Journal of Urban Mathematics Education
December 2011, Vol. 4, No. 2, pp. 44–66

K–2 Teachers' Attempts to Connect Out-of-School Experiences to In-School Mathematics Learning

Allison W. McCulloch
North Carolina State University

Patricia L. Marshall
North Carolina State University

In this article, the authors report on a 3-year professional development research project. The project focused in general on early mathematics teaching and learning in urban schools and in particular on promoting teachers' awareness of the importance of making connections between students' out-of-school experiences to promote deep understanding of K–2 school mathematics. Children cross into school spaces bringing with them a wide variety of out-of-school experiences; this is especially true in the early elementary grades when they have spent more of their lives out of school than in school. Effective teaching at this level requires that teachers put forth concerted efforts to make connections between these out-of-school experiences and formal curricular content. The authors present the strategies that participating teachers (n = 49) employed in their attempts to make such connections as well as implications for future professional development research.

KEYWORDS: cultural connecting, culturally relevant pedagogy, elementary teachers, mathematics education, professional development, urban education

Cultural diversity in K–12 classrooms in the United States is increasingly becoming a prominent topic of discussion in education policy and research, and is even often heard on popular media outlets. These discussions often highlight that the cultural backgrounds of too many teachers today differ considerably from a growing number of children in U.S. schools (Zumwalt & Craig, 2008). The reality of these divergent cultural backgrounds has special implications for teacher education, specifically in regards to the structure of professional development as children today cross into school spaces bringing with them a wider variety of out-

ALLISON W. MCCULLOCH is Assistant Professor of Mathematics Education at North Carolina State University, Department of Science, Technology, Engineering, and Mathematics Education; 2310 Stinson Drive; 502L Poe Hall; Raleigh, NC 27695-7801; email allison_mcculloch@ncsu.edu. Her research focuses on the role of affect and culture in the mathematics teaching and learning process.

PATRICIA L. MARSHALL is Professor of Multicultural Studies at North Carolina State University, Department of Curriculum, Instruction and Counselor Education; 2310 Stinson Drive; 602H Poe Hall; Raleigh, NC 27695-7801; email patricia_marshall@ncsu.edu. Her research focuses on how intersections between elements of teachers' personal identities and their professional concerns about working with ethnoracially diverse students influence understanding and adoption of critical equity pedagogies.

of-school experiences than in previous eras. This "bringing with" is especially true in the early elementary grades where children have spent more of their lives out of school than in school. "Effective" teaching at this level therefore requires that teachers put forth concerted efforts to make connections between children's out-of-school experiences and formal curriculum content. But too often mathematics (and the formal mathematics curriculum) is seen by many to be "culture free," lacking in any truly useful out-of-school experiences that might be drawn upon. Nevertheless, young children do engage in a variety of wide-ranging experiences with number and operations (albeit informally) before formal schooling begins. Reaching across borders—metaphorically, the out-of-school and in-school wall—is especially necessary for effective teaching of early elementary mathematics.

Therefore, in this article, we report on a 3-year professional development research project focused in general on early mathematics teaching and learning in urban schools and in particular on promoting teachers' awareness of the importance of making connections between children's out-of-school experiences to enhance deep understanding of the content of K–2 school mathematics. We present here some of the strategies teachers who participated in our study employed in their attempts to connect out-of-school experiences to in-school mathematics learning, as well as outline implications for future professional development research.

Importance of Making Connections

In recent years, research has highlighted the underachievement of U.S. students in mathematics compared to many of their international peers (Gonzales et al., 2009). There exists a well-documented "gap" between present levels of achievement in mathematics and the levels of excellence set as a goal for all students, particularly for African American students (Hilliard, 2003). To address these major concerns, many scholars and researchers have begun to examine the connection between the development of mathematical knowledge and culture (e.g., Boykin, Coleman, Lilja, & Tyler, 2004; Civil, 2002; Cobb & Nasir, 2002; Gutstein, 2003; Leonard, Napp, & Adeleke, 2009; Lipka, 2005; Martin, 2000; Moschkovich, 2002; Moses & Cobb, 2001).

