators working toward an equitable and just society can help students develop not only a sophisticated understanding of power relations in society but also the belief in themselves as conscious actors in the world. Helping young people develop a sense of personal and social agency can be an important step toward achieving equity.

Finally, teaching for social justice also includes helping students develop positive social and cultural identities by validating their language and culture and helping them uncover and understand their history (Murrell, 1997). This can be complicated and may be especially hard for teachers from cultural backgrounds that are different from those of their students. However, respecting and listening to—and learning from—children and adults who make up the school and community are essential to help students develop such identities (Delpit, 1988). Thus, a pedagogy for social justice has three main goals: helping students develop sociopolitical consciousness, a sense of agency, and positive social and cultural identities.

Ladson-Billings (1994) describes aspects of a liberatory education for African Americans, which may be extended to other marginalized students:

Parents, teachers, and neighbors need to help arm African American children with the knowledge, skills, and attitude needed to struggle successfully against oppression. These, more than test scores, more than high grade-point averages, are the critical features of education for African Americans. If students are to be equipped to struggle against racism they need excellent skills from the basics of reading, writing, and math, to understanding history, thinking critically, solving problems, and making decisions. (pp. 139–140)

As Ladson-Billings points out, an emancipatory education does not neglect disciplinary knowledge. In fact, learning specific subjects such as mathematics can help one better understand the sociopolitical context of one's life. No one would argue that learning to read is unimportant in understanding society. Similarly, mathematics can be a valuable tool in deepening one's awareness. And conversely, becoming more interested in analyzing the conditions of one's community can motivate students to acquire more tools to further those investigations (MacLeod, 1991).

These complementary and related components—making sense of sociopolitical contexts and learning subjects like mathematics and reading—are integral to a pedagogy of social justice. An education that provides students with the knowledge and dispositions to struggle against racism and other forms of oppression ultimately helps create a more just and equitable society.

It may be hard to imagine teaching mathematics for social justice because of the dearth of examples in the literature. There are several possible explanations for this, especially in public, K–12 schools. First, educational practices that involve students in discussions and actions that critique sources of knowledge, question institutional practices, and run counter to norms and power structures within society are potentially problematic and can threaten schools and authority. Teachers put themselves at genuine risk by raising such issues. Second, the pressure of high-stakes tests, so prevalent in urban districts and increasingly dominating the public school agenda in the United States, can cause teachers and administrators to shy away from such a pedagogy (Lipman & Gutstein, 2001). Third, the roots of mathematics education as a field stem from mathematics and psychology (Kilpatrick, 1992), and researchers have historically focused more on cognition than on sociocultural contexts (although this situation is changing [see Lerman, 2000]). And fourth, there is the common notion that mathematics is an “objective” science that is neutral and context free.

However, Frankenstein’s work at the college level does offer a social-justice model (1991, 1995, 1997). She has taught for years, not youths who are essentially “captives” in highly regimented schools, but rather adults who have a fair amount of autonomy in their lives and educational choices. She provides examples of teaching mathematics for social justice, such as having students analyze military versus domestic expenditures to help them understand and critique societal fiscal priorities, and she demonstrates how it is possible for students to transform their awareness of society through mathematics classes.

Even outside of mathematics, there is limited research on actual K–12 classroom practices involving social justice pedagogy. (For some examples, see Bigelow, Christensen, Karp, Miner, & Peterson, 1994; Bigelow, Harvey, Karp, & Miller, 2001; La Colectiva Intercambio, 1996; MacLeod, 1991; Sylvester, 1994.) Case studies of teaching for justice and equity in K–12 mathematics classrooms may help us understand critical features of such a pedagogy and some of the associated enabling and disabling conditions, and they may ultimately help us move toward a more just and equitable society.

This article spans almost 2 years in an urban, Latino public school where I tried to teach mathematics for social justice. In 1997–1998, I taught a seventh-grade mathematics class from November through the end of the school year, then moved with the class to eighth grade in 1998–1999. Here I describe aspects of my teaching (mainly my curriculum and, to a lesser extent, my pedagogy) and of my students’ learning. My aim is to describe the context of the classroom, provide specific examples of how teaching mathematics for social justice took shape in my situation, and examine the interconnections of my teaching and students’ learning, which were

necessarily interwoven.¹ Thus, I describe my overall goals, the classroom environment and culture, and aspects of my curriculum and pedagogy, and I provide evidence for students' learning and changed dispositions.

As a teacher, my larger goals were the three I discussed above for teaching for social justice: to help develop students' social and political consciousness, their sense of agency, and their social and cultural identities. But I was a *mathematics* teacher, and so I had mathematics-specific objectives that were related to these larger goals. Therefore, I developed a series of 17 real-world mathematics projects that connected to students' lives and experiences. In this article, I focus on the relationship of the goal of developing sociopolitical consciousness to students' mathematics learning and dispositions. Elsewhere, I discuss helping students develop a sense of agency (Gutstein, 2002a) and positive social and cultural identities (Gutstein, 2002b).

First I discuss my research site and methodology. Then I provide an overview of my teaching goals, classroom, and pedagogy, and then describe the curricular components of my class. The next sections contain an explanation of the three mathematics-specific objectives I had for my students, followed by the interrelationship of the goals of teaching for social justice and the *Standards*-based curriculum. Throughout these sections, I interweave my data and analysis. I conclude the article with theoretical and practical implications and raise further questions about teaching for social justice and increasing equity in schools.

METHODOLOGY

I taught my classes at Diego Rivera School² located in a working class, Mexican/Mexican American community in a large, midwestern city. Rivera is an elementary public school of about 800 students, 99% of whom are Latino with the vast majority Mexican, and 98% are low-income. About half of the students are immigrants, and most of the remainder are first generation in this country. Almost all students speak Spanish. The school has regular and honors tracks, and honors-track students are demographically indistinguishable from regular-track students. At the middle school grades, students move as a group from teacher to teacher for different subjects.

In many ways, Rivera is typical of schools in the district. Its students must meet all the district-required standardized-test, attendance, and behavior mandates. Students wear uniforms to instill pride in the school, to reduce economic pressures on families, and to claim the school as neutral territory with respect to gangs. The vast majority of students go to the neighborhood high school, which has a dropout rate of around 50%. Virtually all students live in the neighborhood and walk to school, except for some honors-track students who live in nearby, low-income communities.

¹ Indeed, as Ladson-Billings (2001) points out, in Hebrew and other languages, teaching and learning are the same word, although I explicate them somewhat independently here.

² This and all student names in this article are pseudonyms.

My seventh-grade class in 1997–1998 had 26 students and was an honors-track class. In 1998–1999, in eighth grade, two students replaced two others who left Rivera. All 28 were from Latino, immigrant, working-class families. About half were born in the United States and the rest in Mexico except for one student from the Dominican Republic and another whose family was from Puerto Rico. Spanish was the first language of all the students in my class, and all but one were fluently bilingual in Spanish and English.

This investigation was a practitioner-research project (Anderson, Herr, & Nihlen, 1994; Cochran-Smith & Lytle, 1993) in which I used semi-ethnographic research methods such as participant observation, open-ended surveys, and textual analysis of documents (Hammersley & Atkinson, 1983). Teacher-researchers engage in systematic, self-critical inquiry on their own practice to develop theory and contribute to educational research and also to solve pedagogical problems. Theory, for them, is not just a product of their research but also a guide to understanding and improving their own practice. In my case, that meant to better meet my goals of teaching for social justice. However, in this article, I focus on the broader implications of my research rather than describing how I tried to improve my teaching.

I collected data from a variety of sources such as students' standardized-test scores from sixth, seventh, and eighth grades and also the results of their high school admission tests. I maintained a practitioner journal in which I periodically recorded reflections and observations on students' mathematical work, their dispositions, classroom climate and culture, my personal interactions with them and their families, and classroom discussions around various topics both mathematical and social. I also collected student work, including 41 sets of weekly student journal assignments that covered issues such as their reflections on their mathematical learning and their thoughts about issues we were studying or discussing. My data also include copies of 12 unit tests, 4 in-depth mathematics projects, and occasional samples of their class and home work from their regular mathematics curriculum.

In addition, I collected student work on 16 of the 17 real-world projects. This material consisted of mathematics work and individual write-ups, and if it was a group project, there was a group write-up as well. These write-ups ranged from answering a number of open-ended questions on the particular topic to writing a full essay, and they always dealt with students' views on the social issue that we were analyzing. Two of these real-world projects involved small groups of students surveying others (80–100 responses per group) on what we termed "meaningful topics," such as opinions on abortion, homosexual marriage, and teen pregnancy; I videotaped (but did not transcribe) all their in-class presentations on the survey projects. I also administered three anonymous surveys of from 12 to 16 questions, the first of which included both open-ended and forced-choice questions; the latter two were entirely open-ended.

An important data source that informed my analysis while teaching was my informal conversations with students both within and outside of school. I currently maintain contact with about half of them (they are in their senior year of high school

as of this writing), and I continue to reflect on and learn from our ongoing conversations about what transpired in our class and how it continues to influence their lives. I have copresented with a few of them at national and regional educational conferences and plan to continue to do so.

