

Culturally Relevant Mathematics Teaching in a Mexican American Context

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This article examines mathematics instruction and its intersection with culturally relevant teaching in an elementary/middle school in a Mexican American community. The findings are based on a collaborative-research and school-change project involving university researchers, teachers, and the school's principal. On the basis of ethnographic data and an interdisciplinary theoretical framework, we propose a three-part model of culturally relevant mathematics instruction. The 3 components are (a) building on students' informal mathematical knowledge and building on students' cultural and experiential knowledge, (b) developing tools of critical mathematical thinking and critical thinking about knowledge in general, and (c) orientations to students' culture and experience.

I was 15 [when I came to the U.S.] The first thing I learned was that I was different. Even with my Latino peers. There are levels of being Mexican. I didn't know how bad it was to be who I was. There were so many pressures from name calling, insults in the street, said aloud because I was so Mexican ... I had a lot of anger. It was this anger, and anger at the experiences of my brother in school. We all did not do as well because of the school experiences. That made me want to be a teacher.

—Ms. Salinas, a sixth-grade teacher in the school

In this article, we hope to contribute to a theory of *culturally relevant teaching* (Ladson-Billings, 1995) of mathematics in a Mexican immigrant community. Our analysis is based on the ideas and practices of five teachers. The teachers are participating in a school-change project in a public school located in a low-income Mexican American community in a large midwestern U.S. city. The purpose of the project is to help teachers use what they know about their students' culture to improve students' learning of mathematics, and of other subjects as well, and to help students develop critical approaches to knowledge and the tools they will need to be agents

¹This is a pseudonym, as are all proper names throughout.

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of social change. The project is intended to build on teachers' "wisdom of practice" (Shulman, 1987) by making their pedagogical knowledge explicit as part of the school's collective knowledge base. As more teachers become involved, we hope that this knowledge base will enhance teaching and learning and support the process of change in the school as a whole. At this point, our research focus has been the pedagogical practices and thinking of teachers.

This project has grown out of work with mathematics teachers to improve students' learning and out of the specific context of the school and its community. The authors are participants as well as observers and researchers.² Our research is intended to inform the school's change process and communicate to wider educational audiences. Our broad research goals are (a) to understand potential relationships between culturally relevant teaching and the current mathematics-education reforms spearheaded by the National Council of Teachers of Mathematics [NCTM] (1989, 1991, 1995) and (b) to understand the ways in which teachers use children's culture in a Mexican American context from the perspective of a developing theory of culturally relevant teaching. We use the term *Mexican American* to refer to this community, which includes transnationals, Mexican immigrants, and Mexicans born in the United States. All aspects of the project are collaborations among teachers, administrators, and DePaul University personnel (two faculty members and one undergraduate student).

The project addresses three compelling issues affecting schools in the United States today. The first is the failure of schools to support the academic success of students of color. The dramatic disparities between White students and students of color (particularly African Americans, Latinos, Native Americans, and some Asian groups) in academic achievement, course failure, drop-out rates, SAT and ACT scores, and college admissions are common knowledge. Summarizing data on mathematics achievement over the past 20 years of national mathematics assessments, Secada (1992) states, "In terms of average score and the distribution of students at or below certain cutoffs, Whites do much better than Hispanics" (p. 629). Indeed, mathematics has functioned to exclude Latino students and others from advanced courses and college-preparatory curricula (Oakes, 1990).

A second issue is that as children go through school, they "begin to lose their belief that learning mathematics is a sense-making experience" (NCTM, 1989, p. 15). This loss is demonstrated in many ways, for example, by a disconnection between their knowledge as exhibited on school mathematics tasks and the *informal mathematics knowledge*³ that they bring to school (Nunes, 1992; Saxe, 1991) and by studies in which children use rote procedures to solve problems unreflectively and to produce answers that make no sense (Carragher & Schliemann, 1985; Hiebert & Wearne, 1986).

²Gutstein is a mathematics educator; Lipman does research on race, ethnicity, culture, and school change; Hernandez was a university student and is now a teacher at the school; and de los Reyes is the school's principal.

³This knowledge, also referred to as *intuitive knowledge* (Leinhardt, 1988) or *prior knowledge* (Saxe, 1988), can be defined as real-world knowledge (derived from and in relation to specific situations and contexts) that children bring to school mathematics tasks and use to make sense of these tasks.

Third, beyond academic success, it is important for all students to develop the tools for active participation in democratic public life (Banks, 1991; Giroux, 1988). This ability to participate is particularly essential for people of color who are marginalized in the political process and in many aspects of social and economic participation. Our work is in accord with Perry and Fraser's (1993b) conception of transforming schools into sites that foster the tools and dispositions to participate in a multicultural, multiracial democracy. It is also in accord with Frankenstein's (1991, 1995) teaching of mathematics to help students analyze social inequality and relations of power.

THEORETICAL FRAMEWORK

This study is informed by three theoretical perspectives: cognitive science approaches to mathematics education and the NCTM *Standards* (1989, 1991, 1995), research on the relationship of culture and schooling, and critical theories of education. Over the past 25 years, advances in cognitive psychology and cognitive science have played important roles in mathematics-education reforms (Kilpatrick, 1992), and prominent mathematics educators have made the study of cognitive science central to their research efforts (Carpenter, Moser, & Romberg, 1982; Davis, 1984; Hiebert & Carpenter, 1992; Schoenfeld, 1987). A central idea is that knowledge is stored in the brain in richly intertwined semantic networks of ideas, concepts, facts, and skills. Individuals learn and integrate knowledge as it relates to and makes (or modifies) connections to existing nodes in the networks. From this theoretical position comes a picture of how understanding develops—we understand things as they “fit into” that which we already know. Among the pedagogical implications is that teachers need to provide opportunities for students to develop links to new ideas, but these ideas must be within the student's potential understanding (i.e., students must be able to make the connections to their existing knowledge). Vygotsky (1934/1962), although not proceeding from cognitive science, elaborated a similar notion with his “zone of proximal development,” which refers to those ideas and concepts that a child can understand with the assistance of a more able other, such as an adult, a teacher, or even a peer. From the viewpoint of cognitive science, this zone may be thought of as those ideas that are reasonably close to the student's core networks of knowledge, but are not yet connected.

The idea of building on children's informal mathematical knowledge developed in part from the foregoing theory of how understanding develops. If we see children's informal mathematical knowledge as part of a well-connected network of ideas and concepts, then using that knowledge as a starting point from which to base instruction makes sense. Evidence confirms that helping teachers build on children's informal knowledge in mathematics classrooms helps children use their intellect well, make meaning out of mathematical situations, learn mathematics with understanding, and connect their informal knowledge to school mathematics (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Fennema et al., 1996; Mack, 1990).

However, little in the mathematics education literature, including the discussions of informal mathematical knowledge, examines how teachers use children's cultural

knowledge (Silver, Smith, & Nelson, 1995). Commenting on this, Ginsburg (1988) says, “Although cognitive science has made an important contribution in showing that children from different cultures possess the potential for at least basic mathematics learning, we need to understand why that potential is seldom realized...”(p. xii). In Secada’s (1991) critique of the narrowness of cognitivist research, he points out the following:

In conclusion, current research on the teaching and learning of mathematics contains elements that serve to legitimate views of diverse learners as deficient learners ... It is not enough to research children’s cognitions, unless we address how divergent forms of cognition can develop in a manner that does not marginalize those forms. (p. 46)

In this project and in this article, we seek to avoid this compartmentalized perspective and instead attempt to unify disparate approaches to address the learning of mathematics. Although we are building on the strengths of the cognitive science approach to mathematics education, our interdisciplinary perspective seeks to address Secada’s (1996) critique of the failure of this approach to address issues of culture and language.

We also draw from the NCTM *Standards* documents the idea of critical mathematical thinking. Both the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) and the *Professional Standards for Teaching Mathematics* (NCTM, 1991) contain standards that exemplify this idea. The curriculum standard on *mathematics as reasoning* (1989) incorporates the notion of students understanding and applying reasoning processes, creating and judging mathematical arguments, and validating their own thinking and answers. The teaching standard on students’ role in discourse (1991) has, in addition, the ideas of students making and exploring conjectures, questioning their peers and teachers, and using mathematical evidence to validate knowledge. These features together encapsulate what we call *critical mathematical thinking*.

