

How Do I Teach Mathematics in a Culturally Responsive Way?

Identifying Empowering Teaching Practices

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Context and Purpose

I am a middle-school mathematics teacher in an urban school. How do I teach mathematics in a culturally responsive way to my urban students? What does this mean? I know I am White and that my students' culture is different from me. I also know that I am from a middle-class background and most of my students come from a poverty background. I know I have to respect my students' culture by including and celebrating Black mathematicians and I do this, but my students are still not learning mathematics successfully. My principal says I am not teaching in a culturally responsive way. So I am confused. I do not know what culturally responsive mathematics teaching means? My goal for this course is to learn how to teach mathematics in a culturally responsive way. How do I teach mathematics in a culturally responsive way? (European-American teacher, Summer, 2008)

Often students' inquiry can be a great teachable moment as well as a "researchable moment." Today, even though much has been written about culturally responsive teaching, I am often surprised to find that the notion of culturally responsive teaching does not resonate with urban teachers and when it does, they do not know how to teach their specific subjects from that pedagogical stance.

The teacher's comment above represents the frustrations of many teachers I encounter in urban schools and in my teacher education classes, teachers who struggle to teach in ways that are responsive to their students. As a multicultural educator, I teach several required diversity courses in our teacher education graduate program at my institution. On the first day of each semester, I engage students

in identifying and sharing the goals/expectations they have for the course they are enrolled in. Generally, students want to learn strategies to effectively teach diverse students as well as how to plan and teach multicultural curriculum and lessons.

A few years ago, in the course "Teaching and Learning in Urban Classrooms," as I typed up the goals and expectations that students wrote, I noticed that several students had listed the same goal—"I want to know how to teach mathematics and science in a culturally responsive way." In particular, one teacher wrote, "Why can't I find help in being a culturally relevant mathematics teacher; all the examples I hear are about history and English teachers?"

As I reflected on the goals and questions students listed, I said to myself, this is a "researchable moment." A year ago, I decided to investigate why teachers are not teaching in a culturally responsive way in their subject areas and what it would mean to teach content areas in culturally responsive ways. The purpose of this article is to report on one aspect of that study—*why* are teachers not engaged in culturally responsive mathematics teaching practices and *what* are culturally responsive mathematics teaching practices.

Theoretical Framework

In many urban school communities across the nation, research and reports indicate that high numbers of urban and low-income children and youth are experiencing dismal academic and personal failure and performing significantly below their White, middle-class peers on all measures of academic achievement, including standardized test scores, rates of graduation, and college matriculation (Haycock, 1998; National Center for Education Statistics, 2003; U.S. Department of Education, 2000; Zuniga-Hill & Barnes, 1995).

The consequences of this under-

achievement for urban students includes the creation of future citizens who will not be productive and contributing members of their families, communities, nation, and the world. Most leading organizations and agencies as well as scholars have recognized the grave consequences resulting from the failure to adequately prepare America's children and youth for 21st century realities.

In particular, organizations such as the National Science Foundation (NSF), the National Council of Teachers of Mathematics (NCTM), and the National Research Council (NRC) are very concerned and their concerns are legitimate. For instance, data show that, in 1995, Blacks were 15 percent of the U.S. population but earned only 1.8% of the Ph.D.s in computer science, 2.1% of those in engineering, 1.5% in the physical sciences, and 0.6% in mathematics (U.S. Census, 1998). Data for other minority groups are bleak as well.

Nationally, while 73% of White 8th-grade students scored at or above basic achievement levels on the 1992 NAEP, only 26% of Black students, and 37% of Hispanic students scored at or above the same level. Also, while 52% of White students enrolled in Algebra II in 1990, only 39% of Black students and 39% of Hispanic students did. In calculus, 11% of all White students were enrolled while only 4% of Black students and 7% of Hispanic students were enrolled (NCES, 1993).

Although the 2007 NAEP data showed that minority students achieved some gains compared to two decades ago, there was no change in the White and Black/Hispanics achievement gap (NCES, 2007). Mathematics or mathematics literacy, like science and technology (STEM), continues to be a gatekeeper to educational and personal success in the 21st century. And for urban/minority students, the stakes couldn't be higher. Bob Moses (2001), founder of *The Algebra Project* explains,

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Today, I want to argue [that] the most urgent social issue affecting poor people and people of color is economic access. In today's world, economic access and full citizenship depend crucially on mathematics and scientific literacy. I believe that the absence of math literacy in urban and rural communities in this country is an issue as urgent as the lack of registered Black voters in Mississippi was in 1961. (p. 5)

Crisis in Mathematics

The crisis in mathematics learning among minority and low-income students is a great concern given that mathematical literacy is considered a valuable knowledge and skill in an increasingly competitive global economy and politically interdependent world. Today emerging research suggests that the crisis in mathematics learning among urban and low-income students is caused by school policies, curricula, and teaching practices that do not engage those students.

This emerging research contrasts with earlier notions which suggested that urban and low income students lack the ability to learn mathematics. Rather, it is now suggested that most practices in urban schools do not consider and capitalize on the rich cultural capital that urban students bring to the teaching/learning process in order to make mathematics learning successful for them (Ladson-Billings, 1997; Gay, 2000; Gutierrez, 2000; NCTM, 2000; Tate, 2005).