Research on the connection between knowledge and culture is grounded in the perspective that students come to understand phenomena as they are related to what they already know (Foster, Lewis, & Onafowora, 2003; Ladson-Billings, 1994). Studies have shown that drawing on informal mathematics knowledge leads to increased understanding and attitudes towards the relevance that school mathematics has in students' lives (e.g., Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Gutstein, 2003; Gutstein, Lipman, Hernandez, & de los Reyes, 1997;

Hiebert & Grouws, 2007; Smith, 2000; Wearne & Hiebert, 1989). As such, it is imperative that teachers provide opportunities for students to develop links between new mathematical concepts and extant understandings. This imperative is especially true in the early grades where "formal" mathematical ideas are limited for most children.

An emerging area of research is focused specifically on teachers making connections to children's informal mathematics knowledge in the context of their cultural knowledge. This work has produced some promising results. For example, Boykin and colleagues (2004) studied the effect of a communal learning environment (one that is designed to be consistent with the home social culture of low-income African American children) and found that African American children in a high communal context (i.e., wherein the success of the group as a whole is valued in conjunction with the success of individuals) performed significantly better on a mathematics post-test than did their peers in a low communal context. Another project that attempted to link school mathematics to out-of school experiences was the Yup'ik project which culminated in a curriculum based on the culture of the Yup'ik people, an indigenous group in Alaska. The researchers documented those children whose teachers used the Yup'ik curriculum (after receiving professional development) showed higher achievement than comparable groups of children (Lipka, 2005).

Though research suggests that making connections to both cultural knowledge and informal mathematical knowledge is important for the development of formal mathematical knowledge, there is little discussion in the literature on how teachers actually might do so, especially at the early elementary level. One exception is Civil and Andrade (2002) who have been working toward making explicit connections between the "authentic" mathematics in which children participate at home, and school mathematics. Working with elementary teachers in working-class Mexican-American communities, teachers and researchers made household visits to acquire understanding of the mathematics in which the children participated at home. Utilizing this knowledge, they designed thematic mathematics units intended to capitalize on the children's informal mathematics experiences and understandings. For example, visits to the homes of second-grade children revealed families exposed children to a wealth of knowledge about construction (e.g., materials and shapes used in building homes, painting, and tiling) and the inherent mathematics therein. Making use of this information, the researchers developed a 2-month-long curriculum project based on construction that integrated mathematics, writing, reading, social studies, and science. The mathematical goals included: measurement (including perimeter and area), identifying and classifying shapes, estimation, and patterns. While there were many very positive outcomes from this project, the researchers also noted difficulties they encountered with this model. When working toward merging required curriculum with children's everyday lives, it was often difficult to extract *school mathematics* from the everyday (Civil & Andrade, 2002). They noted: "The transformation of these everyday experiences into pedagogical knowledge for the classroom involves a balancing act between the real world situations and the teacher's mathematical agenda" (p. 158).

Nurturing Mathematics Dreamkeepers: The Project

Nurturing Mathematics Dreamkeepers (Dreamkeepers) was a quasi-experimental, longitudinal professional development intervention study designed to explore how K–2 teachers in urban schools understand and adopt standards-based teaching practices (National Council of Teachers of Mathematics [NCTM], 2000) that have potential to promote young children's deep understanding of early mathematics concepts. Two ideas formed the Dreamkeepers conceptual framework and served as the focus of the professional development intervention. These ideas were standards-based mathematics instruction (NCTM, 2000) and culturally relevant pedagogy (Ladson-Billings, 1994). Standards-based teaching refers to practice consistent with goals set by NCTM in the *Principles and Standards for School Mathematics* (NCTM, 2000). The standards state that teaching "requires understanding what students know and need to learn and then challenging them and supporting them to learn it well" (p. 16). The standards were a call for teaching mathematics with a goal of promoting deep understanding for all students. Standards-based teaching characterizes teachers who operate from the assumption that a student's mathematical reality is not independent of that student's ways of knowing and acting. This characterization implies that what a student "sees, understands, and learns is constrained and afforded by what the student already knows," and that "mathematical learning is a process of transformation of one's knowing and ways of acting" (Simon, Tzur, Heinz, Kinzel, & Smith, 2000, p. 584). That is, the teacher must let go of the notion that "we understand what we see" and recognize that "we see what we understand" (p. 585). Moreover, what we "understand" is greatly informed by the cultural lens through which we view the teaching-learning process (Foster, Lewis, & Onafowora, 2003; Perry, Steele, & Hilliard, 2003).