A second point of departure is anthropological studies of culture and education and, particularly, theories of culturally relevant teaching. We define *culture* as the ways in which a group of people make meaning of their experiences through language, beliefs, social practices, and the use and creation of material objects. Because culture is continually being socially constructed, and because individual identities are constructed through the intersection of racial, ethnic, class, gender, and other experiences, it cannot be reduced to static characteristics or essences (McCarthy, 1995). Although most students at Rivera speak (and virtually everyone understands) Spanish, to different degrees, and almost all are of working-class or rural Mexican heritage, multiple, overlapping, and sometimes competing cultures are manifested in the community, in the school, and in individual students (e.g., U.S.-born and immigrant, urban and rural, gang and nongang, male and female).⁴ Yet through

⁴For example, at school dances, the DJ needs to alternate between free-style, hip-hop, and disco for first-generation students, and *banda*, *la musica norteña*, and *la quebradita* for immigrant students. Both gang graffiti and elaborate murals based on Mexican culture—*without* graffiti—cover neighborhood walls, sometimes side by side, and children in the school’s gifted program are generally committed to academic achievement while some in the regular programs display resistance to school.

their collective experiences as members of Mexican immigrant families, through a common language, through daily life in an insular, urban barrio, and through common experiences of racism and oppression, these Mexican and Mexican American students have developed aspects of a shared identity (Darder, 1995).

Research over the past 20 years points to a nexus of economic, political, and cultural causes for the failure of schools to educate children of color. A significant factor identified in the research is the discontinuity between some racial and ethnic minority students' home culture and the mainstream, White middle-class culture that pervades most schools. Cultural differences or discontinuities include, for example, communicative and social interaction patterns (Au & Jordan, 1981), social organization (Erickson & Mohatt, 1982), and ways of transmitting knowledge (Phillips, 1982).

Building on the research on cultural discontinuities, anthropologists have examined ways in which schooling can be made more congruent with, and responsive to, students' culture, language, and patterns of social interaction (Trueba, Jacobs, & Kirton, 1990). However, at a deeper level, cultural differences are embedded in relations of power in society and the ways in which these relations of power play out in schools (Bartolome, 1994; Villegas, 1988). In response, scholars have begun to identify pedagogies which foster the success of disempowered, marginalized students (Foster, 1991; Ladson-Billings, 1994). On the basis of an analysis of the knowledge and practice of successful teachers of African American students, Ladson-Billings advances a theory of culturally relevant teaching (1995). According to Ladson-Billings and Henry (1990), culturally relevant teaching

uses the students' culture to empower students to be able to critically examine educational content and process and ask what role they have in creating a truly democratic and multicultural society. It uses students' culture to help students create meaning and understand the world. More than just academic success, it pushes students toward social and cultural success. (p.82)

The pedagogy of culturally relevant teachers is based on three broad propositions: conceptions of self and others that reflect belief in, and commitment to, students and their communities; classroom social relations that are equitable, reciprocal, and that foster community; and knowledge as shared and collectively constructed, viewed critically, multifaceted, and built on children's culture and experience (Ladson-Billings, 1994).

Although much of the literature on culturally relevant teaching has focused on African American students, substantial research exists on teaching Mexican American students in bilingual education contexts (Garcia, 1995; Wong Fillmore & Valdez, 1986), including projects that build on students' language and culture to create more intellectually and socially empowering educational experiences (Cummins, 1989; Delgado-Gaitan & Trueba, 1991; Moll & Diaz, 1987). Language is a central vehicle for both transmitting and creating culture, and is a significant feature of cultural identity in its own right. Thus, suppression of a group's language is a way of asserting dominance over the group (Macedo, 1994). Moreover, students' native language or bilingual abilities "are a substantive part of a well-functioning social network in which knowledge is embedded" (Garcia, 1995, p. 383). Therefore, it is important to explore teachers' use of language as one way to unpack what culturally relevant teaching might

mean in bilingual contexts. Darder (1995) brings these perspectives together, linking issues of language, culture, and identity with a critical perspective, and examines some features of critical education for Latino students.

We situate our work within this critical paradigm. At the heart of this paradigm is a critique of unequal power relations in society and of the role of power relations in schooling. Critical educators hold that a central purpose of education should be to prepare students for active participation in public life toward a more just and democratic society (Friere, 1974; Giroux, 1988). The goal of educators who act within this paradigm is “to empower the powerless and transform existing social inequalities and injustices” (McLaren, 1989, p. 160). Aspects of this transformation include reconstructing schooling in ways that uphold the identities of diverse students, work against social inequalities, and help students develop tools of critical literacy and a sense of efficacy in society (see, for example, Perry & Fraser, 1993a). Critical literacy includes the ability to approach knowledge critically, to see relationships between ideas and the interests they serve, and to see one's own and others' situations in social and historical context (Macedo, 1994). The purpose of critical literacy is to help people recognize oppressive aspects of society so they can participate in creating a more just society.

Throughout this article, we use the term *critical* in several senses. We describe critical orientations to education and literacy. We also refer to critical mathematical thinking as a way to capture aspects of the NCTM *Standards* documents, such as justifying answers and using mathematical argumentation and evidence to validate knowledge. Another meaning of critical is the notion of teachers helping students take a critical approach to knowledge in a broad sense, that is, encouraging them to explore multiple perspectives, question the standard curriculum, and construct their own knowledge. A major focus of this article is to examine ways in which culturally relevant mathematics educators extend the notion of critical mathematical thinking to critical approaches to knowledge in a broad sense beyond mathematics, and we reflect on how these approaches may help students develop critical literacy.

RESEARCH SITE

The research site is Diego Rivera Elementary and Middle School, an urban public school of 743 students and 42 teachers. Ninety-nine percent of the students are Latino (96.4% Mexican American) and 99% are low income. At least half of the children are immigrants and the vast majority of the remainder are first-generation residents in the United States (the school does not have exact data on the percentage of immigrants). Forty-three percent of the students are eligible for bilingual education. The principal and all 26 aides are Mexican American, and only two of the administrators and office staff are non-Latino. Fifty-five percent of the teachers are White, 19% are Mexican, 14% are non-Mexican Latino, and 12% are African American. Rivera has three programs: a bilingual middle school program (6–8), a monolingual (English) middle school program (6–8), and a gifted bilingual program (one class in each of Grades 1–8). This third group of students is demographically similar to the other bilingual

students except that most live in other Mexican communities in the city.

The school is located in one of the largest Mexican American communities in the United States. The community, still a “port” of entry, has a history of struggle against oppression and for basic democratic rights. As a part of these struggles, activists and artists decorated the neighborhood’s walls with murals. About 10 years ago, the school community took inspiration from the murals; organized to change the school’s name to Diego Rivera, a famous Mexican muralist; and became a school that emphasized the fine arts. The principal hired two local muralists who, with the students, transformed the school over the years into a celebration of Mexican art. The walls, inside and out, are covered with murals and indigenous motifs, which spill out of the school onto neighboring buildings and streets.

For the past 3 years, the school has been attempting to foster a deeper connection with both Mexican and Mexican American culture and the larger Mexican American community, as well as a more inquiry-based curriculum. For example, a curriculum partnership with the nearby Mexican Fine Arts Museum integrates the humanities, language arts, and fine arts programs. This partnership is part of the more ambitious goal of helping teachers build on children’s culture to support their academic success and encourage students to question ideas and think independently.

DESCRIPTION OF THE PROJECT AND METHODOLOGY

We are currently in the third phase of a multiyear project. In phase one, the 1994–95 school year, Gutstein began working with eight mathematics teachers in all three programs at Diego Rivera. He introduced the *Mathematics in Context* (MiC) middle school curriculum (National Center for Research in Mathematical Sciences Education & Freudenthal Institute, in press) to the middle school teachers and worked with teachers on MiC and general mathematics-education issues. He observed and participated in classes, helped teachers plan lessons, team taught, and worked with children individually and in small groups in several classrooms. (He also took field notes and recorded his reflections to support the teachers’ growth; these notes became part of the project’s data.)

This part of the project raised interesting questions: What were the bases of some teachers’ connectedness with their students? Did the connectedness relate to the way teachers taught mathematics? Gutstein initiated discussion with some of the teachers, de los Reyes (Rivera’s principal), and Lipman, whose research focuses, in part, on culturally relevant teaching in African American contexts and school change. Phase 2 of this project, which is the focus of this article, evolved from these discussions. Thus, initial questions and formulation of our research emerged from reflecting on the experience of helping teachers improve their mathematics teaching, the perspectives of educators at Rivera, and the potential relevance of the theoretical frameworks previously described.