In fact, Martin Haberman (1991) uses the term "pedagogy of poverty" to describe the unresponsive teaching practices in urban schools. Further, research suggests that one of the problems contributing to urban students' academic underachievement is the lack of access and opportunity to learn (Ladson-Billings, 2000; Lee, 2006; Nieto, 2000; Oakes & Lipton, 2007). Lee (2006) believes this lack of access creates a learning gap and therefore an achievement gap. Tracking has been documented as contributing to the lack of access and has a deleterious effect on urban and low-income students' academic success and advancement.

For example, research shows that most elementary schools across the nation use ability grouping while most high schools group students by curricular tracks—college preparatory, honors, AP, general, and vocational. Studies also show that ability grouping is more prevalent in mathematics at the high school level where tracking practices are the norm. Oakes and Lipton (2007) document that high-track students

receive rich and challenging curriculum and therefore experience more on-task learning opportunities, high expectations, and more instructional practice while low-track students receive watered-down curriculum and less rigorous and challenging work.

Sonia Nieto (2003) also addresses the effects of tracking that keep minority students from gaining access to pre-college and high-status mathematics. In her article, "Equity and Opportunity: Profoundly Multicultural Questions," she asks, "Who's taking calculus?" She notes that while 12% of White students are enrolled in calculus, only 6.6% of African Americans and 6.2% of Latinos and Native Americans are enrolled. These tracking practices contradict best practices recommended by the National Council of Teachers of Mathematics (NCTM, 2000) and fail to reflect culturally responsive teaching.

Culturally Responsive Pedagogy

This article draws on the theoretical frameworks of culturally responsive pedagogy. Over the years the dominant teaching practice in mathematics (as well as other subjects) for urban students has followed a traditional approach that is based on linear and dualistic thinking (right or wrong, one correct answer) and views the teaching and learning of mathematics as solely objective and culturally-neutral. These conceptions and practices in mathematics do not meet the learning and problem-solving styles and processes of most urban students and have immensely contributed to their low motivation and lack of interest and success in mathematics learning (Tate, 2005).

In fact, most scholars of culturally responsive teaching view cultural bias in mathematics instruction as a major factor affecting urban students' success in mathematics and other science subjects (Gay, 2000; Tate, 2005). Consequently, researchers have called for more appropriate and more responsive practices, now described as culturally responsive teaching (Gay, 2000; Ladson-Billings, 1994; Nieto, 2000; Tate, 2005).

Culturally responsive teaching has been defined as an approach to teaching that uses students' cultural knowledge as a 'conduit' to facilitate the teaching-learning process (Assembly of Alaska Native Educators, 1999; Ladson-Billings, 1994; Villegas & Lucas, 2002). Studies on culturally responsive teaching have reported positive effect on students' learning (Ladson-Billings, 1994; Pewewardy, 1992).

In mathematics the notion of culturally responsive teaching has been conceptu-

alized as ethnomathematics (D'Ambrosio, 1997), which is defined as the study of mathematics that considers and integrates the culture in which mathematics arises or how different cultures "go about the tasks of classifying, ordering, counting, measuring or mathematizing their environment" (Ortiz-Franco, 2005).

Contrary to Western perspective, the concept and discipline of mathematics is not "universal." Despite what some may think, mathematics is only universal to those who share a particular cultural and historical perspective. Drawing on the concept of "afrocentricism"—the idea of locating students within the context of their own cultural frame of reference (Asante, 1991) during teaching and learning, Tate (1995) argues that the failure to "center" African Americans in the process of mathematics learning contributes to their failure to learn and understand mathematics. He explains that failing to provide African American students with curriculum, instruction, and assessment that are centered on their experiences, culture, and traditions, is a major obstacle to providing them with an empowering mathematical experience.

NCTM (2000) recognizes the role and importance of culture and learning as a socio-cultural process. Consequently, the organization has developed standards that include teachers' understanding of how students' cultural, linguistic, ethnic, racial, gender, and socioeconomic background influence their learning of mathematics and, particularly, the role of mathematics in society and culture, and the contribution of various cultures to the advancement of mathematics. Additionally, the NCTM standards suggest pedagogical practices that includes the use of inquiry-based and cooperative learning, which are aspects of culturally responsive teaching.

Given these research groundings and organizational policy statements, studies have begun to examine the application and success of the theory of culturally responsive teaching in mathematics. For example, Schoenfield (2000) examined some school districts that have reformed their curricula based on the NCTM standards. The results of this research revealed a significant improvement in students' achievement. With the new curriculum, 50% of the minority students met or exceeded the standard and the proportion of minority students performing well doubled. Schoenfield concludes that a culturally responsive curriculum helps minority students to make sense of the world.

Gutierrez (2000) examined the contextual factors of one high school mathematics department that successfully enhanced urban students' mathematics enrollment in advanced level mathematics. She agreed that the implementation of a rigorous curriculum, active commitment to students, commitment of a collective enterprise or cooperative learning, and instructional scaffolding—practices that align with culturally responsive practice—influenced the tendency of the students to take more mathematics and higher levels of mathematics than their counterparts in other schools (p.100).

Gutierrez specifically noted that effective math teachers of Black and Latino students seek out resources that relate to students' interests and connect to challenging mathematics curriculum concepts. She indicated that they get to know their students well enough to know how to relate new ideas to their lives and personal interests.