I triangulated the data from the multiple data sources. I compared my observations of students' work and attitudes in the classroom; their mathematical work and writings on the real-world projects; and students' own reports as manifested in their journals, my conversations with them, and the surveys I conducted. After I left the classroom, I assembled all the textual data. In my analysis, I was guided by broad theoretical conceptions of teaching for social justice (e.g., Freire, 1992). I initially developed analytic codes for my data using open coding (Emerson, Fretz, & Shaw, 1995) to generate as many codes as possible. I then reread the data using focused coding in order to group codes and infer connections among them. From this iterative process, I induced key analytic and explanatory themes that guided my subsequent readings and interpretations of the data. I looked for patterns and relationships that emerged, and these guided me to search for other connections and interrelationships. These formed the basis of the analysis I present in this article.

AN OVERVIEW OF MY CLASSROOM, PEDAGOGY, CURRICULUM, AND SPECIFIC MATHEMATICS OBJECTIVES

The challenge we now face is how to create a curriculum filled with responsible social and political issues that will help students understand the complexity of such problems, help them develop and understand the role of mathematics in their resolution, and allow them, at the same time, to develop mathematical power. (Romberg, 1992, p. 435)

My three mathematics objectives related closely to Romberg's challenge and were all part of my larger goals in teaching for social justice. I wanted my students to use mathematics to understand—and potentially act on—their sociopolitical context (i.e., to *read the world* to develop mathematical power and in the process to transform their attitude toward mathematics). Table 1 contains both the larger goals involved in teaching for social justice and also my mathematics-specific objectives, and it points out that the first larger goal and first specific objective are essentially the same.

Table 1
Teaching Goals and Objectives

Goals of Teaching for Social Justice	Specific Mathematics-Related Objectives
Develop Sociopolitical Consciousness	Read the World Using Mathematics
Develop Sense of Agency	Develop Mathematical Power
Develop Positive Social/Cultural Identities	Change Dispositions Toward Mathematics

The first objective, understanding and acting on one's surroundings, can be referred to as learning to "read the world" (Freire & Macedo, 1987). Reading the

world is akin to developing a sociopolitical consciousness of the conditions and context of one's life, but I am speaking here of doing this with the *specific* use of mathematics. In my view, reading the world with mathematics means to use mathematics to understand relations of power, resource inequities, and disparate opportunities between different social groups and to understand explicit discrimination based on race, class, gender, language, and other differences. Further, it means to dissect and deconstruct media and other forms of representation and to use mathematics to examine these various phenomena both in one's immediate life and in the broader social world and to identify relationships and make connections between them. I tried to help my students learn how to do this by having them complete real-world projects in which mathematics was the primary analytical tool. For example, I developed a project in which students analyzed racially disaggregated data on traffic stops. The mathematical concepts of proportionality and expected value are central to understanding racial profiling. Without grasping those concepts, it is hard to realize that more African American and Latino drivers are stopped than one would expect, and this disproportionality should lead one to examine the root causes of the anomaly. Mathematics can be a vehicle that leads into a deeper consideration of the bases of inequitable treatment.

Although I describe this elsewhere (Gutstein, 2002b), an important theme that emerged from my analysis is that my students also began to examine more generally inequality and discrimination in their lives and society—and not just with mathematics. We had discussions that started from mathematical investigations of, for example, housing discrimination but then moved on to broader, related topics. We also discussed topics that seemed to have little to do with mathematics but that then became grist for mathematical explorations. I call this *going beyond the mathematics* (Gutstein, 2000).

From Freire's (Freire & Macedo, 1987) point of view, reading the world is inseparable from *reading the word* (acquiring text literacy). He led mass literacy campaigns focused on emancipation in Brazil as well as in newly independent African nations in the 1970s. Freire's (1994) emphasis was on helping people develop literacy through reading their worlds as a starting point:

Anyone taking a literacy course for adults wants to learn to read and write sentences, phrases, words. However, the reading and writing of words comes by way of the reading of the world. Reading the world is an antecedent act vis-à-vis the reading of the word. The teaching of the reading and writing of the word to a person missing the critical exercise of reading and rereading the world is, scientifically, politically, and pedagogically, crippled. (pp. 78–79)

In my case, reading the *word* refers to developing mathematical literacy and mathematical power.

My second mathematics-specific objective was to help my students develop mathematical power, to use Romberg's words. I embraced, and tried to actualize, the vision for school mathematics elaborated in the NCTM's *Standards*. I use the following from the *Principles and Standards* (NCTM, 2000) as a working definition of mathematical power:

Students confidently engage in complex mathematical tasks . . . draw on knowledge from a wide variety of mathematical topics, sometimes approaching the same problem from different mathematical perspectives or representing the mathematics in different ways until they find methods that enable them to make progress . . . are flexible and resourceful problem solvers . . . work productively and reflectively . . . communicate their ideas and results effectively . . . value mathematics and engage actively in learning it. (p. 3)

I used *Mathematics in Context (MiC)* (National Center for Research in Mathematical Sciences Education [NCRMSE] & Freudenthal Institute, 1997–1998) as the basis of my curriculum. *MiC* is a comprehensive curriculum for Grades 5–8 developed with funding from the National Science Foundation (NSF) and was one of 13 curricula whose development was funded by the NSF to help make the NCTM’s *Standards* into a reality. Teaching *MiC* was a significant component of my class.

My third objective was that through the real-world projects, students would develop a profoundly different orientation toward mathematics than they had after years in public schools and would become more motivated to study and use it. Although my students used *MiC* the preceding 2 years, their previous teachers were new to the curriculum. By the students’ accounts, my observations, and her own admission, their fifth-grade teacher lacked experience and confidence in teaching mathematics and taught very little *MiC*. Their sixth-grade teacher was knowledgeable about mathematics but felt the pressures of standardized tests and curriculum coverage and supplemented *MiC* a good deal (Gutstein, 1998); from my observations, she was a good traditional mathematics teacher. Thus, despite some exposure to *MiC*, when my students entered seventh grade, they had much of the typical and well-documented disposition with which most mathematics educators and teachers are familiar—mathematics as a rote-learned, decontextualized series of rules and procedures to memorize, regurgitate, and not understand.

My curriculum had two main components: *MiC* and a series of real-world projects. The basic curriculum was *MiC*³, on which we spent probably 75–80% of our time. *MiC* has 10 units per grade, although no class at Rivera ever completed that many. My students finished several units per year and also completed most of the assessments that come with the units. At the time, Rivera used *MiC* in mathematics classes in Grades 4–8.

MiC’s philosophy is multifaceted (NCRMSE & Freudenthal Institute, 1998). Much is similar to that of the NCTM’s *Standards*, such as the importance of valuing multiple strategies, the necessity of student interaction, and the assumption of different roles for students and teachers. *MiC* emphasizes that students gradually develop formal approaches to mathematics: “It is preferable that students use informal strategies that they understand rather than formal procedures that they do not understand” (p. 5), and that students should “reinvent significant mathematics.”

³ I have worked closely with the developers of *MiC* over a number of years and was a consultant on the Teacher Resource and Implementation Guide (NCRMSE & Freudenthal Institute, 1998). I am also a member of the *MiC* consultants group.

It also holds that mathematics is a product of human activity, that models help students develop mathematical understanding at different levels, and that real-world contexts are necessary for learning mathematics.

MiC's real-world contexts were particularly appropriate because I wanted my students to learn mathematics *meaningfully*, that is, to view mathematics as a relevant tool, connected to their lives and experiences, with which to make sense out of social phenomena. Researchers have reported various ways that teachers help students learn mathematics meaningfully. These include teaching mathematics in culturally relevant ways (Gutstein, Lipman, Hernández, & de los Reyes, 1997; Ladson-Billings, 1995a; Tate, 1995), teaching it in critically literate ways (Frankenstein, 1997), and using students' and their community's *funds of knowledge* to develop curriculum (Andrade, Carson, & González, 2001; González et al., 1993). However, although *MiC* uses real-life settings for *all* its contexts, my students felt that they could not relate that well to these settings (Gutstein, 1998). But even if my students felt that they could relate to the *MiC* settings, I still would have developed the real-world projects to incorporate issues of economic and racial discrimination and inequality, immigrant status, gentrification, and other examples of injustice facing them and their families on a daily basis. *MiC* contexts, though mostly likable and interesting according to my students, did not deal with these sorts of issues. Nonetheless, *MiC*'s real-world contexts were essential because they helped create a classroom culture in which other real-world contexts could be investigated.

Over the almost 2 years that I taught them, my students completed 17 real-world projects, lasting from a couple of days to a couple of weeks. Besides mathematics, all the projects included writing and interpreting data, graphs, pictures, maps, or text (often newspaper articles). In one way or another, virtually every project related to and built on my students' lived experiences as urban youth from immigrant, Latino, working-class families. For example, the following was part of the *Racism in Housing Data?* project. I gave students the data for the highest median house price in the area at the time (in 1997, the suburb of McFadden, \$752,250) and asked them these questions:

How could you use mathematics to help answer whether racism has anything to do with the house prices in McFadden. Be detailed and specific!! Describe:

1. What mathematics would you use to answer that question.
2. How would you use the mathematics.
3. If you would collect any data to answer the question, explain *what* data you would collect and *why* you would collect that data.
4. Give examples of data that would cause you to believe that racism *is* involved in the McFadden housing price, and explain why you reached that conclusion based on the analysis of the data.
5. Give examples of data that would cause you to believe that racism *is not* involved in the McFadden housing price, and explain why you reached that conclusion based on the analysis of the data.