Phase 2 (1995–96) went beyond working with mathematics teachers to study culturally relevant teaching and change in mathematics teaching. This phase involved Gutstein and Lipman (both Anglos), Hernandez (a Mexican American university

student who is a lifelong resident of the community), de los Reyes (the principal, a Mexican American, who was a bilingual teacher herself for 15 years and has deep roots and family in the community), and five teachers from the bilingual programs (two Mexican American, one Peruvian, one Colombian, and one Anglo). These five include a second-grade teacher, a third-grade teacher, a seventh-grade mathematics teacher, an eighth-grade mathematics teacher, and a sixth-grade science teacher. Gutstein has worked on mathematics education with the upper-grades mathematics teachers for 3 years, including on their use of MiC, but with the second- and third-grade teachers only during Phase 1.

Every project participant, except Gutstein and Lipman, is fluently bilingual. The teachers were selected on the basis of de los Reyes's recommendation, which used four criteria: (a) they believed all children could learn; (b) they valued the culture and language of the children and their families; (c) they cared about all the children; (d) they saw their work as a calling, that is, they believed that together with the children and the families, they could make a difference in children's lives and their communities. During this phase, Rivera began using the MiC curriculum in the bilingual programs in Grades 4–8, and Gutstein continued working with teachers. This article reports on our work in Phases 1 and 2.⁵

Because we were interested in meanings (tacit and explicit), beliefs, and ideologies embedded in practice, particularly the interpretations that school actors give to their own actions in this context, we used qualitative methods (Erickson, 1986). As observers and as participant observers assisting teachers in their work with children, we used standard ethnographic field methods (Hammersley & Atkinson, 1983). Our data were drawn from our field notes of classroom observations and participation in classroom activities. We also used (with permission) classroom observation data from Gutstein's preservice mathematics education students. Our data also included open-ended interviews with teachers and administrators (Spradley, 1979), materials used and produced by both teachers and students (texts, other curriculum materials, classroom assignments, homework, assessments, and scratch work), and other school documents (demographic data, communications to families, school brochures, etc.). We transcribed our field notes in narrative form and also audiotaped our own reflective journals. De los Reyes participated in all aspects of the project except classroom observations and interviews.

A second source of data came from practitioner reflections on their own practices and beliefs through group conversations and taped journals. This method is based on an epistemology that acknowledges experience as a "criterion of meaning" (Hill-Collins in Ladson-Billings, 1995); recognizes teachers' "wisdom of practice" (reflections on their experience and expertise) as valid sources of knowledge about successful teaching (Shulman, 1987); and appreciates the tradition of action research, in which teachers engage in systematic, reflective inquiry on their own

⁵Phase 3 (1996–98) is an extension of Phase 2; our emphasis is on helping the school develop as a whole by reflecting on the relationships with families and community and the role of the students' culture in the school.

practice to solve pedagogical problems and contribute to educational research (Carr & Kemmis, 1986). A third source of data was semistructured student interviews conducted by Hernandez in the language of the student's choice.

The taped interviews, meetings, and participant journals were transcribed. We analyzed our data collectively in audiotaped group meetings of university researchers and school participants; these tapes were also transcribed. Beginning with broad concepts of culturally relevant teaching and inquiry-based mathematics instruction, we used a "grounded theory" process (Glaser & Strauss, 1967) in which the theory emerges from iterative analyses of data. To facilitate analysis, we coded our field notes and transcriptions for themes and analyzed and reanalyzed these codes for patterns and relationships (Hammersley & Atkinson, 1983).

As we discuss above, our research agenda has two parts. This first part is our ongoing attempt to understand what culturally relevant teaching might mean in this context. To address this, we explored beliefs and educational practices related to—

- the role of culture in curriculum and pedagogy;
- notions of cultural competence, bilingualism, and biculturalism;
- perspectives on families and community;
- relationship of students viewing knowledge critically to their role in society;
- conceptions of knowledge and the role of the teacher in knowledge construction.

The second part of our agenda is our interest in how teachers use their connections with children to build on their informal mathematical knowledge. Here, we examined how teachers—

- learned to elicit and listen to children's thinking;
- made use of that knowledge to inform instructional decisions and integrated it into their enacted curriculum;
- integrated their students' culture into the classroom beyond surface-level uses like word problems based on stereotypical cultural artifacts.

Although teachers' use of children's mathematical thinking to make instructional decisions has been well researched in mathematics education (Fennema & Franke, 1992), teachers' use of children's culture in mathematics instruction has not received much attention.

An important aspect of this project has been the MiC curriculum, used by two of the teachers in the project and by several other teachers at Rivera. Each of the 40 MiC units (10 at each grade, 5–8) was drafted at the Freudenthal Institute in The Netherlands and sent to the National Center for Research in Mathematical Sciences Education to be "Americanized" for U.S. schools. (An ongoing question for Rivera educators has been, What are the implications of using a European-originated curriculum in a Mexican American context, and what, if anything, do teachers need to do to make it meaningful to Rivera students?) MiC's philosophical underpinnings

⁶That is not so coincidental; Thomas Romberg, Chair of the NCTM Commission on Standards for School Mathematics, is the initiator of the MiC curriculum.

embody many of the recommendations of the NCTM *Standards* documents⁶, including viewing the student as a constructor of knowledge; promoting teaching as guiding students to reinvent significant mathematics rather than teaching as telling; building on prior knowledge; valuing multiple strategies and emphasizing the role of discourse and student interaction; and using a progressive formalization from concrete to increasingly abstract mathematical representations (NCTM, 1989; 1991; 1995). Implicit in MiC are aspects of critical mathematical thinking—making mathematical sense out of real-world contexts and solving meaningful problems.

Although some of the real-world situations in MiC may relate to Rivera students' lives and experiences, the curriculum as a whole is not necessarily connected to their home cultures. That challenge remains for teachers. It is up to them to integrate subject-specific curricula with what they know about their students. Additionally, while MiC does not encompass a critical approach to knowledge in general, it does contain seeds of this approach. For example, it often presents scenarios in which characters in the text come up with multiple answers and students have to judge the validity of these. Again, however, it is up to teachers to extend these ideas beyond mathematics and to help students develop generally critical approaches to knowledge.

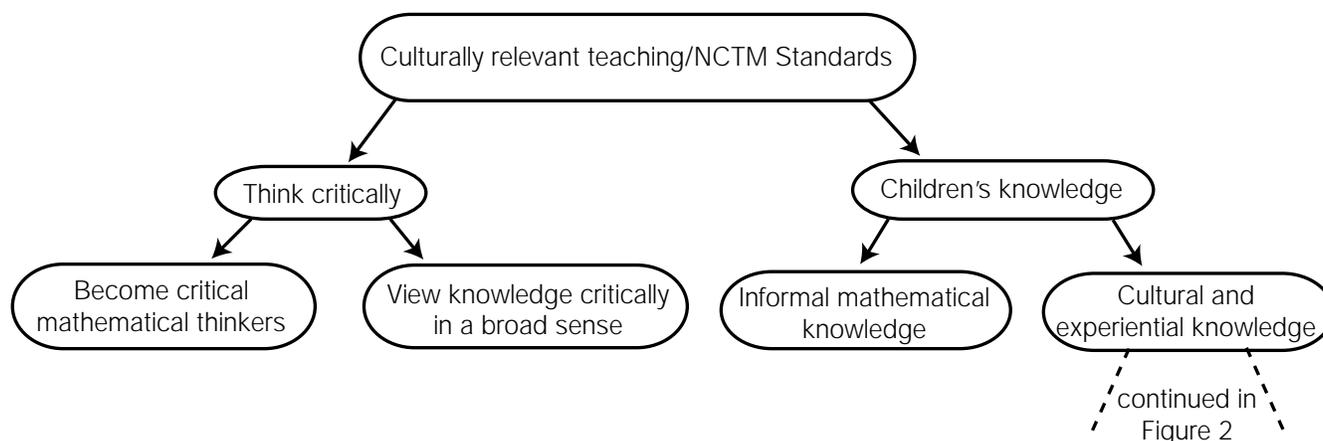
A MODEL OF CULTURALLY RELEVANT PEDAGOGY IN MATHEMATICS CLASSROOMS

On the basis of our theoretical framework and findings thus far, we posit a theoretical model of mathematics instruction that is based on the NCTM *Standards* documents and their intersection with culturally relevant pedagogy in this particular context. The main components of this model are (a) connections between becoming critical mathematical thinkers and viewing knowledge critically in a broad sense, (b) connections between building on students' informal mathematical knowledge and building on students' cultural and experiential knowledge, and (c) orientations to students' culture and experience. (Points (a) and (b) are represented in Figure 1, and point (c) is represented in Figure 2.) The model suggests that the *potential* relationship between the NCTM *Standards* documents and culturally relevant teaching involves thinking critically about knowledge and the world and building on children's informal knowledge and experience. We emphasize the word *potential* because although a relationship between culturally relevant teaching and the *Standards* documents is possible, they are not linked without conscious action; we explain this more below.