In summary, researchers on culturally responsive teaching have outlined core dimensions of culturally responsive teaching that support successful learning for urban and low-income students. These include:

- ◆ Belief in the learnability of students and their capability to do rigorous and high-level mathematics (high expectation);
- ◆ Providing instructional scaffolding that supports student success;
- ◆ Knowing and caring about students; positive teacher-student interactions and relationships in a learning community; promoting cooperative, collaborative and collective learning;
- ◆ Contextualizing teaching and learning by connecting what is taught to students' lives and communities; and
- ◆ Engagement in equitable and social justice practice; and integrating students' culture into the official curriculum. (Frankenstein, 2005; Gay, 2000; Gutierrez, 2000; Ladson-Billings, 1994; Tate, 2005)

Thus, given the plethora of scholarship on culturally responsive teaching and NCTM's recommendations for preparing teachers of mathematics for multicultural and culturally responsive mathematics teaching, why are teachers not engaged in culturally responsive mathematics teaching practices?

Design of the Study

The purpose of this qualitative study was to explore teachers' inquiry regarding culturally responsive mathematics

instructional practices and specifically to examine culturally responsive mathematics teaching practices. Two questions guided the study:

1. Given the proliferation of scholarship on culturally responsive teaching, why are teachers not engaged in culturally responsive mathematics teaching practices?
2. What are specific culturally responsive teaching practices in mathematics?

Participants

The participants in this study were both preservice and inservice teachers enrolled in the researcher's graduate course on "Teaching and Learning in Urban Classroom" at a university in a large urban community. There were 45 participants who enrolled in the spring semesters of 2009 and 2010. Thirty-five were Whites, eight were African Americans, and one was Asian American and another was an Asian international student. Thirty-six were females and nine were males. Twenty-five were elementary and 20 were secondary school teachers.

The course is aimed at assisting students to examine an alternative theoretical framework that offers a new vision of the urban learner, socio-cultural characteristics of urban students, and the sociopolitical contexts of schooling in urban school communities. Most importantly, the course aims at examining research related to culturally responsive and transformationist pedagogy and change agency. My role as the course instructor automatically made me a participant in the development, analysis, and interpretation of the study (Patton, 2002).

Data

The data for the study were collected at the beginning and toward the end of the courses. Specifically, data collected involved structured in-class activities, online discussions, and the researcher's field notes. The structured activities involved prompts that were posted to the class following the researcher's review of students' personal goals and questions for the course.

The first structured in-class activity occurred during the second week of class and addressed the first prompt and research question: Why are teachers not teaching mathematics in a culturally responsive way? The second structured in-class activity occurred during the tenth week of the course and addressed the second research question: What are

culturally responsive teaching practices in mathematics instruction?

Prior to this second activity, following a series of learning experiences and rigorous and complex conversations, participants had become familiar with the discourse on culturally responsive teaching, perspectives on responsive curriculum and reading texts such as *Culturally Responsive Teaching: Theory, Research & Practice* (Gay, 2000), *The Dreamkeepers: Successful Teachers of African Americans* (Ladson-Billings, 1994) and *Teaching to Change the World* (Oakes & Lipton, 2007).

For the structured activities, participants were first asked to work individually to complete the activities and then put in small groups to discuss and generate a list of their collective ideas. Each group then shared their list of ideas. Similarly, for the second activity, participants were assigned into groups to read, identify, and summarize culturally responsive mathematics teaching practices. In addition, participants were engaged in online discussions that allowed them to dialogue about culture curricular and pedagogical practices.

For example, three discussion topics were posted:

1. Does culture matter in teaching and learning?
2. Can teachers engage in culturally responsive curricular practice given today's high-stakes testing and what would it mean to do culturally responsive curriculum in math, science, etc? and
3. Is tracking practice equitable and just, and what would a detracked classroom look like?

The researcher reviewed the discussion threads and identified pertinent ideas related to culturally responsive mathematics teaching practices. The researcher collected the lists, read, identified, and analyzed the major themes (Marshall & Rossman, 1999; Straus & Corbin, 1998).

Results and Discussion: First Research Question

For the first research question—Why are teachers not engaged in culturally responsive mathematics teaching?—the data revealed four major themes:

1. View of mathematics as culturally-neutral;
2. Convenience and dominance of textbook-based mathematics instruction;
3. Curriculum standardization and high-stakes testing; and

4. lack of culturally responsive mathematics teaching models to emulate.

These are discussed in the following four sections.

1. View of Mathematics as Culturally-Neutral

Participants presented that mathematics is an abstract subject, a “universal language,” that numbers are the same across time, culture, and space, and therefore, mathematics instruction does not have anything to do with culture. As one group noted,

mathematics is numbers and does not have anything to do with culture, so while culturally relevant teaching lends nicely to social studies, language arts and the arts, it does not apply in mathematics teaching and learning.

Another substantive comment from one group was:

Being brutally honest, as a math teacher, I never really thought about the approach to mathematics as needing any diversity. After all, math is universal, the occurrence of uniform and consistent concepts, never changing through time. I must admit that before attending this course I had no idea that culture had anything to do with mathematics, let alone teaching from a culturally responsive way. I knew that I wanted to engage my students in real-world projects and did so, but that was the extent of my knowledge. Now I truly feel guilty; as though I've put my former students at a disadvantage because I was not teaching my math curriculum that was culturally responsive.