One week later, I assigned the second part of the project, in which I reproduced the students' various responses in summary form. I asked students to pick two of

the responses, explain in writing why those were good data with which to analyze if racism was involved, and answer the question, “How can you use the data you picked out to know whether or not racism is involved?”

I intended these assignments to help students use mathematics to make sense of complex social questions. But just as using *MiC*—where all mathematics is from the world—does not guarantee by itself that students can use mathematics to analyze if racism is a factor in housing prices, similarly, projects like this do not either. A colleague of mine commented, referring to a project where students analyzed world maps and discovered that not all accurately represented reality (Gutstein, 2000, 2001), one does not just walk into a classroom with maps over the shoulder and expect students to create real meaning. How students construct meaning depends much on the teacher’s pedagogy and on the classroom environment co-created by the teacher and students.

In my class we *normalized* politically taboo topics (Gutstein, 1999)—that is, we went beyond mathematics and discussed issues that mattered in students’ lives. In particular, race, racism, discrimination, power, and justice became ordinary topics of conversation. Sometimes they were related to mathematics and sometimes not. Also, as students used mathematics to discover some vastly unfair things, many at times felt powerless. I had to learn how to help them reconcile feelings of “oh well, what can I do about it” with their increasing awareness of injustice. There was also my role as a white, male professional teaching Latino, working-class youth and trying (presumptuously?) to help them develop positive social and cultural identities. There were other issues, such as whether students wrote on their projects what they thought I wanted to hear and the influence of district and school contexts and the support of the principal. All of these issues and my attempts to deal with them are important but beyond the scope of this article. I discuss these further in (Gutstein, 1999, 2000, 2002a, 2002b).

READING THE WORLD USING MATHEMATICS

From a Freirean perspective, reading the *world* and reading the *word* are dialectically related and, ideally, reinforce each other. By reading the world, we become motivated to read the word better; by reading the word, we can better read the world. Of course, in practice, this is not always so straightforward. Freire worked with adults involved in social production who chose to learn to read. Some lived in newly independent nations, rebuilding their countries. Even among those in his native Brazil, many were working for social change. Power relations between teachers and students were generally equitable. However, middle school students in highly regimented, disciplined, urban schools where high-stakes tests and punitive structures reign do not necessarily approach math with the same openness. Furthermore, Freire (Freire & Macedo, 1987) advocated that active participation in transforming society be the context for learning to read the world and the word:

Reading the world always precedes reading the word, and reading the word implies continually reading the world. . . . In a way, however, we can go further and say that

reading the word is not preceded merely by reading the world, but by a certain form of *writing* it or *rewriting* it, that is, of transforming it by conscious, practical work. For me, this dynamic movement is central to the literacy process. (p. 35)

This too does not easily transfer to middle school students at Rivera. Nevertheless, even though my students did not share the actual life experiences or the specific outlook of the adults with whom Freire worked, they did begin to read the world using mathematics.

As a Freirean pedagogy (Freire, 1992) suggests, I did not try to have my students answer questions so much as raise them. Questions such as why females, students of color, and low-income students score lower on SAT and ACT exams are not easily answerable—and students did raise that question in one of our projects. I did not try to answer many questions like this—nor could I answer all their questions. And I did not want my students to accept any view without questioning it. I did share my own opinions with my students because I agreed with Freire's contention that progressive educators need to take the responsibility to dispel the notion that education can be the inactive transfer of inert knowledge and instead to promote the idea that all practice (including teaching) is inherently political. I take Freire (1994) to mean here that educators need to be explicit in their views while at the same time to respect the space for others to develop their own.

[I]nasmuch as education of its very nature is directive and political, I must, without ever denying my dream or my utopia before the educands, respect them. To defend a thesis, a position, a preference, with earnestness, defend it rigorously, but passionately, as well, and at the same time to stimulate the contrary discourse, and respect the right to utter that discourse, is the best way to teach, first, the right to have our own ideas, even our duty to "quarrel" for them, for our dreams . . . and second, mutual respect (p. 78).

My criteria for evidence of reading the world included that students used mathematics as a tool to analyze social issues like racism and other forms of bias and to understand power relations and unequal resource allocation in society. I looked for signs that students used mathematics to scrutinize representations of reality (like maps) and to link them to issues of injustice. My criteria also included that students looked for relationships between various social issues we studied. Consistency of their ideas was less important, because the situations were complex and because middle school students are just beginning to more deeply form and articulate their ideas about the world.

One of our projects (from Peterson, 1995) involved simulating the distribution of world wealth by continents. I told students the number of people and the total wealth of each continent. The students found the percent each continent's population was of the world's population, and then using those percents we distributed ourselves randomly to each "continent" (area of the room). We then distributed the "wealth" of the world (two bags of cookies), using the same idea, to each continent and shared the cookies equally within the continent. Thus, the two students in North America each received a stack of 14 cookies, whereas the four of us in Africa shared the crumbs (literally) of 1 cookie. As a group, we compared the ratios of North America to Asia (1 1/2 cookies per person) to Africa. Students saw that

the average wealth of a North American was 56 times greater than that of an African. While students were genuinely shocked and upset to learn about the wealth inequity, Marisol went deeper in her analysis and presented it verbally in class. She later wrote:

And even if some continents have more wealth than others, that doesn't mean that the people in the continent all have the same amount of wealth. Some have no wealth at all, while others can have billions of dollars of wealth. If you look at Africa, there are 763 million people living there and they have 436.6 billion dollars in wealth. For all we know, one person might have 436.6 billion dollars in wealth and everybody else might not have any at all. Of course, we know this isn't so, but it just makes you realize that knowing how much wealth each continent has doesn't really tell you anything about how much wealth the people have on each continent. In the U.S., Bill Gates holds more money than anybody else, but if you divide the wealth by population, Bill would probably have an average amount of money and a homeless would have an average amount of wealth.

Her comment is a mathematical critique of the weakness of a one-number summary for a data set. It represents a relatively sophisticated understanding for a middle school student and forms an informal basis upon which to abstract more complicated mathematics. More important, it helped students deepen, in a concrete way, their understanding of wealth inequality *between* continents to include the idea of wealth inequality *within* a continent. Several students responded in their own writings to Marisol's point in class. Omar connected his own life experience to the world situation, and, using her framework, he drew an analogy between the world wealth inequality and the inequality between his hard-working parents and a well-paid, professional athlete:

What Marisol said on Friday was right on the spot. Not all the wealth is distributed equally. You may see some homeless guy looking for food but then the next moment, you see someone driving their brand new Mercedes convertible. For example, even the ones that aren't homeless. Our family makes somewhere in the neighborhood of \$40,000. I heard that Michael Jordan makes about \$1,000 for every minute he plays. So that means that in 40 minutes he makes our whole family's earnings. While my parents work year round for that money. I really think Marisol hit [it] right on the money. I learned that lesson that plays a huge role in life.

I followed up this project with a related one a few months later where we considered the wealth distribution within the United States. Using data from Wolff (1995), we compared the financial wealth of the wealthiest 1% of the United States, the next 19%, and the bottom 80%. Before I gave the students the data, I asked them to guess the distribution. Every student was significantly off in her or his estimate and believed U.S. wealth to be more equitably distributed than it was. Students wrote what they thought about the subject before and after the activity, what they learned, how (specifically) they used mathematics, whether they could have understood the ideas without using mathematics, and how the activity made them feel. All but 3 of the 26 expressed that they learned a lot and gave specific examples; one of the three said she already knew how unevenly distributed the wealth was in the United States, but her estimate also was very wrong. Twenty three

reported feelings including “shock,” a strong sense of “unfairness” [many], “anger,” “mad,” “this is a really powerful situation,” “bad and disturbed,” “disappointed,” “determined” [to change things], and “it makes me think a lot.” Only one student reported feeling “nothing,” one student did not understand the activity as evidenced by his report, and one felt “mixed” [because] “in a way I’m happy the U.S. is ‘rich’ because it gives people more opportunities (or at least it seems),” but she also wrote, “I still have questions about why this is like this and if we could ever change it.”

I often explicitly asked students to make judgments about complex social situations on the basis of data. In the *Racism in Housing Data?* project, students responded in a variety of ways. Some of these were relatively straightforward applications of mathematics. For example, one student discussed how she would use mathematics to compare the percentages of different-race home owners in the community, as well as the prices that people of different races paid. However, she then went further mathematically and discussed racism within the context of changing prices over time and the size of the house:

[A]lthough price, you can’t be sure of, since the worth of things is going up and down. For example, if a White has a house that cost him \$100,000 but he got it 30 years ago, and a Black just got a house for 200,000 a year ago, that wouldn’t be racism. It would be racism if, let’s say, a white family got the house 3 months ago and they paid 250,000 and then a Black family paid for a house 3 months ago but they paid \$752,000 [the median house price for the suburb], that would be racism, unless the house of the Black people was 3 times as big. If there was no racism, it would be if the White family paid for the house \$250,000 and the Black family paid \$250,000, but both bought their houses 3 months ago. I reached my conclusion by looking at what time they bought it and at what price.