For the Dreamkeepers project, the concept *culture* was defined as "the consistent ways in which people experience, interpret, and respond to the world around them" (Marshall, 2002, p. 8), including the tendencies, styles, and/or orientations commonly exhibited in academic contexts by persons from the same cultural/ethnoracial community or background. Thus, culture was understood as a critical element in the teaching learning process because learning itself is "fundamentally contextual" (Perry, 2003, p. 4).

Similarly, the concept *race* was presented as a central element of culture. We explored unique issues surrounding race as a critical social construct that permeates all facets of life in U.S. society, including the experiences of teachers and students in schools. Foster, Lewis, and Onafowora (2003) characterize culture as "anthropology's essential concept" (p. 261) that has particular implications for the teaching-learning process. Yet they stopped short of equating culture with other related social constructs such as race, noting, "whereas culture, race, ethnicity, and nationality are intertwined in complex ways, culture is not coterminous with any one of these constructions" (p. 262).

Even so, in the United States, race represents a peculiarly complex construct that historically has been deliberately conflated with group culture. In part, this is because of the longstanding practice in the United States of classifying people by "race" (Marshall, 2002). Correspondingly, most individuals in the United States acquire group and personal identities that are aligned with the particular worldviews and ways of being (i.e., culture) that are directly and commonly associated with the racial group within which they are classified (Helms, 1993). Thus, although we made distinctions between the two concepts—culture and race—we highlighted that the concepts are often used synonymously in discussions of schooling. In so doing, we took into account some of the professional literature related to behavioral styles. Hilliard's (1992, 2003) focus on the behavioral styles of African American students as a cultural/ethnoracial group and the implications for teaching and learning was instructive.

In conjunction with this broad interpretation of culture, the Dreamkeepers project participants were introduced to the notion of cultural relevance as a professional pedagogical orientation. According to Ladson-Billings (1994) there are three primary tenets of cultural relevance: high academic achievement, cultural competency, and sociopolitical awareness. Teachers who effectively promote high academic achievement among students use an array of resources and presentation styles that align with their students' unique learning tendencies. They incorporate students' cultural realities into instruction and, in turn, create a learning atmosphere that is unique to the children in the class, and thereby enhances their interest in academic learning. In a similar vein, cultural competency refers to teachers' abilities to "capitalize on the cultural practices and sensibilities of their students" (Nasir, Hand, & Taylor, 2008, p. 219). It also addresses teachers' abilities to acknowledge themselves as cultural beings and recognize that their worldviews and frames of reference are likely to differ from (and perhaps be in conflict with) at least some students in their classrooms. Lastly, sociopolitical awareness speaks to teachers' knowledge of structural inequities (i.e., status, resource, and power differentials among diverse groups) in the larger society, and how these come to bare on schooling. Teachers who adopt a culturally relevant pedagogical orientation work with colleagues, parents, communities, and the students themselves to neutralize or counteract these effects.