Thinking Critically

Viewing mathematical knowledge critically—becoming what we call a “critical mathematical thinker” (e.g., making conjectures, developing arguments, investigating ideas, justifying answers, validating one's own thinking)—is a central feature of the NCTM *Standards* documents and is best exemplified by the standard on *mathematics as reasoning* (NCTM, 1989). Viewing knowledge critically in a broad sense—encouraging students to explore multiple perspectives, questioning the standard curriculum,

and helping students find their own voices and construct their own knowledge—are aspects of critical literacy. Several teachers in this project wish to be critical in



both senses.

Figure 1. Culturally relevant teaching and the NCTM Standards

Ms. Herrera, the third-grade teacher in the gifted bilingual program, exemplifies this relationship. A Mexican American woman in her late twenties, she was born and grew up in the community and attended Rivera as a child. Ms. Herrera was determined to return there to teach in order to “give something back” to the community. When we met, she had almost no formal exposure to the NCTM *Standards* documents.

In our 26 observations from 1995–96 (many of which were full days), we observed her constantly challenge her students to justify their answers. This behavior is illustrated by the following class described in our field notes. Students had been exploring fraction strips in small groups, comparing the sizes of the pieces, and had individually made their own “fraction pizzas.” Ms. Herrera had introduced fraction names and then fraction symbols after students had done some initial exploration. Although at first most children thought that one-eighth was larger than one-third, by the time of this class, most knew which was larger. From our fieldnotes:

The students have been experimenting with their fraction strips. Ms. Herrera has written on the board one third and one eighth as symbolic fractions and asks the students which is bigger. The majority say one-third. Ms. Herrera: “One third!?” [She makes a face as if to say, “You must be crazy!”] “Why!? Why one third!? Why not one eighth? Eight is bigger than three, isn’t it!?” There is a chorus of “Yes” from the class. Ms. Herrera: “So? Why is one third bigger than one eighth?” [Again with an incredulous look.] Students hesitate. Then, one student says that one third is bigger because there’s only three pieces, but Ms. Herrera isn’t satisfied. She asks if everyone agrees, but continues to push the students to explain and justify their answers. Finally someone says that each piece of the pizza that has only three pieces is bigger than each piece from the pizza with eight pieces. The discussion moves on, students give other reasonable explanations, and the class comes to a well-reasoned consensus that one third is indeed larger than one eighth.

Clearly, Ms. Herrera is carrying out recommendations consistent with the NCTM’s *Professional Standards for Teaching Mathematics* (1991): having students

explain, justify, and defend their answers; pushing for multiple interpretations; and encouraging mathematical communication. Mathematically, she is attempting to help students overcome a common misconception among early fraction learners, who often extend their knowledge of whole numbers to fractions and overgeneralize (Mack, 1990).

Our interpretation of Ms. Herrera's actions has been confirmed by others, including a number of preservice students in Gutstein's mathematics education classes. The following is from one of their field-experience papers:

The definition [of perimeter] was never given directly to the students. They had to find one that made sense to them and then explain it to the rest of us [the whole class, Ms. Herrera, and the preservice teachers], at the risk of being questioned, often relentlessly, by Ms. Herrera in order to make it clear and specific. The result of this whole process was that the students came up with understandings of the concepts that were personally meaningful to them and their group members.... There is also an emphasis on being able to communicate these ideas to the rest of the classroom through the group discussion and presentations at the end of the math time. The routine questioning and demands to "show me how you know this" by the teacher facilitated this larger communication. It became clear to me that the questioning process is an excellent way of ... helping them prepare to always support their statements and conclusions with evidence... The questioning is expected and the students are always ready with answers that they prepare for communicating.... The students that move through Ms. Herrera's class will be well prepared for later work, and they will have the appropriate skills for being critical learners who will have the ability to question what they see and hear as well as what they want to communicate to others. "The goal of the constant questioning," Ms. Herrera explained, "is to hopefully help them internalize this method of critically analyzing problems and solutions."

We have repeatedly seen Ms. Herrera disagree with her students, make them justify their responses, ask for alternative explanations, screw up her face in disbelief, and challenge their thinking. In itself, we see this behavior as good (mathematics) teaching. However, in Ms. Herrera's case, there is more to it than that. She often challenges their reasoning—and not just in mathematics. Since she has had little exposure to the NCTM *Standards* documents and is not consciously trying to implement them, they do not motivate her to act in a certain way. Instead, Ms. Herrera says that she sees a direct relationship between "pushing them to say why is a third bigger than an eighth" and "helping them become leaders." Although she certainly helps her students develop tools of critical mathematics thinking and reasoning, she also, quite consciously, tries to help them develop the ability to "stand up for what they think is right." A teacher implementing the NCTM *Standards* documents may push and challenge students' mathematical thinking, and Ms. Herrera's actions with her students may have a similar effect on their mathematical thinking, knowledge, and confidence. However, the primary purpose of her actions is different—it is to make her students "be strong leaders, 'cause they can be." She articulates an educational philosophy and practice that links a critical approach to classroom knowledge with a stance that sees nurturing leadership as a central responsibility for educators, one that derives from her own experiences as a Mexican American woman.

There is no necessary connection between implementing the *Standards* documents and implementing this aspect of culturally relevant teaching. Teachers may teach

mathematics in ways that help students become critical mathematical thinkers but may not help them be critical about knowledge and society in general. Culturally relevant mathematics teachers may consciously see teaching mathematics in this way as part of a larger set of beliefs about teaching. A distinctive feature of culturally relevant teachers is that their critical mathematics teaching is part of a broader set of pedagogical orientations, dispositions, and practices that foster a critical approach to knowledge, help students question the authority of adult perspectives, and promote democratic practices in the classroom. This pedagogy is manifested in their day-to-day relationships with students and in the ways they organize their classrooms, as well as in their explicit teaching. In our view, they are giving students tools necessary for active and conscious participation in society. Culturally relevant teachers deliberately help students acquire these tools through teaching a specific subject. Ms. Herrera describes how this has unfolded in her class:

Ms. H: I mean, I was always the type that was like, OK, everyone is doing it, so I have to do it, too. I could never stand up, because I was brought up the way, well, “You do it ’cause I’m telling you to do it.” And now I find myself, some of the kids, when I tell them, I think we better do it this way ... “Why, teacher, can’t we do it another way.” And then I think hmmm, now what am I going to do? So I sit down and I explain that we can do it this way, but if you have another way of doing it, let’s try it another way. So, I don’t find myself saying, “No, you have to do it this way.” I find myself saying, “OK, is there another way you can do it then?”

Q: What I hear you saying, then, is that this process is leading to a more genuinely democratic classroom, is that right?

Ms. H: Yes. Even the shyest one will go ahead and say, “Why?” But I see that as a very good thing, as something really good, ’cause it’s helping them. I mean, as Hispanics, we’re always all down here, I mean, I don’t know, that’s what I see. I want them to be strong leaders, ’cause they can be. They could be, they’re up there. I want them to stay up there, not to just follow along. We can see that they are becoming ... they want to be like something up there.

Although we cannot predict the long-term results of Ms. Herrera’s efforts, we can see in the following classroom observation that students are doing what they have seen Ms. Herrera do and are appropriating her critical approach to knowledge. Moreover, they are acting as leaders of their whole class. This classroom is a place where students are arbitrators of knowledge. From field notes:

Small groups are presenting their science projects to the rest of the class. These were the projects that they had developed and put together to show the second-grade class. Ms. Herrera tells them that they will present them again, but this time it will be for a letter grade, and the class and she will be the audience. She calls the first group up to the front of the room [they present].... Another group comes up, then another.... The group doing the presentation on forms of matter (liquid, solid, gas) passes out materials to the class. They then ask students what they have in their hands and tell the students that they not only have to answer, but that they need to justify and explain their answers. Then when someone says, “I have something solid,” they probe, push, and challenge their classmates to explain why and usually push for more than one answer.