Another student used the criteria of salaries for different ethnicities and related that to changing neighborhood demographics and rising taxes:

There would be racism if the Latino average salaries are for example, \$40,000 a year and the whites are \$250,000 a year or more, and the builders are building more new houses in the Latino area so that Latinos’ taxes would go up when people move in, thus making the Latinos move out, then it would be racism. It wouldn’t be racism if the salaries of the whites and Latinos were about the same and the houses were being built on both Latino and whites’ neighborhoods.

Another student also discussed salaries, but with respect to house price and affordability:

First I would find the price of a house in McFadden and a working-class Latino’s annual income. Then I would divide the house’s price to find the annual payment. Then I would take the income and subtract the cost of living (food, clothes, etc.) and compare the difference to the house’s payments. If there is a large difference in the two, it is possible discrimination exists in the prices of McFadden because the price is impossible for most, if not all, working-class Latinos. I would say there was no racism involved if the prices were more affordable for minority groups.

Students also related McFadden’s prices to other suburbs:

Well, first of all, since McFadden is the most expensive suburb, what we could do to find out using math would be look at different suburbs. What I mean is that we look

at other suburbs like Piedmont and others' prices, and depending on the average single-family house cost, we could find out if it was racism or not. You see, because many Latinos live in Piedmont and other suburbs that aren't so expensive.

It is worthwhile to examine the complex issues students brought up. Some students contended that they could tell if racism was involved by looking at house prices by neighborhood. If the same houses were higher priced in neighborhoods of color, then racism existed—that is, prices were unfairly raised to make people of color pay more. However, other students claimed just the opposite! They stated that if house prices for the same houses were higher in white communities, this was racism because realtors knew that people of color could not afford as much and were keeping neighborhoods white by raising house prices beyond what families of color could afford. From discussions like these, students began to appreciate that the answers were not simple and that mathematics played a role in trying to sort out difficult, real-world questions.

In another project, I asked students to examine 1997 SAT and ACT exam scores by race, gender, and social class. The project was particularly intense for students because Latinos and low-income students were on the bottom, and this raised significant questions about how to do this type of project without reinforcing negative stereotypes, depressing, or paralyzing students—and about my role (Gutstein, 1999, 2002a). In part 1, students made up three questions about the scores that could be answered with mathematics and explained how they would use math to answer them. Part 2 read:

The SAT is made by the Educational Testing Service (ETS). Look at the SAT data by income level and average score of all students. Write a one-page letter to ETS about that data, asking any questions you want and making any points you want to. Include a graph that shows the income level and average scores as a way to talk about and question the data.

Of the 21 students who completed the project, 5 interrelated class and race (e.g., “your data might not be correct because I know that race and income don't equal intelligence”). Eleven questioned the relationship of income and quality of education (e.g., “what if you have a really smart student that only has an income of \$9,000 would he/she not get much of an education?”) Three others raised the same issue solely about race (e.g., “How come whites and Asians get higher scores, yet everyone else gets lower scores. How does race affect your scores? Now I really want to know is there racism involved”). The remaining 2 suggested that effort could overcome the discrepancies (e.g., “All of these [low-income] people want to become doctors, lawyers, sports players, etc. So why are ‘rich’ smarter?”) The majority reasoned that either whites or people with higher income (not necessarily mutually exclusive) got a better education, and better education led to higher SAT scores—but most could not explain why. Overall, there was the strong current that “the income of what you [ETS] put for every year has nothing to do with a person's mind.”

In reading the responses, the main theme that emerges is students' efforts to make sense of an extremely complex situation. Their questions were genuine and came from their experiences as educationally disadvantaged and marginalized students

who saw themselves in the data and wanted to know why. They learned that situations like these were complicated and that mathematical analyses could be entry points to learn about inequality.

STUDENTS' DEVELOPMENT OVER TIME

Throughout the almost 2 years, the students slowly but steadily became more able to connect mathematical ideas to their growing understanding of the sociopolitical context of society. However, this growth was often accompanied by contradiction, ambivalence, and equivocation. I believe this was partially because they rarely analyzed social phenomena in school, they reported, let alone in mathematics class, and they were just beginning to develop their ideas and understanding of society. Much of what we learned about the world surprised, even shocked, them and occasionally contradicted their previous beliefs. (See Gutstein, 2000, 2002b, for additional discussion of this issue.)

Yet they grew over time. In our first project (December 1997), students read an article about a developer wanting city permission to raze a small neighborhood park to build parking spaces for upscale lofts. I wanted them to understand why developers coveted their close-to-downtown neighborhood. Given their age at the time, only a few of my students often went downtown and the proximity was not that concrete to them. But “proximity” is a mathematical concept involving time, geometry, and measurement, and I wanted my students to use mathematics to understand the situation.

Students had to find the distance from the park to a downtown landmark (for which they had to measure and convert distances in two maps with different scales, a difficult task) and determine how long it would take to drive from the park to the landmark at 25 miles per hour without stops (about 3 minutes). The point was for students to realize that the neighborhood was close to downtown and to understand how that was related to development. This led us into discussions of neighborhood change, gentrification, and the history of community struggles.

I asked students to write whether the city should grant permission to the developer to raze the park. Almost all argued that the city should not give permission—but their arguments were *not* about gentrification. Rather, they discussed green space (the neighborhood is densely populated) and the need for places to play (partially as alternatives to ubiquitous gangs). A typical response was, “I really think that people shouldn’t disable the park because then kids won’t have a place to play. Parents also won’t be able to go out as much and many other things. Parks are probably the number one diversion in the whole city.” Even using mathematics, students did not, by themselves, connect the distance (and time) to downtown with the future of the neighborhood.

However, by spring of eighth grade (May, 1999), students overwhelmingly showed evidence of connecting mathematical analyses to deeper critiques of previous assumptions. On the map projection project, all but one student felt that

something was amiss in their education after using mathematics to see that standard classroom maps misrepresented the real size of countries⁴ (Gutstein, 2001). An overwhelming response was “What else have I been lied to about in my education?” as a genuine question about the reliability of what they had been taught. By this time in eighth grade, they understood, mainly *through* mathematics, that their prior beliefs were not necessarily accurate, and they were learning to raise important questions. They were developing their capability to read the world using mathematics.

But were they also learning mathematics and developing mathematical power? Or was this a case of students developing sociopolitical consciousness but not the mathematical knowledge, conceptual understanding, and procedural fluency and also the cultural capital to make their voices heard in order to effect real change in society? Especially for low-income students of color, for whom mathematics has functioned as an effective gatekeeper (Moses & Cobb, 2001), this is a serious life question. I turn next to the question of what mathematics the students *did* learn.

THE DEVELOPMENT OF MATHEMATICAL POWER

As I began to analyze my data, I tried to understand the separate roles that *MiC* and the real-world projects played in students’ mathematical learning. It became clear to me, however, that I could not easily attribute students’ progress to either *MiC* or the projects because there was too much interaction. It also became clear that separate attribution was not that meaningful. One would expect that students who use *MiC* develop mathematical power. The curriculum’s origins⁵, its alignment with the *Standards*, and research on *MiC* (Romberg, Shafer, & Webb, 2000) all attest to this. It is more important to understand how the two components functioned together to help students achieve my three math-specific objectives.

My data demonstrate that almost all students developed aspects of mathematical power. Of the 28 students, only one failed to show significant aspects of mathematical power. The other 27 exhibited mathematical power as shown by their tests, quizzes, projects, and class work. There was a range in their mathematical sophistication, as some of the following examples show, and some students came into my class already having some mathematical maturity. They developed the ability to create mathematical generalizations and construct their own solution methods on nonroutine problems. These 27 became demonstrably more adept at explaining their mathematical reasoning and problem-solving strategies, and

⁴ They found that although Greenland and Africa appear relatively comparable in size on the standard classroom map (the Mercator projection), Africa is about 14 times bigger. They also discovered that Mexico, the home country of all but two of the students, was actually larger than Alaska despite appearing appreciably smaller on the map.

⁵ Thomas Romberg was the initiator and one of two directors of the *MiC* curriculum. He was also the person who chaired the first commission on the development of the 1989 NCTM *Standards* and was the director of the National Center for Research in Mathematical Sciences Education at the time.

almost all became substantially more confident as well (this last point is corroborated by their responses to an open-ended survey I gave at the end of eighth grade).

Two key elements of the *MiC* (NCRMSE & Freudenthal Institute, 1997–1998) philosophy, which are integral to the development of mathematical power, are multiple ways of solving problems and reinventing significant mathematics. “Cereal Numbers” is a seventh-grade unit in the number strand. A goal of the unit is that students learn various ways of multiplying and dividing fractions using the context of producing, tasting, and testing various cereals. One of the questions asks, “How many cups of Corn Crunch #1 are needed for 60 taste testers if the serving size of the cereal is $1\frac{1}{2}$ cups and each test portion is one fourth of the serving size?” (p. 29). Students worked on this problem in class, individually, or in small groups; calculators were always available in class. I asked them to explain their answers in writing. Here are four responses, from two individuals and two small groups:

Response #1: 22 $\frac{1}{2}$ cups of cereal. What I did, I went from four by four. 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60, and I counted them and they were 15, and so I multiplied $1\frac{1}{2}$ which is for 4 people times 15 and got 22 $\frac{1}{2}$.