2. Convenience and Dominance of Textbook-Based Mathematics Instruction

Participants presented that, like most other subjects, mathematics instruction is teacher-directed and textbook-based. Participants viewed the convenience of textbook-based curriculum, which makes it difficult for teachers to think outside and about culturally responsive mathematics instruction. Participants also noted that school districts purchase prepackaged curriculum materials that teachers must teach verbatim and that failure to follow the mandated curriculum materials can put one in trouble. One comment was:

Our district is very concerned about testing. As a math teacher I definitely feel the pressure of covering our state standards and so must follow the curriculum and textbook for my grade level. In the face of this strong Bureaucracy one often finds

that “giving up” or rather “fitting in” is the easiest method of retaining one’s sanity.

3. Curriculum Standardization and High-Stakes Testing

Participants noted that teachers feel pressured to increase students’ test scores and so teach to the test. Because of this pressure to raise test scores, many teachers feel restricted and powerless to teach in ways that are culturally responsive to meet their students’ needs. More importantly, the participants commented that the urban school district’s adoption of the *Success for All* (Missouri) program mandates scripted instruction and limits teachers’ ability to consider other ways of teaching mathematics. For example, one participant made the following comment:

In these days of high stakes testing and NCLB, the fate of a school hinges on how well its students perform on various state mandated tests. Due to these tests, a great deal of pressure is placed on schools and teachers to make certain that students perform adequately. As a result, many schools simply teach to the test, often at the expense of any real learning taking place.

Another comment pointed to schools’ inability to respond to diversity and embrace multicultural education:

The demand for accountability has led to increased focus on “core curriculum” content, standardized testing, and standardization in teaching that has left many classroom teachers from doing “diversity” and “multicultural education; that when teaching mathematics lessons you are given exactly what to say and what to do.

Participants resoundingly agreed that, in their school districts, administrators mandate specific curriculum and scripted instruction and do not support anything that deviates from the standard. As one group noted,

because we are working so hard to improve our test scores in the district, much of our time is spent teaching traditional math curriculum.

4. Lack of Culturally Responsive Mathematics Teaching Models to Emulate

Participants expressed that culturally responsive teaching is a new concept to them. Some phrases used to describe this non-awareness include: “uninformed—never seen in it action” and “never heard of it.” As noted in some groups’ lists,

We did not even know about culturally responsive teaching until hearing about

it the first day of class and from the title of one of the textbooks required for the course.

We do not know what culturally responsive teaching in mathematics looks like.

Participants also noted that college courses they had taken did not discuss culturally responsive teaching let alone modeling it so do not know what it looks like. During the whole group class discussion, a math teacher who had taught in an urban school for five years, made the comment:

Before taking this course I had never heard of culturally responsive mathematics curriculum. I was aware that students in the urban core may require different instructional practices, for instance, more time or repetition on a specific concept.

Another comment from one list stated,

When considering how districts prepare teachers for urban schools, I think it is important to see good examples in action. We currently have some sort of mentor program but none talks about culturally responsive teaching.

Results and Discussion: Second Research Question

For the second research question—What are culturally responsive mathematics teaching practices—the data revealed several themes, but first participants recognized that culturally responsive mathematics teaching is encompassing, multidimensional (Gay, 2000), and goes beyond curricular effort. Seven major themes emerged from the data:

1. Deconstruct misguided beliefs about mathematics teaching and learning;
2. Integrate culturally relevant content and social and justice issues;
3. Utilizing culturally responsive instructional strategies;
4. Foster communal learning;
5. Openness to students’ divergent thinking and problem-solving;
6. Detrack the mathematics classroom; and
7. Teacher’s critical consciousness, advocacy, and activism.

As a researcher-participant in the study, I have drawn on my experience and insights as I developed, contextualized, and discussed these themes in order to enhance their meanings.

Deconstruct Misguided Beliefs about Mathematics Teaching and Learning

Participants noted that culturally responsive mathematics must first begin with the classroom teacher deconstructing beliefs about mathematics as a culturally-neutral subject, as universal truth, as a non-reasoning system, and, as an exclusively European and Western discipline. Participants commented that to teach mathematics from a culturally responsive way means that teachers cultivate a different understanding that begins with the conviction that mathematics is a human activity that is grounded in people's culture and their "attempts to describe and understand physical and social phenomena" (Mukhopadhyay & Greer, 2001).

That is, teachers understand that mathematics and mathematical knowledge is not culturally-neutral, absolutist, or universal. Rather, it is situated within a sociocultural frame of a given cultural group. Hence most researchers on culturally responsive mathematics teaching have posited that different cultures have their ways of thinking about and doing mathematics that differ from others (D'Ambrosio, 1997). Thus, students who come from different cultural backgrounds enter the teaching and learning process with their cultural thinking and processing styles when doing mathematics, and teachers must understand this.

For example, Tate (2005) illustrates with an example of how culture impacts on student's learning of mathematics. He describes a situation in which he observed a student teacher stating a mathematical problem using pumpkin pies. Tate explains that, while apparently other European American students were intrinsically involved in solving the problem, one student, an African-American student, was disengaged. When asked about the student disengagement, the student teacher replied, "Oh, he does not like math." While the student teacher thought she was engaging in a culturally relevant pedagogy because Thanksgiving was in the air (and yes, she was culturally responsive to her European American students), the student teacher failed to realize that pumpkin pie was not universal to all. In fact, for most African Americans, sweet potato pie would resonate more.