Our goal in the Dreamkeepers project was to capture and analyze the extent, if any, to which teachers incorporated tenets of cultural relevance into their pedagogy in general and their mathematics instruction in particular. That is, as the teachers acquired more critical understandings of culture and race through the project intervention we sought to facilitate an epistemological shift in the pedagogical orientations of most (if not all) of the teachers (Gay, 2002; Haberman, 1995; hooks, 1994; Ladson-Billings, 1994; Moses & Cobb, 2001; Simon, Tzur, Heinz, & Kinzel, 2004). The key objective throughout the project was to promote (provoke) changes in their classroom interactions and professional worldviews. Thus, the idea of *pedagogical orientation* was interpreted as the actual techniques and strategies used to deliver mathematics lessons. It also referred to the substance and focus of the teacher's articulation of pre-teaching intents and post-teaching reflections.

Ultimately, the shift we sought involved the teachers themselves perceiving a need to alter, or change outright, their pedagogy in response to being challenged to consider and capitalize on children's culture and out-of-school experiences in their planning and implementation of in-school mathematics lessons. We felt confident in our assumption that few (if any) of the participants were currently enacting this orientation to their mathematics pedagogy. This assumption was based on participants' input during early retreat activities (including participation in the cross cultural simulation BaFá BaFá [Shirts, 1977]), responses on a survey of multicultural course/professional development experiences, and early classroom observations of mathematics lessons.

Professional Development for Primary Teachers: The Nurturing Mathematics Dreamkeepers Project Intervention

All experimental group teachers in our project were required to participate in an extensive professional development intervention that combined standards-based mathematics and culturally relevant pedagogy. The professional development was organized into four, 2-day sessions ("retreats") spaced throughout each academic year of the project. Each retreat addressed both foci and activities included exploration of the teachers' mathematics content knowledge. Also through the retreats, teachers developed critical awareness of how young children understand key early elementary mathematics concepts, and explored the influence of cultural factors on the teaching-learning process. The overall themes for one year of retreats appear in Table 1. Retreat activities were interactive in that teachers were doing, analyzing, and reflecting with respect to both mathematics and culturally relevant pedagogy (e.g., Banilower & Shimkus, 2004; Loucks-Horsley, Hewson, Love, & Stiles, 1998). They also included examination of student work samples (e.g., Kazemi & Franke, 2004) and classroom videos (e.g., van Es & Sherin, 2008). Particular care was taken to design the Dreamkeepers project intervention to be in alignment with characteristics of high quality professional development as noted in the literature. For example, Darling-Hammond, Wei, Andree, Richardson, and Orphanos (2009) summarized the research on effective professional development, indicating that it needs to be intensive and ongoing. Moreover, it should connect to practice, address the teaching of specific curricular content, focus on student learning, build strong relationships among teachers, and align with school improvement goals. Table 2 outlines the manners in which the Dreamkeepers project intervention was consistent with these critical components of professional development.

Table 1
Nurturing Mathematics Dreamkeepers Retreat Intervention Topics

	Culturally Relevant Pedagogy	Standards-Based Mathematics
Retreat I	• Understanding culture	• NCTM Standards • Constructing counting systems • Base 10 and base 4 number systems • Counting strategies
Retreat II	• Professionalism: The Dreamkeepers Identity • Defining CRP • High academic achievement • Cultural competence	• Teaching mathematics for understanding • Mathematical models and tools • Learning trajectories for addition and subtraction
Retreat III	• Promoting academic achievement • Language and cultural identity	• Early algebraic thinking • Patterning
Retreat IV	• Cultural competence • Enthoracial identity • Sociopolitical consciousness	• Early rational number sense • Fair shares

Table 2
Critical Components of the Nurturing Mathematics Dreamkeepers Professional Development Design

Critical Component	Professional Development Design
Intensive and ongoing	• Approximately 90 hours per year • Four intensive, 2-day retreats each year • One week intensive summer institute each project year

Connected to practice	• Reflection on own teaching of specific lessons • Analysis of peers lessons • Focus on cultural relevance in mathematics teaching • Focus on student understanding
Addresses the teaching of specific curricular content	• Emphasis on teaching and learning of K–2 mathematics • Highlighting understanding of number and operation
Focused on student learning	• Analysis of student work samples • Reflection on student understanding in the context of specific lessons
Facilitates relationships among teachers	• Observed same grade peer's mathematics lessons • Analysis of peers teaching • Engaged in cross cohort/grade/school collaborations • Worked together to develop workshops for conference Presentations
Aligned with school improvement goals	• Schools were invited to participate based on their student population and school improvement goals • Participants were leaders within school-based professional learning communities • Participants drew upon Nurturing Mathematics Dreamkeepers project goals in formulation of school improvement plans