Response #2: For this problem we figured that if it was $1\frac{1}{2}$ for one person, it would be 3 for 2 and so on until we got to 10. When we got to 10, we multiplied that by 6 to get the amount for 60. The answer was 90 cups. Then we divided that by 4 to get the total amount of a test = 22.5.

Response #3: If $1\frac{1}{2}$ cups were for 4 people, then we need to know how much serving per person, because if you multiply $1\frac{1}{2} \times 60$, it won't work. So we divided $1\frac{1}{2} \div 4$ people, then we already know each person's serving. Now we multiply by 60, so we could find the answer. $1\frac{1}{2} \div 4 \times 60 = 22.5$ (22 $\frac{1}{2}$) cups.

Response #4: 22.5. I found the answer by multiplying $1\frac{1}{2}$ by 60, because there are $1\frac{1}{2}$ cups in Corn Crunch 1 and 60 people, then I divided it by 4 because there are 4 servings in $1\frac{1}{2}$ cups and what I want to know is how many cups (4 servings) are needed for 60 servings.

Mathematically, these are distinct ways of thinking. The first student divided 4 into 60, by counting by 4s and then counted how many 4s. She then multiplied the result by $1\frac{1}{2}$ ($60 \div 4 \times 1\frac{1}{2}$). The second response explains how the group used an adding strategy until they knew how many cups were needed for 10 full servings. They then multiplied by 6 to find how many cups for 60 full servings, then divided that total by 4 since they had 4 times too many testing-size servings ($1\frac{1}{2} \times 10 \times 6 \div 4$). The next group found the size of the testing serving, then multiplied that by 60 ($1\frac{1}{2} \div 4 \times 60$). The final student found how many cups would be needed for 60 full servings, then, as in response #2, divided by 4 to know how many testing servings she would need ($1\frac{1}{2} \times 60 \div 4$). As was my usual practice, I had taught none of these methods. The students invented each solution, clearly communicated most of their work and thinking, and provided some of the rationale for their choices. This type of mathematics and communication represents a range of mathematical sophistication and was typical of most of the students in my class.

Another example of students' ability to invent and creatively apply mathematics is from an *MiC* assessment in the "Comparing Quantities" unit within the algebra strand. In this unit, students learn to solve, in a variety of semiformal ways, systems of simultaneous equations in two and three variables. One of the methods is called *notebook notation*, which is essentially Gaussian elimination done in a "notepad" format. The assessment, "A Birthday Party," reads,

During Rachel's birthday party, Rachel thinks about the ages of her parents and herself. Rachel says, "Hey Mom and Dad, together your ages add up to 100 years!" Her Dad is surprised. "You are right," he says, "and your age and mine total 64 years." Rachel replies, "And my age and Mom's total 58." How old are Mom, Dad, and Rachel? Explain how you got your answer.

Ricardo's response was typical of the class. Figure 1 shows his notebook notation chart. His description follows.

#	Mom	Dad	Rachel	Years
1	1	1	0	100
2	1	0	1	58
3	0	1	1	64
4	1	1	2	122

Figure 1. Ricardo's notebook notation chart for the Birthday Party assessment.

I first did a notebook notation with the info they gave me which are [lines] 1, 2, 3 and I got 4 by adding 2, 3 which are 1 mom, 1 dad, and 2 Rachels and got 122 years. Since I know 1 dad and 1 mom equal 100 years, take away 100 years from 122 yrs and get 22. 22 is for 2 Rachels, divide by 2 and get 1 Rachel 11 years. So that's Rachel. Since I know Rachel is 11 years, #2 says 1 mom and 1 Rachel = 58, so take away 11 from 58 and get 47, that's for 1 mom. That's for 1 mom. So far I got Rachel and mom. #1 is 1 mom and 1 dad = 100 yrs, since mom is 47 yrs take that from 100 yrs. and get 53 yrs, the dad. That's how I got all for Mom, Dad, and Rachel.

Of the 25 students who took the assessment, 21 answered the problem correctly. Of these, 14 used some variation of notebook notation, often combined with informal reasoning as shown here. The other seven students who answered correctly either used a "try and adjust" strategy (three students), not taught in the unit, or an informal elimination strategy (three students), also not taught. One student had the

correct answer with no explanation, which was common for him. The four who answered incorrectly either used notebook notation incorrectly (two) or had computation errors but were otherwise correct (the other two). An example of a correct, non-notebook strategy, based on the informal reasoning from which the notebook method derives, was as follows:

The Mom is 47, Dad is 53, Rachel is 11. What I did is I added 64 and 58 which is the Dad and Rachel and Mom and Rachel. I got 122 and since the Mom and Dad together is 100 there was 22 years left over so since Rachel is in both combinations. I divided the 22 into half so that each parent will get exactly same age for Rachel and I got that she was 11 years old. So then I subtracted $64 - 11 = 53$ for the age of her father and for the Mom, I did the same $58 - 11 = 47$ for age of the Mom. And then I added the parents' age to make sure and it equal 100. So it worked.

A third, non-notebook strategy that made informal use of variables and equations:

Mom = 47, Dad = 53, Rachel = 11. Add all the ones on top, you get 2 d 2 M 2 R for 222 yrs. You subtract 100 yrs for 1 m and 1 d and you do it again you get 22 for 2 Rachels and then \div in 2. You subtract 11 from 58 to get mom and subtract $100 - 47 = 53$.

Nowhere in the assessment does it suggest to students to use notebook notation, nor had I taught the other methods. Furthermore, another strategy that students learned in the unit, *combination charts*, cannot work on any problem with three variables, although we never discussed that in class. Yet no student tried to solve the problem using combination charts.

Students also used informal reasoning and invented their own solutions on the real-world projects. On one project, Analyzing Map Projections—What Do They Really Show??⁶ groups of students used world maps to estimate areas of specific countries given the data that Mexico is about 760,000 square miles. All six groups created their own ways to measure the countries, because I had not given them any suggestions. Each group communicated clearly its ideas in writing and estimated the areas more or less correctly. Students used various methods including tracing and gridding Mexico to find square miles per square centimeter, then tracing and gridding other areas and using their baseline data to estimate; visualizing how many Mexicos fit into each other area and multiplying the number by 760,000; and reallocating pieces of countries in order to have square or rectangular areas. One group even reinvented the formula for the area of a triangle and wrote this explanation:

For Scandinavia, we saw that it sort of resembled a triangle in this shape . . . [a right, scalene triangle] so we decided that if we added this [another identical triangle with dotted lines, flipped over on top of the first, forming a rectangle] it'll be a rectangle so we found the height and width and multiplied those numbers. Then divided that number by 2 because I added another triangle to make a rectangle, I had to divide it now . . .

⁶ The two maps were the Peters projection map, which does not distort relative sizes of land masses but whose shapes tend to be elongated, and the traditional Mercator projection map, which does distort land mass sizes.

Another group explained:

What we first did was trace the country from the map. Then we grid it in 1 cm squares. We counted up the squares. We did this with Mexico first because that was our unit. So when we counted the squares we got 22. We divide 760,000 into 22 to get what each square represents in land. So we got 34,545. Then after we counted all the squares in another country we multiplied the # of squares of that country \times 34,545 to get the total area.

A third group reported how they reallocated land after finding area per square centimeter:

Mexico was measured as a T shaped land mass, side to side and top-to-bottom. Alaska was measured only as a square-shaped area . . . Africa was measured as a rectangle and we then measured and subtract the water from the total as seen below. [Figure 2 shows the group's representation of Africa.]

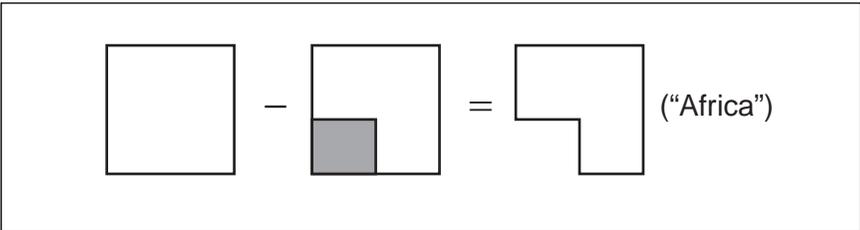


Figure 2. Reallocating land to estimate the area of Africa.

Scandinavia was treated similarly. Measuring it as a square and removing the area composed of water, like below. [Figure 3 shows the group's representation of Scandinavia.]

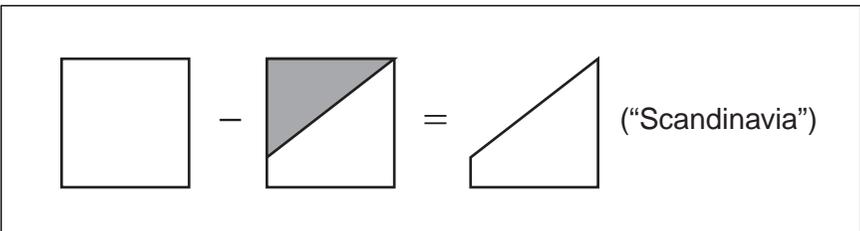


Figure 3. Reallocating land to estimate the area of Scandinavia.