Participants commented that many of their diverse and urban students often lack motivation in learning mathematics and say that they are not good in mathematics. That is, these students are described

to exhibit the lack of what researchers call *mathematical identity* and *socialization* (Martin, 2000; Zaslavsky, 1998)—the perception of one's disposition and self-efficacy in mathematics learning and performance and especially the inability to recognize the relevance of mathematics to their lives and realities (Berry, 2008; Gutstein, 2006; Martin, 2000).

For example, high school students of color who were asked why they had not enrolled in higher level courses replied with the following reasons, "I didn't know that I could, and I don't want to fail" (Banks, 2005). One study participant made the comment: "I have found that many of my students come to me both afraid of and disliking math." Participants suggested that teachers must empower urban and diverse students to construct a strong "mathematical identity" and to deconstruct the belief that they are incapable of learning mathematics.

This is a critical aspect of culturally responsive mathematics teaching. Teachers must have faith that their urban students can learn mathematics and, more importantly, convey it to them. For instance, in the popular movie *Stand and Deliver* (1990), Jamie Escalante conveyed this belief to his predominantly Latino American students at Garfield High School in East Los Angeles, by saying that mathematics is in their blood, because their ancestors, the Mayans, were the first to conceptualize the concept of "Zero." He impressed upon them, "You Burros have math in your blood." This altered the disposition of the students to the extent that not only did they learn mathematics, they were the highest-scoring school on the ACT that year. Teachers must de-racialize mathematics and help urban students understand that mathematics is created and practiced by all peoples (Joseph, 1992) and across all cultures.

Nothing can be more empowering than dispelling misconceptions. Teachers should locate mathematicians of students' background to prove that people of their race/ethnicity do math and do it well. Further, inform students that if they can use money, they have math in their DNA and thus can do math.

Integrate Culturally Relevant Content and Social Issues

Integrating culturally relevant content into mathematics teaching is very challenging for teachers. In his description of multicultural education, Banks (2005) explains integration of multicultural content

to mean the use of examples, metaphors, and perspectives from different cultural frames when examining concepts, theories, paradigms, etc. Through a series of experiences in the course, participants agreed that doing culturally responsive teaching involves integrating culturally relevant content into the mathematics curriculum.

Participants identified specific ways to integrate multicultural or culturally relevant content. These include: using word problems that are culturally familiar; integrating social issues relevant to the students' community; and evaluating instructional materials and resources for hidden curriculum and bias. Participants provided examples of how they have attempted to do culturally responsive mathematics since learning about culturally responsive teaching. For example, in one of the one discussion threads, one participant shared:

I teach in an urban school and my students are 68% African Americans, 30% Hispanics, and 2% White. In teaching algebraic equations, I begin by using my students' interests. For example, when I make up a math problem I do not just start it out by writing the problem on the board. Instead, I take the students through series of familiar experiences: I ask the class to shout out their favorite music hip-hop CDs, the artists and their cultural background and then ask them how much the CDs cost, the amount of money the artists earn if they sold X number. I also ask them to research the number of artists of their favorite CDs. Then we work together to turn it into some type of algebra problem. Somehow this seems to get more kids engaged in the math than if I would have just put up numbers on the board that don't relate to the kids' interest.

In particular, participants noted that mathematics presents a great opportunity to teach and help students learn about issues of social, political, and economic justice, especially as an analytical tool for examining and understanding community and societal issues and inequities in an unjust world. Examples of using data about disparities between racial groups and women were identified as powerful ways to help students understand social stratification, inequality, exploitation, and oppression. For example, they suggested that, for urban students, data related to job opportunities, leadership positions, school graduation, sports, and businesses in their community will be motivating for mathematics learning.

For instance, some participants noted that while there are many liquor stores

in their students' communities, there are hardly any grocery stores for shopping. Marilyn Frankenstein (2005) agrees and explains that mathematics is a powerful learning tool for examining, interpreting, and challenging social inequities. She cites examples of how she uses everyday realities like unemployment and data from the U.S. Department of Labor's Bureau of Labor Statistics to help students understand mathematics—fractions and ratios—to read the world and the politics of mathematical knowledge.

Turner and Strawhurn (2007) also discussed examples of how two teachers in a working-class neighborhood school in New York constructed a mathematics unit that integrated issues of equity and student lived experiences. In the unit, middle school students used mathematics to confront overcrowding in their school and learned critical mathematics as they measured spaces, calculated areas, generated data, and questioned the inequities in society as they discovered their school was more crowded than other schools. The students then petitioned the school district to correct the inequities.

Bob Peterson (2005), one of the editors of *Rethinking Schools*, also discusses examples of how he engages his students in studying the mathematics of sweatshop economics and the quantitative injustices built into the wealth and income structure of society and the world. Gutstein (2007) has also developed mathematical curriculum and lessons around the military and the Iraq War—data about human losses, the huge budget for the Iraq war, and who is fighting the war (ethnically, racially, and by gender). Students can use such data to perform mathematical activities such as charting, graphing, and analyzing.

Jan Goodman (2006) describes examples of how she integrates issues of social inequities in a mathematics lesson. For example, she describes how she invites two students, male and female, to perform the same task—to erase the chalkboard—but she then pays the male student \$1 and the female student 74 cents. Students debrief the inequity and then learn that, in the real world, females make 74 cents for every \$1 that a man makes. Goodman explains how students get engaged in analyzing graphs, charts, and problem-solve issues of social inequality.