What we believe is important in these examples is that the educators in this study do not approach critical thinking about mathematics only from the standpoint of helping students learn mathematics, nor do they implicitly define pedagogy narrowly

as a set of beliefs and practices related to a particular discipline. Rather, their approaches to instructional practice are rooted in a particular ideology, orientation, and world view that are essentially emancipatory and are aimed at helping their students develop personal and social agency in contexts of marginalization and disempowerment. As Bartolome (1994) argues, in discussing the pedagogies of teachers who prepare students to deal with social inequality,

it is important to point out that it is not the particular lesson or set of activities that prepares the student; rather it is the teacher's politically clear educational philosophy that underlies the varied methods and lessons/activities she or he employs that make the difference. (p. 179)

This may be seen quite explicitly in the words of Ms. Andula, a second-grade teacher at the school:

I want to make kids humans who question and ask Why? Why? Why? again and again... I want them to give their own opinions and know their rights, not just know their rights but act on them, act on their rights.... One contribution we can make is to help make individuals who question, who do not just accept, who are fighters, who can help to change society ... My hope is that something will be planted or awakened in them, that I can foster and nurture. We need to help them develop skills, academic skills, but also use the skills of looking inside themselves, the ability to observe others and make connections with themselves.... I'll probably be gone before there's a big change, but I see change, little changes. There are little changes every day, kids who question, who say, "You are wrong."

Children's Knowledge

The second aspect of our model involves perspectives on, and the use of, children's knowledge. A fundamental idea of the pedagogical philosophy of both the NCTM's *Standards* documents and culturally relevant teaching is that teachers use the knowledge and experiences that children bring into the classroom. For the NCTM, informal mathematical knowledge is central, whereas for culturally relevant teaching, cultural knowledge and student experience are key. Both suggest that teachers need to be well aware of children's knowledge to use it as a starting point from which to build. This commonality motivated us to examine potential connections between how teachers used and viewed various types of children's knowledge.

For some teachers in the project, the idea of building on students' informal mathematical knowledge is integral to their own concept of good teaching, which includes using their students' cultures in constructing curriculum. For others, this idea is relatively new. For all the teachers, the practice seems also to grow out of a deep conviction that the students' knowledge and culture are valuable sources of classroom knowledge. These teachers, like those with whom Ladson-Billings worked, see teaching as "pulling knowledge out" of students (Ladson-Billings, 1994). They believe that students come to school with a rich store of cultural and experiential knowledge, talents, and strength and that these are a foundation for further learning. The following example from our field notes is from Mr. Chamorro's seventh-grade, bilingual class, which was using a discrete mathematics unit ("Ways to Go") from the MiC curriculum. Mr. Chamorro emigrated from Colombia 5 years

ago and reports using his own experiences in coming to this country as a way to relate to his students. This section of the unit is titled “As the Crow Flies,” and students are asked to examine maps of the northwestern United States and compare road distances with air distances between some of the cities on the maps. The English idiom “as the crow flies” does not appear to exist in the Spanish used in Mexican American communities or in Mexico.

Mr. Chamorro’s class is having trouble with the concept of scale. He draws a quick, outline map of the United States on the overhead projector and asks if the United States is the same size as the picture. Students have no problem with that idea. He also asks about the concept of “scale” and a boy calls it by its Spanish name, *escala*, which Mr. Chamorro repeats . . . there is a quick discussion in Spanish about scale . . . students then measure the distances between cities on the maps, but since cities are marked with dots inside of small circles, students’ measurements vary. Mr. Chamorro asks several questions about measurement, such as “what happens if you go to the doctor and they measure you when you have shoes, then you go and they measure you without shoes”, and other questions to point out the inexactness of measurement. Students appear satisfied with their multiple solutions. . . A little later, Mr. Chamorro explains that students are to compare the “road” distance with what the text calls the “as the crow flies” distance. Initially, it does not appear that “as the crow flies” makes sense to students, since few seem to answer Mr. Chamorro’s questions about it. Mr. Chamorro quickly draws a little map on the overhead, a grid of three streets across, three streets down. He puts a small circle at top left and writes “Home” and puts a mark at bottom right and writes “DR” (Rivera’s acronym). He then tells student that “the crow flies over the buildings [to get from home to DR], but you have to walk around the streets.” He draws a straight line across the grid from the “home” to “DR” to show the crow’s path. To further illustrate his point, he says something like, “the crow flies up to the corner [while he “flaps” his arms to act out the crow flying], then he stops for the red light, turns left at the corner. . .” The kids laugh at the image of the crow doing this, and it appears that Mr. Chamorro’s point is clear. There is then some more discussion about why the road distance is different from the “crow flies” distance. Mr. Chamorro then asks about the road from Mexico City to El Paso and asks if that’s entirely straight the whole way and if the road distance is the same as the actual distance. Students say no and seem to have no trouble understanding the idea.

In this vignette, we see Mr. Chamorro using students’ informal knowledge several times to help students understand important mathematical concepts. Mr. Chamorro helps students understand the mathematical idea of scale by drawing a map of the United States and asking if that is the real size of the country. He helps students understand inexactness of measurement, another mathematical concept, by referring to their experiences being measured with and without shoes. For the concept of “as the crow flies” distance, he uses the visually graphic image of a flying crow stopping for red lights and making sharp turns, and he additionally uses

their knowledge of their community. Finally, his example of the road from Mexico to El Paso, places known to students, uses students' informal knowledge of the geometry of roads as nonlinear objects and helps them visualize further the relationship of actual distance to the road distance.

Mr. Chamorro makes use of students' informal knowledge to help them develop mathematical ideas in the foregoing vignette, and he also uses their cultural knowledge (in this instance, their language) as a part of the curriculum. The following excerpt is from a bilingual class that Mr. Chamorro conducts almost entirely in English.

[The class is using "Ways to Go," pages 6–7. The text presents a regular map, an abbreviated road map, and a photo of the same area as "models of reality" and "representations of the real world." The text asks the students to compare the models and "list some advantages and disadvantages of each model."] Mr. Chamorro asks in English what are the advantages and disadvantages of all three models. There is silence. After waiting a minute, Mr. Chamorro asks: "*¿Qué es tener ventaja? Si un niño de Alemania viniera a esta escuela, ¿cuál sería la ventaja de ustedes y la desventaja de él?*" [What does it mean to have an advantage? If a boy from Germany came to this school, what would be your advantage and his disadvantage?] A boy: "*Es que nosotros hablamos español, y él no sabría inglés.*" [that we speak Spanish, and he wouldn't know English] Mr. Chamorro: "*El tendría que aprender inglés y español.*" [He would have to learn English and Spanish.]

First, Mr. Chamorro helps the students understand the concept of advantage and disadvantage by using their own experiences and knowledge—that is, he builds on what they know, rather than give them a definition, and he allows them to construct their own knowledge. More important, he validates their culture, language, and knowledge by helping them see that their bilingualism is an advantage rather than a hindrance—and even conducts the conversation in their home language to emphasize the point. And, he turns on its head the public and media conception of people from immigrant Mexican communities as "disadvantaged," which has a particular political meaning in the context of the students' lives. He uses their cultural knowledge as a bridge to the set academic curriculum. But he also uses it as a curriculum of empowerment—that is, he aims to help students gain strength in the knowledge that their bilingualism has value and advantage. This corroborates Ladson-Billings' notion (1994) of culturally relevant teaching as

a pedagogy that empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes. These cultural referents are not merely vehicles for bridging or explaining the dominant culture; they are aspects of the curriculum in their own right. (p. 18)

Ms. Herrera also uses students' informal mathematical knowledge in the third-grade class; the following is from one of Gutstein's preservice student's field-experience papers:

Ms. Herrera tells students that they will investigate perimeter [and explains to us that the majority of students have no prior knowledge of the concept]. She asks students to cut out tracings of their hands and feet and use them to

measure different things in the classroom. She specifies that they must at least measure the outside edge of their desks in both foot and hand measurements ... the students jumped into investigating for themselves what she has presented. It seems that the majority of the students quickly define for themselves that perimeter is indeed the outside edge of an object. Ms. Herrera then asks the students if a globe, for example, has an outside edge that they can measure. They eventually decide that it isn't possible to measure round objects in the same way and narrow their definition of perimeter to being a measurement of something with straight edges and corners⁷... The definition was never given directly to the students ... the result of this whole process was that students came up with understanding of concepts that were personally meaningful to them and their group members... this classroom allowed the students to bring in their informal knowledge and build upon it.