As a final example, I present a relatively typical explanation for a problem I found in a mathematics magazine. The problem was to figure out how far the basketball player Shaquille O'Neal had to jump to stuff a basketball through a hoop. I told

students that O'Neal was 7 feet tall and the hoop was 10 feet off the ground and gave them no other information (rulers were available, but I did not suggest measuring). Here is what the group wrote:

We measured people's length from the top of the head to the beginning of your wrist and we found that it was $\frac{1}{6}$ of the body. So we converted 7 feet into inches and we got 84 in. then we took $\frac{1}{6}$ of 84 in. and got 14 in. which means that the measurement from Shaquille's head to his wrist is 14 inches when he's dunking, that is 98 in. So we took 10 feet (rim) and turned it in to inches which is 120 and then subtracted it by 98 in. and got 22 in. That's 1 foot and 10 in. We know that when you dunk you don't just touch the rim your whole hand hangs in. So we measured from the wrist to the top of the head.

These types of written responses were common from my students. There were also less coherent responses from students, but those were less common, especially on group responses. Overall, students not only communicated their findings well, they also developed confidence, represented mathematics in multiple ways, created their own solution methods, applied and extended others, and generally developed mathematical power.

The students also did well on conventional measures. All passed their eighth-grade standardized tests, which determined if they would pass to ninth grade, and all passed my class as well in both years. Over the almost 2 years, they gained 1.0 month on their standardized test scores for every month that I had them (65 school weeks). Eighteen students took entry exams in mathematics and language arts for magnet high schools, and 15 were accepted. As of this writing, all but one are in their senior year in high school, most on college-bound tracks. This is to be expected, since the class was an honors-track class in elementary school, and the district uses traditional assessments to determine tracks. Nonetheless, it is gratifying to see the progress they continue to make, having had a mathematics curriculum of real-world, social justice projects and *MiC* in seventh and eighth grades, especially in a district with an abysmal Latino dropout rate.

STUDENTS' CHANGED ORIENTATIONS TOWARD MATHEMATICS

Not surprisingly, as students used mathematics to develop sociopolitical awareness and question the source and veracity of knowledge and developed mathematical power, their views on mathematics began to change. Not all students loved mathematics or found it easy. But even among some who did not like it, there was the sense that it was a valuable tool with which to make sense of things that were important to them. My data show that perhaps all but three of the students changed their attitudes about mathematics.

In analyzing the data, I started from the premise that students learn more than what is taught explicitly—that is, classroom culture plays an important socializing role. Situated learning theory (Lave, 1988) proposes that knowledge is not only an individual attribute but is also cocreated as students function as community members. What counts as knowledge in one setting may not be considered as knowledge in

others, as researchers have documented about out-of-school mathematical knowledge (Nunes, 1992). Thus the framework of the *community of practice* (Lave & Wenger, 1991) into which students are enculturated helps explain my students' changed attitudes toward mathematics. My students regularly used mathematics to understand inequities, and discussions about these injustices were a normal part of classroom life. As Bishop (1991) writes, "Mathematical enculturation needs to be conceptualized as a social interactive process carried out within a certain knowledge frame but with the goal of recreating and redefining that frame" (p. 89). In my case, the knowledge frame was the goal of teaching for social justice.

Mathematics educators recognize that students in traditional mathematics classrooms believe that mathematics is a nonunderstandable collection of arbitrary rules and procedures, and this may be true whether or not these students achieve conventional school success. Boaler (1997, 1998) studied two schools in England, one of which was very traditional in its curriculum and pedagogy. She used a situated perspective to analyze the classroom culture, "The students' development of mathematical content knowledge could not be separated from their engagement with the common practices of the school mathematics classroom" (Boaler, 2000, p. 114). Though she was speaking of their content knowledge, she also made clear that their attitudes toward mathematics were strongly influenced by the classroom environment. Any teacher using reform mathematics curricula in a traditional setting has confronted this powerful socialization. One might therefore assume that students using mathematics to make sense of real-world phenomena that relate to their lives would develop different dispositions toward mathematics. At the risk of oversimplifying, in a sense we learn what we do, and conversely, we do what we learn.

However, finding evidence to support changed orientations is not easy, because they are internal. Yes, they manifest themselves in action, but inferring dispositions can be difficult. One data source is an open-ended survey the students completed at the end of eighth grade. The survey was anonymous, and, as usual, I exhorted my students to be honest. The school year was essentially over, and all the students were sure of graduating and already knew the high schools they would attend. It was clear that I no longer had the standard power over students that teachers have. Although self-reporting is a problematic data source, my observations and their work corroborated their responses. I believe that they accurately represented their feelings, thoughts, and beliefs.

Two of the questions are particularly relevant to this issue, #7: "How have your views about mathematics changed from being in my class the past 2 years? Please be specific," and #9: "Do you feel you are now better able to understand the world using math? Examples?" On question #7, of the 25 responses, all but 3 students wrote that their views had changed, at times in more than one way (so totals exceed 25). Two wrote that they disliked math more than they had previously. Two students wrote that their views changed but could not say how. One wrote that she knew that giving explanations was part of math and that math problems often had more than one answer. Another wrote that she knew math problems could be "figured out on our own," and two responded that they now knew that there was

more than one way to solve a problem. What is interesting is that only 4 students wrote about issues of mathematical power—however, 16 wrote about using mathematics to understand the world.

Students wrote things such as “Have also learned that mathematics is an everyday thing,” “One main view that has changed was how does math really help solve problems in the world,” “How to connect math to the outside world,” and “I learned that it’s a useful and powerful tool.” Others were more explanatory and clarified how their thinking had developed, “Now I feel math isn’t just in a ‘math class.’ [It] is all around the world it’s happening.” And another wrote, “They changed from thinking ‘math is just any other class’ to thinking that math is involved everywhere you are or any situation.” Another wrote about the meaningfulness of mathematics, “I think that now I look at mathematics at a different perspective because at first I just thought of math as operations with numbers, but now I realized that it’s a lot more and that it has meaning.” Other students were even more explicit:

Math to me was just a bunch of numbers where you either multiplied or added. Now you [think] more of comparing it to the real world. It seems more now. Math can be used to explain just about everything unlike before.

And finally, one student summed up the changed orientation for many:

Well, I thought of mathematics as another subject in school that I hated. And I didn’t bother to think too much about world issues or everyday issues. Now I know it all relates. And I’ve learned how powerful math can be to help us explain our decisions and help us express ourselves, because like I said before, math makes things more clear.

Question #9 was: “Do you feel now you are better able to understand the world using math? Examples?” Here, students were even more definitive. Of the 23 answers, 20 said yes, 2 said no, and 1 said “sort of” (the 2 who said “no” also wrote that their views on math had not changed). Even the two students who reported disliking math more after my class said they could understand the world better using math. As one student wrote:

Yes, I think I’m able to understand the world with math. All the math problems, projects, discussions about drug testing, Chicano history, etc. have made me understand because knowing about those issues and the discussions that we did made me think of what math might be involved. The math that we did helped me even more.

A couple of others gave specific examples: “Yes, I am An example would be when we used the cookies, now there we used the whole world.” Another student mentioned other projects:

Oh, of course! Like learning about the Mercator map and learning about the world using math to see the inaccuracy of the map. I learned more about tomato pickers and tif’s [a development financing scheme] concerning the problems people face and the unfairness of it all.

And finally, the student who claimed that she hated math after my class wrote:

I think that now I can understand the world better by using math, but that doesn’t mean I like connecting math with what surrounds me. I still think that there are some “BIG IDEAS” you can understand without using math.

The majority of my students reported that their attitude toward mathematics had changed. Almost all reported that they felt more able to understand the world using math, and because of its usefulness, their views had changed.

There are some caveats here. First, I did not see students spontaneously approach a situation in the world and use mathematics to make sense of it unless I specifically asked them or suggested it. That does not mean that they did not nor will not do this, but I only saw this on the real-world projects. Thus, it is hard to know if their dispositions toward mathematics fundamentally changed, or if they learned that *within* my class, they needed to use mathematics in this way to get credit for their work, be accepted, be liked by me, or for some other reason. One possible way to investigate this further would be to look at their attitudes over a long period of time. I do know that 2 years after they graduated eighth grade (fall 2001, the start of eleventh grade), I sent all 26 students another survey similar to the one from May of 1999. Although only 10 returned the surveys, all were clear on whether their views on mathematics changed through our class. One wrote:

Well, I never liked math and to this day I'm still not very fond of it. But although before I never realized it, I realize now how extremely important it is to have good mathematics skills so we can fully understand what is going on around us. Believe it or not, math can be incorporated into almost any situation. (I learned that in class.)

Another student:

Also, I thought math was just a subject they implanted on us just because they felt like it, but now I realize that you could use math to defend your rights and realize the injustices around you. I mean you could quickly find an average on any problem, find a percentage on any solution, etc. I mean now I think math is truly necessary and I have to admit it, kinda cool. It's sort of like a pass you could use to try to make the world a better place.

I do not have evidence about the other 16 students, nor do I know how much the 10 who responded really changed their orientation toward mathematics. The evidence is only suggestive, but it is one more indicator that students realized mathematics was a useful tool for reading—and writing—the world.