In today's changing economic and political landscape, ample opportunities exist to connect students' mathematics learning to the real world. For example, in these hard economic times, who is un-

employed? Whose homes are foreclosed? How many people have lost their jobs? What are the effects of unemployment on the family? Who has health insurance? How many people, families, and children are uninsured in America? How do grocery prices compare today?

In 2008, America witnessed a historic election year. How many people voted during the election compared to previous elections? How did females compare to males in their votes? How did different ethnic groups—Whites, African Americans, Latino Americans, Asian Americans, Catholics, Evangelical, etc., vote? How did the youth voters compare to older voters?

These are powerful curriculum activities that many students will find motivating and relevant as members of their families, classmates, and the community directly or indirectly experience such topics. Teachers and writers in *Rethinking Schools*, such as Bob Peterson and Bill Bigelow, are known for their success in integrating students' lives and culture into and across the curriculum.

In their edited book, *Rethinking Mathematics: Teaching Social Justice by the Numbers*, editors Eric Gutstein and Bob Peterson, have compiled powerful articles that describe examples of social justice integration in mathematics. A mathematics curriculum that provides students an opportunity to draw on their everyday knowledge to solve problems that are important to them will clearly be culturally responsive.

Another way the study participants identified for doing culturally responsive mathematics teaching is to use multicultural literature or stories to capture and engage students' imagination, emotion, motivation, and thinking as well as help them understand concepts and ideas better. Most successful mathematics teachers who view mathematics as communication arts have used this approach to help their culturally diverse students learn mathematics successfully. Schiro (2004), in collaboration with a classroom teacher, Doris Dawson, has written a book *Oral Storytelling and Teaching Mathematics* in which she describes examples of mathematical stories that promote students' mathematical skills. These stories can be used to engage students' interest, make them think and explore, and understand mathematical concepts and ideas. Today there is a plethora of literature books on counting and numbers in other languages and cultures that can be used to create interest and help students connect to mathematics in a culturally responsive way.

Integrating cultural or multicultural content into the mathematics curriculum adds meaning, value, and connection for minority students. However, teachers must be cautioned against integrating superficial content that trivializes and stereotypes urban students' lives and their communities. For instance, in an attempt to add cultural content, some teachers have substituted cultural names such as "ten male Indians plus five female Indians equals what?"

Some teachers have also been documented stereotyping students' communities. A case in point was when a teacher once used the example: If Tamika has 10 lbs. of cocaine and Danisha has 5 lbs. of cocaine, how many lbs. of cocaine are there altogether? Or if Tanisha's mom received \$800 in food stamps and Latonya's mother received \$500, who has more and who has less and by how much? In these examples, some teachers may have believed that they were being culturally responsive in their curriculum and instruction, but failed to realize how stereotypical and derogatory they were being—stereotyping the community as drug addicts and dealers and "welfare queens."

Utilize Culturally Responsive Instructional Strategies

Many scholars and studies have reported that mathematics instruction has not been "user unfriendly" for minority students because of the unresponsive student-teacher relationship and interaction, classroom environment, and content presentation (Tobias, 1990). Peterson (2005) also talks about what he calls "number numbness" in which students develop a negative disposition toward mathematics learning because of a pedagogical approach that is based on rote calculations, drill and practice, endless reams of worksheets, and a fetish for the right answer.

Participants in the study identified effective and culturally responsive instructional strategies that include contextualizing learning by using students' language and experiences to engage in mathematics knowledge construction and skill development, scaffolding mathematics instruction through peer support learning (Ladson-Billings, 1994), and using culturally familiar examples, manipulatives, and hands-on-minds-on mathematics activities. An example was one teacher's use of hip-hop music and CDs to motivate and help students learn, thus using word problems that relate to students and creating a learning

environment that affirms each student's cultural self and sense of belonging.

More importantly, participants discussed the need for teachers to help urban students develop effective strategies for thinking and solving problems in a mainstream mind frame, given that standardized tests often reflect mainstream perspectives. That is, when solving mathematical problems that do not provide for explanation of work, students would need to think and process differently, like "European, middle class" individuals do. Lisa Delpit (1995) supports this practice and suggests the need to help urban students acquire the social capital and access to the culture of power for success in mainstream America. This idea emerged from a simulated activity and discussion about a standardized test item in which a group of predominantly African-American high school students used their cultural thinking and processing styles to solve, but then failed the item (Tate, 2005) because their approach was "mathematically incorrect" even though their response was mathematically logical.

Participants also suggested that culturally responsive mathematics instructional practice must first begin with teachers setting high expectations for all students, holding themselves personally responsible if their students are not achieving, creating motivation by demystifying mathematics as culturally neutral, and scaffolding students' learning to ensure their success (Gay, 2000; Ladson-Billings, 1994).

Finally, participants suggested that culturally responsive mathematics teaching requires teacher self-critique and questioning practice (Shor, 1992). Participants suggest that teachers engage in self-critique by asking and personalizing questions that allow them to gain insights such as:

- ◆ Who is learning math in my classroom and who is not, and why?
- ◆ What is my expectation for each of my students in mathematics learning?
- ◆ How am I scaffolding instruction for student mathematics learning?
- ◆ Do I use word problems that are familiar to my students?
- ◆ What social and community issues am I integrating into mathematics curriculum and instruction?
- ◆ Do I allow students to contextualize their thinking when practicing and solving mathematics problems?
- ◆ Am I open to divergent thinking and problem processing style?