In her classroom, Ms. Herrera regularly uses what students know as points of departure in her teaching in ways similar to the foregoing vignette. However, we have found that she infrequently refers specifically to Mexican culture in her class and makes little use of recognizable cultural objects, Mexican history, discussions about Mexican culture, and so on. Because of this, we have often felt that we, like Ladson-Billings (1990), were trying to "capture lightning in a bottle" in our efforts to document culturally relevant teaching. However, we believe that this is best captured by the notion of the classroom as an extension of the family and community. Because of Ms. Herrera's intimate and deep knowledge of her students' culture and experience, her classroom envelopes students in an extended Mexican family where students occasionally refer to her as Mami or Mom and where parents talk to her about non-school-related, confidential family matters. She described how this happens, first in her relationships to her students, then to the parents:

I try a whole lot to connect to them, to try to understand ... I come in here thinking from the first day, they are already a part of me, already a part of my family. That makes me want so hard to help all of them. They're part of me, my family, my culture, little bits and pieces of me ... I know they're going to go through the same things I went through. I want to see them go beyond what's expected of them ... it's so hard to see how a lot of Hispanics are being treated ... I want them to stand out, be special in their own way....

From the first day I meet them, I tell parents that there has to be a special communication between us, that there has to be a connection between us two. I tell them from the first day that I'm not only going to be their [child's] teacher, but that we're going to build trust about other things too ... We are going to open up doors. The kids are there when I tell the parents that, they hear and see everything I'm saying to them... [In describing the first open house] The next day, for the kids who didn't come, I give them the same talk that I gave the parents the night before. I tell them everything. The kids learn that there are no secrets here.

⁷Ms. Herrera later clarified to us that this was a first definition of perimeter that her students subsequently refined. Their initial point was that perimeter was something along which you could lay a straight edge (e.g., a ruler) in order to measure it; thus, a globe had no "perimeter."

Unlike some bilingual classes that emphasize English competence to the neglect of the home language, Ms. Herrera wants to ensure that her third graders do not lose their Spanish as they learn English. Mathematical discussions take place in English and Spanish, and Ms. Herrera pays close attention to mathematical terminology in both languages as well as to correct translations. Thus, like Delpit's (1988) Native Alaskan village teachers who promote the beauty of the home language while helping students learn standard English as a way to negotiate the necessary codes of power to go beyond the village, Ms. Herrera helps her students strengthen their own language on the way to achieving mathematical power and fluent bilingualism and biculturalism.

Like Ms. Herrera, other teachers in the project emphasize the use and clarity of the mathematical register in students' first language (Khisty, 1995). Mr. Simkin mixes Spanish and English in informal conversations with students as a way to communicate with them as they often do with one another, but he insists on correct translations and interpretation of mathematical terms in both languages. In his class, students learn the names and meanings of mathematical concepts in both Spanish and English. When teaching in English, Mr. Chamorro takes advantage of students' Spanish (e.g., *escala* for scale) to help them relate to and understand mathematical concepts in both languages. Students in the classes of all the teachers in the project comfortably switch back and forth between Spanish and English, except when explicitly practicing one language or the other. We regularly see, for example, teachers questioning in English, students answering in Spanish, and mathematical conversations developing in both languages. In all cases, we see teachers focusing on students' learning mathematics, using whichever language is appropriate, while ensuring that students develop competencies in both languages. Students feel positive about efforts to support the development of both languages. In the student interviews that Hernandez conducted, an overwhelming majority of the bilingual students she interviewed reported that the school makes them feel good about being bilingual.

Several of the teachers believe that affirming students' culture, language, and identities is central to their education. Ms. Andula says, "I believe that before kids can succeed they need to know who they are." She also argues that students' appreciation of their position and role within the broader society must begin with a clear affirmation of their own identity, support for bilingualism and biculturalism, and conceptions of their role in the larger society as Mexican Americans. When the school participated in a recent city-wide history fair, she was critical of teachers who did not ground their projects in an investigation of the students' own history and its connection with the city's history.

Orientations to Students' Culture and Experience

The third main component of our model (excerpted and blown up in Figure 2) depicts two orientations to culture and experience. In the previous section, we discuss how teachers use and build on children's cultural knowledge and experience and how they make use of students' informal mathematical knowledge. In this section, we describe two orientations to culture and experience: a deficit orientation and an empowerment one.

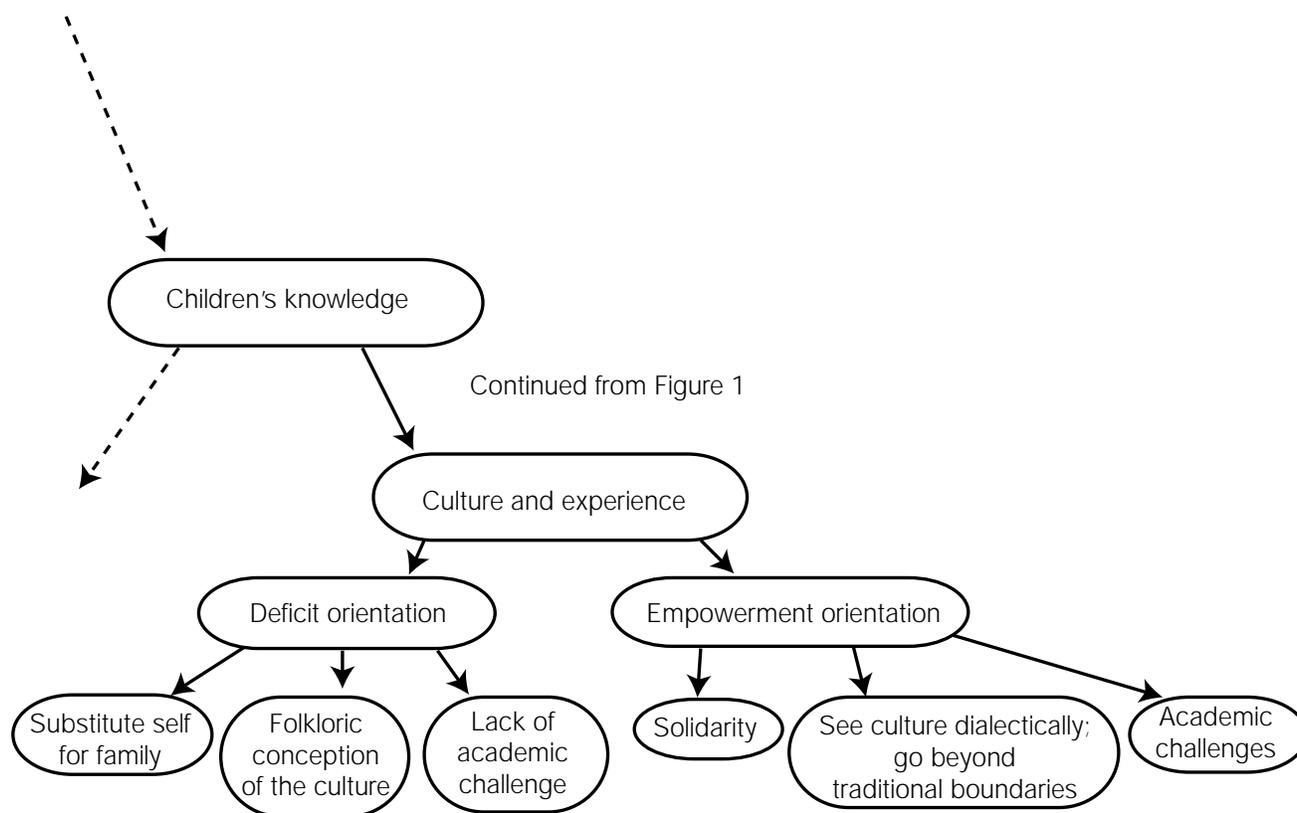


Figure 2. Culture and experience

In our model, an important point is that one can be familiar with students' culture and experience yet still hold a deficit orientation. The teachers in the project have identified three manifestations of a deficit approach to students: (a) substituting oneself for the students' own families, that is, perceiving that the student's family does not support her or him sufficiently and therefore someone needs to step in (cf. Delpit, 1992b); (b) failing to challenge students academically (cf. Delpit, 1992a; Oakes, 1985; 1990); (c) romanticizing Mexican culture and its material manifestations—what one teacher named a “folkloric” approach. (A long history of the deficit approach is documented in the literature; see Cuban, 1989.)