THE INTERRELATIONSHIP OF *MiC* AND THE REAL-WORLD PROJECTS

Because I am primarily concerned with issues of equity and justice, I considered these questions: What is the relationship of using *MiC* (and perhaps, by extension, other *Standards*-based curricula) to the promotion of social justice? Under what conditions can *MiC* be this kind of support? From my experience, I believe that certain elements of *MiC* *potentially* relate to social justice, but this can only be realized under certain conditions. I do not mean to imply that these conditions are the only ones in which this can occur, but in my situation, these conditions were present.

First, *MiC* potentially helps support a social justice pedagogy through its use of multiple perspectives and its way of encouraging students to develop their own

thinking. A good example is from a statistics unit, “Dealing With Data.” In it, students use actual data on the heights of 1,064 father-son pairs collected in England around 1900. In the unit, the story line has four middle school students all agreeing that the sons are generally taller than their fathers, but for four different reasons. The unit presents each reason and also specifies that everything the four say is true. Students using the unit are asked, “Which of the four statements would you use as an argument? Why?” (p. 4). This type of scenario, in which the text asks students to decide among possible interpretations and/or come up with their own rationale, is common throughout the curriculum.

Second, *MiC* (NCRMSE & Freudenthal Institute, 1998) uses real life for all of its contexts. As stated in the *MiC* philosophy:

Mathematics is a tool to help students make sense of their world. Since mathematics originated from real life, so should mathematics learning. Therefore, *Mathematics in Context* uses real-life situations as a starting point for learning; these contexts illustrate the variety of ways in which students can use mathematics. (p. 4)

However, as illustrated above, *MiC*'s real-life contexts may not connect to students' lives nor provide opportunities to raise questions about the genesis of social inequality. This was often true for my students. In response to a question from an open-ended survey I gave in seventh grade, “Do you like the stories in *Mathematics in Context* and can you relate to them?” one student wrote, “No, we can't relate to them. We don't have family and friends in Africa, we don't go in hot air balloons, we don't go canoeing, we don't go downtown and count cars, they give cheap stories” (Gutstein, 1998). All these contexts were in units that we studied, and this comment summed up the feeling of many of my students.

Thus, using meaningful contexts that go *beyond* those in *MiC* is the first condition under which *MiC* can support teachers who want their students to examine complicated issues like racism and discrimination. No single curriculum will be relevant to all students, and a real-life context is not necessarily a meaningful one. Although using *MiC* may help students learn that mathematics can be used to do many things, students in urban U.S. public schools have little (if any) experience in using mathematics to understand serious life issues of personal importance. If teachers want students to develop a deeper understanding of society with all its complexities, they need to engage them in doing so. That implies that mathematics teachers need to have students use mathematics to investigate contexts embodying justice and equity concerns. *MiC*'s real-world contexts, although not necessarily relevant, provide a backdrop for using mathematics to investigate meaningful ones.

Relevant, meaningful context, however, is only one of the conditions. Equally important is a classroom culture that supports the analysis of such contexts. Teachers and students need to create classrooms where they openly and honestly discuss justice issues. *MiC* does not specifically relate to these conversations. However, the inquiring habits of mind engendered by *MiC* explorations are consistent with a pedagogy that has students question assumptions and sources of knowledge and develop critiques of existing power dynamics in society. By promoting this orientation to

knowledge, *MiC* can play a supportive role in creating such an environment.

The third condition is curricular coherence, that is, the way teachers interconnect various curricular components. In my classroom, various features of the projects and *MiC* supported one another and helped students develop sociopolitical consciousness. For example, *MiC* constantly asked students to justify explanations. So did all the projects. *MiC* was both reading and writing intensive, and the projects were as well. Even beyond these connections, there were specific concepts in *MiC* to which I connected the projects. For example, in the unit “Dealing With Data,” students learned about and created scatterplots. Soon after, my students did the project on ACT and SAT scores. I asked them to create a scatterplot of SAT scores by family income. Although creating a scatterplot of heights of father-son or mother-daughter pairs, as “Dealing With Data” requires, did not engage my students much, making a plot that linked SAT scores and income was far more interesting and helped them raise critical questions. With *that* data, “correlation” took on a powerful and personal meaning, and I believe that the connection between the mathematical ideas in *MiC* and the SAT score differentials helped students understand better both the mathematics and the underachievement on standardized tests of students of color and low-income students.

As much as I could, I related mathematical themes in the projects to specific *MiC* units. For example, after we finished “Cereal Numbers,” in which students studied relative and absolute comparisons, we did a project titled Tomato Pickers Take On the Growers. The students read a *New York Times* article in which they learned that wages for agricultural workers—mainly immigrant Latinos—had gone down in the past 20 years *without* adjusting for inflation. Concepts like cost of living, inflation, and graphing were in both the *MiC* unit and the project, and I helped students make the connections and use what they had learned in *MiC* to better understand the project.

However, despite being able to do this on occasion, it was difficult to regularly connect the projects and *MiC*—but I was not very worried about this. A mathematical content analysis would show that there were enough relationships between the big curricular ideas of *MiC* and the projects that I did not have to be overly concerned with aligning specific projects with specific units. It would have been ideal to do this routinely, but I was not trying to supplement *MiC* through the projects. After all, *MiC* is a comprehensive, stand-alone curriculum. Its designers did not intend for teachers to reinforce it. My purpose for the projects was broader than just developing mathematical power or even than knowing that mathematics could be used to solve many real-world problems.

On reflection, I realized that the mathematics in the projects was often less challenging than that of *MiC*.⁷ I first noticed this when a student wrote that she would not have understood the world wealth simulation had I not *told* her how to do the math. “Telling” students how to solve problems is *not* what I would claim as my

⁷ But certainly not always. I am not implying that I made the mathematics simplistic. And occasionally it was beyond *MiC* and too difficult for my students.

pedagogy—so her comment made me think twice. She was right. I had done exactly as she said. In the 80-minute period we had for the wealth simulation, I knew there was little time to initiate a discussion about wealth, draw out students' prior knowledge, share the data with the class, have them do the math, distribute ourselves and the wealth, do more math to compare cookies per person per continent, and reflect together as a group. When some students had trouble apportioning the world population to the class population, I felt pressed for time and told them how to find the answers they needed.

This made me reexamine my goals and the pedagogy and mathematics in the projects. I realized that on several projects, I either told students what to do or simplified the mathematics more than I had intended. This helped make clear to me that I was shifting my pedagogical goals at different times. Unfortunately, real tradeoffs exist when teaching multiple content areas. Although I would have preferred not to have to choose among important educational goals, in my real world as a teacher, researcher, and university professor, I was not able to also be a curriculum developer and to try to ensure that every project had the same type of coherence and sophistication that a comprehensive curriculum like *MiC* has. And although I am now more aware of the choices I made and would try harder to do less telling and pay more attention to aligning the projects with *MiC*, I do not consider what I did to be a serious problem.

What justifies the tradeoff? Several things. First, students were learning more than one thing, and it is hard for teachers to integrate curricula and maintain the same level of challenge in each area. To a certain extent, the tradeoff may be unavoidable. But beyond that, I realized that *MiC*'s quality essentially gave me a license to be less concerned about developing students' mathematical power through the projects. Of course I wanted the students to learn mathematics while doing the projects, and the evidence shows they did. But I had less pressure to ensure that occurred, precisely because *MiC* was my fundamental curriculum. Provided that my pedagogy on the projects and on *MiC* was generally consistent—which it was—and provided that there was challenging math and enough opportunities for students to invent solutions on the projects—which there were—I believe that the tradeoff is reasonable. Teachers can further reduce the tradeoffs when they are conscious of them and communicate them explicitly to students (e.g., “OK, I’m going to tell you how to do this, *only* because we’re short on time, because you *know* I never do this normally”).

This freedom to be less concerned about the mathematical aspects of the projects may have been the most important relationship of *MiC* to the real-world projects, under the given conditions. From the standpoint of teaching for social justice, the projects (and the classroom culture) were a priority, with *MiC* being a collaborating partner because of its real-world contexts, its promotion of an inquiring mind, and so on. But from the perspective of teaching mathematics and having students develop mathematical power, *MiC* played the leading role. That leading role let me develop the projects with a focus more on the social justice aspects and less on the mathematical ones.

CONCLUSION

I have presented here an example of what teaching mathematics for social justice looks like in an urban, Latino school. To reiterate, teaching for social justice, as I perceive it, has three components: helping students develop sociopolitical consciousness, a sense of agency, and positive social and cultural identities. I have focused here on the development of students' sociopolitical consciousness, which for me, in this context, was analogous to reading the world with mathematics. I believe an important lesson from this research is that it is possible to teach mathematics so that students begin to read the world with mathematics, develop mathematical power, and change their dispositions toward mathematics through the process. It is, however, a complicated process for both teacher and students, with many contradictions and complexities.