- ◆ Do I look only for the right answer that I know?
- ◆ Do I look to understand students' strategies and logic when they engage in mathematical problem solving?
- ◆ How caring and supportive is the learning context I foster?
- ◆ How did each of my students do today?
- ◆ How was I responsive to each of my student today?

Foster Communal Learning

Across the literature on culturally responsive teaching, numerous studies have documented the preferred and dominant learning styles of most minority students, especially African Americans, Latino Americans, and Native Americans, which are cooperative, collaborative, and communal and their influence on positive learning and performance (Boykin, 1986; Boykin & Cunningham, 2001; Dill & Boykin, 2000; Hurley, 1999; Ladson-Billings, 1994; Slavin, 1983).

Participants in the study noted that all the texts they read suggested that minority students are more responsive to learning contexts with communal structure that emphasized cooperative learning. Therefore, the participants concluded, communal learning must be a dimension of culturally responsive mathematics teaching. This is supported by Dill and Boykin's study (2000) with African-American fifth grade students in which they examined three learning contexts such as communalism, peer tutoring, and individual learning, and revealed that participants who studied in the communal learning context recalled significantly more text than those who were assigned to individual contexts.

Urban students, particularly African-American and Latino-American students, live in close-knit family and neighborhood contexts where they learn to work and play together. In school, this cooperative or communal learning frame is discouraged. In fact, students are considered to be "cheating" when they ask for support from their peers. Personally, I once worked with a group of teachers in an alternative teacher education program in a large urban community. The teachers were already placed in classrooms of predominantly Latino-American students prior to attending the workshop on cultural diversity. During the course of the workshop one of the prospective teachers related an experience in which she found her Latino-American students "cheating" because they asked their peers for assistance during an assignment.

Apparently, among the students were those who were proficient in the English language while others new to the country did not speak English. As a result, during instruction and work assignment, the students who did not speak English leaned over to their peers for translation. The teacher supposedly "caught" them, assumed that they were asking for answers, accused them of "cheating," and lectured them that in America "cheating" is wrong. Understandably, the students felt humiliated, left the class, and did not return to school for a few days. How many students are pushed out of school because of this kind of classroom practice and humiliation?

Ladson-Billings (1994) observed that cooperative and collaborative learning formed the core element in the pedagogy of the teachers in her study. In the nationally and internationally acclaimed mathematics and science film *Good Morning, Ms. Toliver* (Peabody PBS, 1992), cooperative and collaborative learning formed the structure for learning as students constantly worked together and engaged in collective learning. Participants suggested ways to foster effective cooperative learning structures in a culturally responsive mathematics classroom:

1. Build trust and relationship among students by having them work frequently in partnerships and small groups;
2. Use heterogeneous grouping structure based on race, gender, ability, language, etc.);
3. Teach democratic values and behaviors, rules, and participation roles; and
4. Create learning tasks that are complex with multiple parts that allow each group member to have a part that contributes to the overall activity goal.

Participants suggested that culturally responsive instructional strategies begin with the teacher setting high expectation (getting students to believe that mathematics is learnable) and caring enough about them to challenge them to the highest level. This is so important for urban and low-income students who have been told directly and indirectly that they are incapable of learning hard subjects like mathematics. For example, Ms. Toliver, in the film *Good Morning, Ms. Toliver* modeled this powerfully when she explains her culturally responsive practice:

I tell each one of my students, from the first day of class, that anyone can learn math. I put them in notice that if they approach the subject with an attitude of "can't do it" or

"I don't like it," then their prophecies will probably come true. I tell them that I don't believe in failure, I do not pity my students' school or home situations. (p. 37)

Culturally responsive teaching strategies also mean providing appropriate scaffolding through the use of familiar language, metaphors, examples, and hands-on learning, thereby tapping into the "funds" of mathematical knowledge students bring to the mathematics classroom. Ms. Toliver (1993) manifested this when she talked about a lesson she developed, entitled "Math Trail," by taking students on a math learning walk from school to the community to help them appreciate their community as a rich cultural capital for learning and to see mathematics at work in their community.

On this "Math Trail," Ms. Toliver instructs students to observe sites along the way and to create mathematics problems about what they see. For example, students create and examine problems such as the number of times a bus stops at a particular bus stop in a given time period, the ratio of "gypsy" cabs to Yellow Cabs in the neighborhood, the geometric shapes and angles in the buildings, etc. In this case, Ms. Toliver becomes what Murrell (2001) calls a "community teacher," a teacher who is aware of and actively researches the knowledge and traditions of his/her students and integrates it into their learning.

Openness to Students' Divergent Thinking and Problem-Solving

Based on simulation exercises about the notion of multiple perspectives, participants noted that culturally responsive mathematics teaching requires teachers to be open to student divergent thinking and problem-solving styles, so that the notion of mathematics as either right or wrong should be discarded. To be culturally responsive in a mathematics classroom is to understand students' mathematical thinking. Tate (2005) agrees and discusses the

"default position" of mathematics curriculum, assessment, and pedagogy" (p. 36).

He describes the experience of middle school urban students who responded incorrectly to a mathematical problem on a standardized test. The test item was constructed as follows: "It costs \$1.50 each way to ride the bus between home and work. A weekly pass is \$16.00. Which is the better deal, paying the daily fare or buying the weekly pass?" The predominantly African-American urban students responded "strangely" to the problem by choosing the weekly pass as the better deal. Unfortunately, the students failed this item because they had contextualized their thinking within the context of their lived experiences as they thought and applied the multiple uses for the pass—working seven days a week (not just five days), going to two or more jobs, for rides to visit relatives, social events, church, and allowing relatives or friends to use it when they are not.