In contrast, an empowerment orientation toward students' culture and experience helps create the conditions for students to develop personal and social agency. Three components of this orientation are establishing solidarity with students and their families, seeing culture dialectically and going beyond traditional boundaries, and providing academic challenges.

Solidarity—standing side by side with people as an ally—is a concept identified by Hernandez that resonates with the teachers as well. Solidarity manifests itself in various ways, including for teachers, seeing themselves in their students. Ms. Herrera comments:

I can see myself. I try to bring myself down to where they are, to third grade. I try to think what I'd be doing at that age. I remember myself well as a third grader. Teachers never saw me capable of doing things. Just a little Mexican girl. I don't want to see them treated the same way.

Mr. Chamorro also comments:

I came from the same background as these kids. I'm an immigrant, I came to this country, had new people, a new city, new rules. I consider that when a kid comes to the States, he or she is born again because it is so new. Sometimes I identify myself with these kids. They struggled when they came to this new country, the language barrier, the new customs, the food, the family structure. So rather than being more like a teacher, I'm more like a mirror. I'm trying to have the kids see me as a future image for the kids, if they keep working hard and learning. They have an example in the teachers. They have an example in Mr. Chamorro who is an immigrant, who came to the States with some background preparation but with English skills that weren't that good, but now he is surviving.

But understanding solidarity goes beyond "having been there." We believe that Mr. Simkin's (an Anglo) uses of Spanish in his classroom are also solidarity markers. Sometimes in his classes, he code switches between Spanish and English as a way of expressing solidarity with students who identify more with U.S. culture and English and who themselves code switch. At other times, in the same class, he uses Spanish exclusively with students who are recent immigrants.

Ms. Andula made the distinction "between those teachers who walk the same path with children [i.e., share the culture] from those who can never walk the same path, but who can walk side by side in solidarity." The implication is that it is not necessary to be of the same culture with one's students to make connections with them, but that standing with them may be at least as important. Teachers who are in solidarity with students and families are quite different from teachers who substitute themselves for the families. Delpit (1992b) argues that even well-meaning educators can maintain these deficit orientations that pathologize students, families, and communities of color; for example, teachers with a "messiah complex" believe they have a mission to "save" children from their families and communities. As an example of solidarity, Ms. Salinas said at a faculty meeting that rather than have parenting workshops for students' families, teachers should try to learn from the families and see themselves as equals, not superiors. In this way, the teachers with whom we have been working also convey the idea that students and their families, together with others, have the ability to change their own conditions, rather than conceptualize students and families as victims.

A second aspect of empowerment is seeing culture dialectically, that is, building on its strengths, but struggling with its limitations, and going beyond traditional boundaries that may limit a people's potential. A dialectical view sees culture as the historical and changing production of a people, one that is shaped by evolving realities and, especially for oppressed people, by the experience of living with and against adversity, an experience that fosters strengths and limitations. The goal is to develop the strengths and move beyond the limitations to develop cultural excellence (Ladson-Billings, 1994) and fluent biculturalism and bilingualism (Darder, 1995). This view contrasts with the folkloric notion that romanticizes culture and sees it as a static entity easily objectified.

Examples of the teachers' all-rounded stance toward culture are reconceptualizing gender roles, adult-child interactions, and the relationship of the community to the broader society. Commenting on gender issues, Ms. Andula responded to the question of what strengths the students bring with them to school:

They live their culture, the music, the food, deep ideas about family and family closeness, their sense of sharing, their values, they are kind, despite the individualism of the society... They are sentimental, romantic. This is a positive thing. It should not be looked at "as weak." On the other side, they bring machismo—that's part of the culture too. But we work on that in the classroom. I tell them there are physical differences in males and females, but the capacity is the same, the mental capacity is the same.

A researcher's journal entry, during Phase 1 of the project, also reflected support for females as leaders:

The young women in Mr. Simkin's [mathematics] class are amazing [eighth graders]. They are so clearly the agenda setters in class, the social leaders, and most of all, the intellectual leaders. They speak out, they are confident, they tell the boys what to do. I would love to be able to see them ten years from now, as leaders of their people. I wonder how they got to be like this given [some of] the roles they are supposed to assume in their culture.

We also see teachers reconceiving adult-child relationships. They treat their students differently than is traditional and have children treat adults differently as well. Both Ms. Herrera and Ms. Salinas (the sixth-grade teacher who came from Mexico at age 15) always use the formal *usted* (you) form when addressing their students. This differs markedly from the common adult-child relationships in the community in which adults use the informal *tu* (you) form when addressing children. Both teachers say that they use *usted* to show genuine respect for children and their contributions to the class and to create an atmosphere of mutual respect.⁸

Additionally, some teachers are clearly instilling in their students different ways of relating to adults. For example, Hernandez asked some teachers during a group interview what they thought were the family implications of encouraging the students to take a critical approach to knowledge:

Q: That was something that I wasn't very sure about because ... I wasn't sure whether or not it would go beyond the classroom, like okay, so the kids learn to ask why, but does that mean that they will go out and ask why to their mom and dad? That's something that I'm still not sure about. If they learn to ask why, and to question the authority of a math book, or the authority of a social studies book, will the practice enable them to ask why to their mom or why to their principal or why to someone else in authority?

Ms. A: I think that they will really really do that eventually. I think that we have kids in first and second grade ... they are building up in skill, which is a right for any human being. We are building up that skill. They will even mimic the teacher in the beginning, because kids at that age do it. But it becomes a part of themselves, when they start asking questions that are more deep to people, that are more serious about, they won't accept it. I think that it is *moldear* ... *moldeando* [to mold ... mold-

⁸Mr. Chamorro also does this; however, using *usted* for children is the norm in Colombia. We have not yet investigated how his students see this practice.

ing] their personalities. I think that it's not [natural], but I think that it will become a part of them and that eventually they will have the strength and the *coraje*, *la valentía* [courage] to confront their parents and say why.

This practice has had very interesting effects in Ms. Herrera's class and in her relations with her students' parents. Not only have students appropriated her constant questioning in the classroom, but they appear to have taken it home. When Hernandez sat in on parent-teacher conferences on report-card pickup day, well into the year, she observed parents telling Ms. Herrera how their children were asking more questions at home. During the conferences, Ms. Herrera, in a manner consistent with her pedagogy, asked students for detailed explanation and justification about their work during that quarter rather than tell them what she thought they needed to do. Hernandez observed many parents also questioning their own children in the same ways, to Ms. Herrera's amazement. Ms. Herrera explains this by saying that parents told her that they hear their own children giving reasons and asking why at home. Furthermore, Ms. Herrera believes that parents do not see the questions as challenges:

Parents don't see it as negative, they see their kids learning to explain. They don't see it as a challenge, they are accepting that their kids are not machines, but that they are learning. The kids, when I ask them why, they don't see it as a challenge, but as something to learn from. They learn that you have to find ways to defend well-thought-out explanations, what you're saying has to be clear. Parents see it as something that will benefit their child. It's part of being independent, it's learning that you do not have to be quiet ... I grew up really shy, and I want them to see that they don't need to be the same way.

Thus, Ms. Herrera appears to be helping children make the distinction between an intellectual challenge and an inappropriate challenge to adult authority (cf. Ladson-Billings, 1995).

Finally, teachers see that the safety and comfort of a tightly knit community and a vibrant, homogeneous culture can also be barriers that hold back children and help create fear of the outside world. Both Mr. Chamorro and Mr. Simkin take their students downtown to help break their isolation. Mr. Chamorro exemplifies an orientation toward biculturalism or becoming participants in two worlds:

All I want is for my kids is to be successful, no matter what society they are in... to succeed, it has to be in whatever society ... [taking them downtown] teaches the kids there's a world outside the *barrio* [neighborhood]. This broadens their scope and perspective. They are afraid to leave the *barrio*. [to the kids, he says] All those big buildings aren't as big as they look. Hey listen, there's something outside Mulroon Street [a pseudonym].

In this example, he not only broadens students' experiences and knowledge beyond their own community and culture, he also uses their experience of being downtown to teach them that mainstream society is part of their world also.