I have also argued that curricula like *MiC* can theoretically support a social justice pedagogy, under certain conditions. The development of "critical thinking skills" is an implicitly hoped-for outcome of using the NCTM's *Standards*. We can conjecture that a curriculum based on and aligned with the *Standards* should (and presumably would) help develop those skills. As Ladson-Billings (1994) puts it, "thinking critically" is something students need to struggle successfully against racism and for justice. One can argue that a curriculum like *MiC* can play a role in teaching for social justice because it helps develop the critical thinking that is necessary in the struggle for equity and justice. In fact, in earlier work, we (Gutstein et al., 1997) argued a similar point about the theoretical relationship of NCTM-based pedagogy to the goals of culturally relevant teaching (Ladson-Billings, 1995b). Although not identical to how I describe teaching for social justice, culturally relevant teaching is strongly oriented toward equity and justice (Tate, 1995).

However, this is mainly a theoretical argument, because there is little experience in teaching mathematics for social justice in K–12 classrooms using an NCTM's *Standards*-based curriculum as the mathematical foundation. In this study, I document one teacher's efforts—my own—to enact this relationship in practice and draw out lessons and implications from the experience. I believe it is worthwhile to recapitulate some of the important things I learned in the process.

Virtually all my students began the process of reading the world with mathematics, although this was a nonlinear process. This is evident from their writing and work on the real-world projects. The projects they completed, which contained issues of differential treatment and experiences facing people of color, low-income people, and immigrants, provided contexts in which they used mathematics to make sense of and learn about issues that were important to them and relevant to their lives and communities. These projects were the major site of learning to read the world, but *MiC* contributed as well.

My students almost all also developed mathematical power. As a class, they invented their own solution methods, solved problems in multiple ways, generated multiple solutions when appropriate, reasoned mathematically, communicated

their findings both orally and in writing, and developed their mathematical and personal confidence. Their mathematical sophistication and maturity varied, but all succeeded on conventional measures and most graduated into magnet, college-prep high schools. *MiC* was the primary vehicle that helped them develop mathematical power, with the real-world projects also playing a role.

Through their practice of reading the world with mathematics, the students began to change how they felt about mathematics. Although not all loved math, virtually all understood that mathematics was a tool not only to solve both realistic and fanciful, sometimes enjoyable, problems in books, but it could also be used to dissect society and understand inequality. For the most part, they believed themselves capable of using mathematics to better understand social inequities because that was their experience for almost 2 years. That is, they learned what they practiced, and immersed in a classroom culture where mathematics played this role, these students took on a different belief system about the nature of mathematics. This transformation was a beginning, like learning to read the world, and it is hard to know whether or how it will develop over time.

MiC and the real-world projects played mutually supportive roles and had strong interconnections. To help the students develop sociopolitical consciousness, I asked them to use mathematics on real-world, justice-oriented projects that complemented but went beyond *MiC*'s real-life, but usually nonrelevant situations. I had to work with them to create a classroom culture that went beyond the mathematics and normalized taboo topics, to which *MiC*'s promotion of multiple viewpoints and critical perspectives contributed. I needed to connect and make coherent the two curricular components, and although there certainly were areas in which I could have improved, my pedagogy was generally consistent, and I was able to specifically link some of the important mathematical content areas. Finally, and possibly most important, I came to understand that in the real world there are some implicit and perhaps inevitable tradeoffs between developing mathematical power and helping students learn to read the world with mathematics—and how to possibly reduce these by being conscious of, and explicit to students about, the various tradeoffs.

Of the various conditions that contributed to my students' growth, I believe that the primary one was the way they and I cocreated a classroom environment in which they discussed meaningful and important issues of justice and equity (Gutstein, 2002b). The impetus was mine, but each student walked into the classroom with a powerful sense of justice stemming from her or his life experiences as a member of a marginalized community subject to immigration raids; police harassment; low-paying, dead-end, exhausting jobs; and various other forms of race, social-class, and language-status discrimination (Gutstein, 2002a). This sense of justice, though at times mitigated by aspirations of an immigrant community to "make it" in a land of hoped-for opportunity (Ogbu, 1987), became a starting point for normalizing taboo topics and for the real-world projects. Issues my students cared about—from the conditions of immigrant farm laborers to SAT scores to wealth inequality to unfairness in advertising—were ultimately meaningful because of their sense of

justice and shared experiences. The interrelationship of the goals of teaching for social justice and the students' deeply felt emotions and values allowed us to create together a classroom in which they could study real-life, relevant issues *and* develop mathematical power. A question some have raised to me, and for which I do not have an answer, is how might teaching for social justice in a white, middle-to-upper-income, suburban school be different?

I believe that my students could have developed mathematical power without the projects, but could they have learned to read the world using mathematics without *MiC*? While that, too, is an open question, I know that beyond what I discuss here, there is the issue of just how much mathematics students need to read the world. It is my experience that youth (and adults) sometimes gravitate to shallow explanations and avoid subtlety and complexity. Wealth distribution can seem quite black and white, and not every classroom will have a Marisol to take the analysis one step further. *MiC* raised the level of mathematical sophistication and helped combat the inclination to seek simplistic solutions. As these young people grow and become actors in a changing society, they will need sharper tools of mathematical analysis than they developed in my class, and the maturity that *MiC* helped to bring about definitely serves as a basis for the future.

Lubienski (2000) and Boaler (1997, 1998) raised a related issue about working-class students learning mathematics in ways more or less congruent with NCTM recommendations, but they differed in their findings. At the risk of oversimplifying, Lubienski questioned whether "open, contextualized" problems in an NCTM-aligned curriculum benefited the students she taught, whereas Boaler found that an "open" curriculum and pedagogy significantly benefited those she observed. There are significant differences in setting, methodology, curriculum, pedagogy, and goals between each of their reports and mine, but there are also similarities in the social class of the students.

Spanning both their work and mine is the larger question I posed at the start of this article about the relationship of *Standards*-based curricula to equity and justice. On the basis of my research, I believe that curricula like these *can* increase equity by raising working-class students' mathematics achievement and improving their opportunities (e.g., admission to magnet high schools), but we need to be *very* vigilant and heed Secada's (1996) warning: *Standards*-based curricula can exacerbate differentials based on existing opportunity-to-learn inequities (e.g., qualified teachers) and language issues. More important, from my perspective, these curricula *can potentially* play an important role in the larger effort for justice, but, as I explain here, certain conditions were present. An open question is, Under what other conditions might these curricula play this role?

I also began this article with the premise that one way to increase and promote educational equity is to teach for social justice and help students develop as conscious agents of change, so that they can struggle successfully against oppression (Ladson-Billings, 2001). As Freire writes, learning to read the world is part of learning to write the world. My initial premise is really an argument for a broadened view of working for educational equity. Beyond the myriad ways that

equity has been approached in mathematics education lies also the possibility of a more explicit focus in the classroom. Teachers can promote more equitable classrooms by helping students explicitly and consciously use mathematics itself as a tool to understand and analyze the injustices in society. Mathematics educators might reflect on different ways to address the equity principle in the *Principles and Standards* (NCTM, 2000), including the suggestions in this article, and consider alternative, more overt approaches toward the goal of democratic citizenship and a more just society.

But one cannot easily know how our 2 years together helped students develop more as agents of change, nor in fact, whether helping them do so will contribute to justice in society. Life changes are hard to document, even if one follows them through the years (which I have been doing), and it is difficult to attribute students' development to any particular events, especially those in school. What I can do is to leave readers with four short vignettes that may at least raise possibilities and hopes for the future and point to this area for future research in mathematics education and education at large.

- When Lupe was in 10th grade, she saw a late-night television report about violent vigilantism against Mexicans without documents crossing the border into Arizona. My phone rang at midnight, and in a horrified and furious voice, she asked me, "What can we do about this? We have to do something!"
- In a second incident, Marisol, who earlier had reported hating math, filled out an application to a Latino leadership program (also as a sophomore) and wrote about what she saw as the impact of the class. I had no idea about this until she mailed me a copy. She wrote:

For example, he showed us how hauntingly incorrect our world maps are by letting us compare one of the maps used in today's society with a Peters Projection map. Through math we discovered how unproportioned the countries are to each other in a regular map, and why that was so. . . . Throughout my two years of having him as a teacher, we *always* had math assignments that dealt with important issues in some way or another. . . . He taught me how to think about the world through more critical eyes.

She finished her essay with these words:

But whatever I choose to do I know that it will involve helping people in one way or another. I don't want to do something that will only bring money to my paycheck, I want to do something that will also bring justice to the world and to our society.

- A third story is about how Elena made a scathing critique of racism in a 10th-grade essay on the Declaration of Independence—and used mathematics. She wrote, "We have been called 'minorities' even though we are not. Statistics say that by the year 2025 the population of Latinos will be greater than any other racial group, so you tell me ARE we a 'minority?'" She made her mother, a Rivera aid, find me and give me a copy of the essay. This relates to a project we did in eighth grade about U.S. and world racial population proportions (from Frankenstein, 1997).

- And finally, Freida returned to the Dominican Republic but spent the summer between 10th and 11th grades in the United States. That summer (2001), she told me that she had taken her copy of the Peters Projection world map to her social studies teacher (I gave each class member an 11" by 17" laminated Peters map for graduation). Her teacher told her, "Get that thing out of here." Undaunted, Freida took the map to her classmates and continued to advocate for what she called the "correct" representation of the world. As Freida wrote to me that summer, "you could use math to defend your rights and realize injustices around you . . . it's sort of like a pass you could use to try to make the world a better place."

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