According to the dominant, Eurocentric, and middle-class paradigm of problem solving and mathematical thinking, the students supposedly failed this test item even though their thinking was logical and accurate, because the item was constructed based on a middle-class perspective. According to this European-American perspective, an individual only works five days a week, has other means of transportation to use during the weekend, does not come from a collectivist culture that would consider sharing the pass with relatives, and thus would choose the daily fare, which was cheaper and deemed mathematically "correct."

Actually, participants in this study were engaged in this very scenario. Interestingly, a majority of the participants (98%) chose the daily fare, having used the thinking and processing style of their middle-class position. Through thorough debriefing they became aware of how minority students contextualize their thinking and processing style based on their

cultural and lived experiences, which they then agreed was valid and relevant.

Detrack the Mathematics Classroom

Following an active online discussion on tracking and ability grouping, most participants agreed that to engage in culturally responsive mathematics teaching is to detrack the mathematics classroom, although a few participants viewed tracking to be beneficial because they have personally experienced and valued the opportunities it offered them personally. For instance, as one participant noted,

I teach seventh and eighth grade math. I have students who can't count money, subtract with borrowing, or add decimals. In the same class, I have students who can find percentages, understand measures of central tendency, and solve two-step equations for x . Since math is about learning and exploring new skills, my only options (that I can see) are (1) to teach new skills to the remedial students and let the advanced students help or do busy work, or (2) teach to the advanced students and leave the remedial students further in the dust. While some juggling can be done, I can't really address any topic to the entire class. The result is that some of the class is learning and the others are left behind. After the discussion on differentiated instruction, I can see the need for detracking and how to detrack.

Detracking the mathematics' classroom means exposing all students to the same high-status mathematics curriculum and providing instructional scaffolding that supports their success such as cooperative learning, use of manipulatives, and contextualizing their learning. Teachers associated with *Rethinking Schools*, such as Bill Bigelow and Bob Peterson, to mention a few, have detracked their classrooms (for details, see *Rethinking Mathematics: Teaching for social justice by the number* by Gutstein and Peterson, 2005).

Teacher's Critical Consciousness, Advocacy, and Activism

Finally, participants recognized that part of culturally responsive mathematics teaching involves teachers' critical consciousness, advocacy, and activism. Through both online and structured discussions on standardized testing and culturally responsive teaching, participants noted that teachers' commitment to social justice and to their students is what teaching for social justice and teaching to change the world is about. Participants made several comments that speak to their

Suggested Ways to Foster Effective Cooperative Learning Structures in a Culturally Responsive Mathematics Classroom

1. Build trust and relationship among students by having them work frequently in partnerships and small groups.
2. Use heterogeneous grouping structure based on race, gender, ability, language, etc.
3. Teach democratic values and behaviors, rules, and participation roles.
4. Create learning tasks that are complex with multiple parts that allow each group member to have a part that contributes to the overall activity goal.

sense of advocacy, activism and agency. For instance:

If teachers are to protect learners and learning, which is the ultimate goal, we must exercise our sense of advocacy and agency.

High-stakes testing should not define the way we teach, obviously it is important and matters but it should not deter us from doing what is best for our students, which is being culturally responsive in our practice.

Summary and Conclusion

Bob Moses (2001), author of the *Algebra Project*, argues that if minority/urban students are to be successful in mainstream, capitalist society and the workplace of the future, they must gain access to the “culture of power” (Delpit, 1995), and so he sees algebra as both a crucial gatekeeper and as the key to access to the culture of power and full economic opportunity. He argues that culturally responsive teaching must be an integral element in the mathematics program for minority/urban students—that such pedagogy would promote a spirit of personal responsibility, which will allow students to break out of the vicious cycle of oppression and victimization they experience.

Imperatively, teachers must know and be able to approach their mathematics teaching practices from a culturally responsive framework. Teacher education and professional development activities must clearly engage and model for preservice and inservice teachers how to undertake culturally responsive mathematics teaching. It is one thing to know about the concept but it is extremely important to model it. For example, one participant noted:

I agree we should integrate social justice issues in the math curriculum. One such social justice issue is the prisons and incarceration rates. A good majority of my students have been affected, are currently being affected or will be affected by this issue of incarceration. Because of that and feeling as though it is a pretty emotional issue, I have some reservations about using that specific issue with my students. At the same time, there is certainly that “connection” for the students and I do believe that it would result in some very thought-provoking reflection, ideas and solutions from the students. I feel that I need more direction; how do I know what are the right issues to integrate in the mathematics curriculum and discuss?

The latter sections of this article have

focused on ways to undertake culturally responsive mathematics teaching. Culturally responsive teaching is multidimensional and involves a teacher transformationist pedagogy that includes designing and implementing culturally responsive curriculum and pedagogy, student empowerment, and mathematical identity development (Gay, 2000).

Giving the critical role of mathematical literacy in today’s knowledge-based and scientific-based society, urban and diverse students must be empowered to develop a strong *mathematical identity and literacy* if we as educators are to foster their critical citizenship and upward mobility. To achieve this goal requires teachers to develop the habits and mind of culturally responsive practice.

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