We suggest that culturally relevant teachers do not romanticize the culture or community (nor do they pathologize it), but rather look at it squarely and see its strengths and limitations. They look at the children eye to eye. They are not do-gooders because they do not proceed from a paternalism rooted in a deficit mentality. With an orientation toward empowerment, teachers see their role as helping children move

forward to reshape their world, children with the potential to become leaders both in their communities *and* in the broader society.⁹ As Darder (1995) concludes,

Latino teachers who possess an implicit understanding of the cultural and linguistic community of their students and who also embrace the pedagogical principles of critical pedagogy are better able to create an educational environment that stimulates greater creativity, voice, and participation for Latino students. (p. 345)

The last aspect of empowerment has to do with providing academic challenges to students. Mr. Chamorro teaches the seventh-grade gifted program mathematics class, three seventh-grade mathematics classes in the bilingual program, and one in the English program. When Rivera School purchased the MiC curriculum it did so with funds from the district's gifted program office because that was a source of financial resources. The materials were to be used only in the gifted program for the first year, as a pilot program. The MiC curriculum is far more challenging than Rivera's other mathematics curriculum, but by midyear, Mr. Chamorro was using it essentially full-time in all his classes. His rationale was that all his students needed to learn the challenging mathematics in MiC. Mr. Simkin, who teaches the eighth-grade gifted program mathematics class, also spread MiC to his other, regular program classes, although not to the extent Mr. Chamorro had. His reasoning was basically the same. Finally, Mr. Chamorro taught in the district-mandated remedial summer school the year before Rivera formally adopted MiC. Although the summer school is for students substantially below grade level on standardized tests, Mr. Chamorro used MiC rather than the standard textbook.

CONCLUSION

Our experiences working with teachers in schools in many different contexts and teaching and attending preservice education classes lead us to believe that most educators would not readily make the connection between teaching mathematics and social activism, although exceptions can be found in the mathematics-education literature. For example, Frankenstein (1991, 1995) teaches mathematics to adults and uses her classes as a way for them to develop class consciousness and learn how society is structured through mathematical analysis, Tate (1995) describes an Africentric approach to mathematics teaching that empowered students and that involved students in *mathematizing*¹⁰ social problems, and Apple (1992) advocates for "a much more active and socially aware [mathematics] teacher," (p. 425). Still, mathematics is usually seen as a neutral and objective subject, devoid of specific class, cultural, or political content; the connection to social activism may seem to be a stretch. Even when mathematics learning is seen as personally empowering, it is rarely thought of as having broader, social justice implications for those learning it. We note that

⁹This is similar to Friere's (1974) discussion of the internalization of oppression and his idea of education as the practice of freedom, or *conscientizacion*.

¹⁰*Mathematizing* in this context refers to analyzing a real-world situation from a mathematical perspective.

this is less true for education in general, with a strong literature on transformative education and education for social justice (e.g., Friere, 1974; Giroux, 1988; hooks, 1994; and McLaren, 1989).

Yet our data suggest that the teachers in this project do make the connections between mathematics teaching and social activism. Although we have no evidence of teachers helping students mathematize society or use quantitative data about society, as Frankenstein does in her classes, our concept of “teaching as social activism” has been expanded. There is a range in how these teachers put their beliefs into practice. Some, like Ms. Andula, are explicit in terms of their activist philosophies. Some of the teachers are explicit about the relationships between teaching mathematics and producing leaders among students from a marginalized group. Teachers like Ms. Herrera are not overtly political in their analyses but see themselves and their own experiences of oppression reflected in their students. In both instances, these teachers steadily help prepare children to be leaders of their people and society. It is our sense that despite their surface differences, all the teachers fall within Ladson-Billings’s (1994) notion of culturally relevant teaching, “teachers ... need to help arm African American children [i.e., marginalized peoples] with the knowledge, skills, and attitude needed to struggle successfully against oppression” (p. 139).

Our research goals were to understand potential relationships between the NCTM *Standards* documents and culturally relevant teaching and to understand, from the perspective of culturally relevant teaching, how teachers use children’s culture when teaching mathematics in a Mexican American context. The model we present here, based on theory and initial data, summarizes what we have learned. Clearly, it requires further investigation and development. Nonetheless, we believe we have uncovered certain things. First among these is that there are different ways in which the NCTM Standards and the theory of culturally relevant teaching may overlap. Both the NCTM Standards and culturally relevant teaching encompass the idea of teachers’ using children’s knowledge, albeit different types of knowledge. For the Standards, the knowledge of interest is children’s informal mathematical knowledge, whereas for culturally relevant teaching, it is children’s cultural knowledge. And both also include the notion of critical thinking, although again, each describes and interprets this concept differently. Although they are related, an important distinction exists between thinking critically in mathematics—an essential component of mathematical reasoning and power—and viewing knowledge critically in general—necessary for effecting social change.

However, although these intersection points exist, teachers must actualize them. Researchers in mathematics education and culturally relevant teaching have little dialogue with each other; for this reason, among others, preservice and in-service mathematics education rarely includes cultural issues beyond surface-level discussions. The fact that the recently published *Handbook of Research on Multicultural Education* (Banks & Banks, 1995) contains very few references to mathematics indicates that too little research has been done that spans the two fields. Furthermore, there is no reason to believe, for example, that teachers who build on one type of students’ knowledge will necessarily build on another. This lack of interchange also

holds for mathematics educators and proponents of critical education, which partially explains why classroom teachers rarely integrate critical mathematical teaching with critical education. However, what we have seen in this project is that elements of the overlap between the NCTM Standards and culturally relevant teaching do exist in practice, and they are worthwhile pursuing as we think about how to improve mathematics education for all our children.

Our second main area of learning has come in trying to understand what culturally relevant teaching in a Mexican American context looks like. Although our knowledge is partial, our research suggests some elements. Some of these are known, for example, the fact that teachers build connections with families to create classroom cultures that mirror students' own or that teachers build on students' first language as part of a curriculum of empowerment and as a way to promote cultural excellence and biculturalism. But other aspects have not been sufficiently discussed, if at all. For us, a significant point is that teachers in this project see culture in a realistic, nonpatronizing, and all-sided way; they recognize aspects of the culture that they believe may hold students back, particularly with respect to gender, adult-child interactions, and the comfort of the community. Another important insight for us is that by demonstrating solidarity with students, whether or not they share the culture, teachers may create educational settings in which students, families, and teachers can be allies in a common effort.

Finally, we cannot overstate the strength of the collaborative nature of this research. The teachers and de los Reyes, the principal, contributed much of the analysis; indeed, they *are* the experts on culturally relevant teaching. That it is often difficult for them to articulate what they do, because they are immersed in their culture and practice, points out the necessity for collaborative work. Hernandez brought to the project the role of insider-outsider, viewing Rivera not only through the eyes of a cultural and community insider with commitment to the community but also as an outsider to the school itself and as a novice teacher. Gutstein and Lipman functioned as cultural and community outsiders but brought theoretical knowledge and frameworks, mathematics-education knowledge, and the perspectives of having observed in many schools. These multiple perspectives have enriched our group discussions and analyses, and as a result, the conversations have been particularly fruitful in untangling some of the complexities of the relationships between mathematics education and culturally relevant teaching.

As our group of teachers, administrators, and university personnel continues to dialogue, we intend to keep trying to capture the "lightning in a bottle," that is, the knowledge of teachers whose practice is reflected in our model, so we can share it with the school and the larger educational community. We shall also pursue more deeply the relationships between critical mathematics teaching and critical approaches to knowledge in general, and between building on children's informal mathematical knowledge and building on their cultural knowledge and experience. In particular, we have questions that have implications for education in general and for mathematics education programs:

- What is the impact of culturally relevant mathematics teaching on students' learning?

- How does an “outsider,” that is, someone from outside the culture, who does not and cannot “walk in the same path” become a culturally relevant teacher?
- How do families perceive teachers’ efforts to develop critical approaches to mathematics and approaches to knowledge that are oriented toward social change?

Mathematics educators cannot afford to be isolated from research related to culture and learning and to culturally relevant teaching. Despite recent moves to incorporate this research, genuine interconnections are still woefully inadequate. Reflecting on our research thus far, we believe that to help students develop tools to participate actively in society and work for social justice, educators need to integrate: students’ informal mathematical knowledge and their culture and experiences, critical mathematical thinking and critical approaches to knowledge in general, and empowerment orientations to culture and experience. This implies, in our view, a significant reorientation in the way many conceive of the reform of mathematics education and of educational change.

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