In addition to attending the project retreats, participants were required to observe each other teaching two consecutive mathematics lessons four times each year. To facilitate these observations, they were organized into same-grade "buddies" (pairs or triads) with a teaching peer from their same school. Following the observations (at a mutually convenient time before or after school), the teachers engaged in a structured reflective session with a trained research assistant in which they discussed the children's understandings of mathematics concepts along with the role of culture in the planning and implementation of the lesson. According to Garet, Porter, Desimone, Birman, and Yoon (2009) these types of activities (i.e., observation, reflection, feedback) lead to not only enhanced knowledge and skills but also change in teacher practice.

Methods

Participants

The participants in the Dreamkeepers project were practicing kindergarten, first, and second grade teachers (n = 49), organized into three intervention groups or "cohorts" based on the year they joined the study. They were drawn from six elementary schools in a large, urban school district in the southeastern part of the United States. Some participating schools had multiple cohorts of teachers in the project. The teachers' classroom experience ranged from 2 to 20+ years, with the mean years of teaching experience being nearly 10 years. All participants were women, with 37 Whites, 11 Blacks, and 1 Asian. Table 3 presents the cohort breakdown by grade-level. The Dreamkeepers project teachers as a whole did not exhibit deep understanding of many of the mathematics concepts typically taught in early elementary grades (as determined by project mathematics assessments), though their understanding did improve over the course of the project. As noted earlier, we cannot be certain individual teachers were not practicing culturally relevant pedagogy intermittently in their teaching prior to their participation in the Dreamkeepers project. However, we are confident that none were enacting this orientation to their pedagogy on an ongoing basis, based on our early observations and interviews of the teachers. Furthermore, our inter-actions in retreat sessions revealed that the knowledge of nearly all of the teachers in relation to features of culture and its effect on teaching and learning was slight at best.

Table 3
Participants by Cohort and Grade Level

	Kindergarten	First Grade	Second Grade	Total
Cohort I (3 schools)	2	4	2	8
Cohort II (3 schools)	5	4	1	10
Cohort III (6 schools)	13	7	11	31

Data Collection and Analysis

The Dreamkeepers project was a mixed-methods investigation in that we collected and analyzed data drawing on both qualitative and quantitative methods (Tashakkori & Creswell, 2007). Data reported here are drawn from video recorded mathematics lessons and post-teaching reflective sessions that were collected at four intervals during each academic year. Video recorded mathematics lessons were analyzed using a multi-step process involving the collection of both qualitative and quantitative data. Each video recording was first viewed in its entirety. Then each lesson was mapped according to its structure (e.g. lesson opening /closing, whole group instruction, small group activity) (Stigler, Gozales, Kawanaka, Knoll, Serrano, 1999).

Next, each lesson was coded using a rubric developed specifically for the project and consistent with the goals of standards-based mathematics instruction and culturally relevant pedagogy (see DeCuir-Gunby, Marshall, & McCulloch, 2011). The rubric categories focused on teacher communication and actions that were consistent with the guiding theories and goals of the project. Categories included: learning connecting, illuminating thinking, affirming multiple representations, extensions of tasks, language matching, relevance making, cultural connecting, and communalizing.

Finally, critical events identified by the lesson rubric were transcribed verbatim and those transcripts were open coded for further interpretation (Corbin & Strauss, 2008). Four-hundred-eighty-two (482) K–2 mathematics lessons (each ranging in length from 20 to 40 minutes) were coded using the lesson rubric. For the purposes of this article, we were most interested in teacher actions that were attempts to connect children's out-of-school experiences to school mathematics. As such, we focused on a particular set of codes that were created to capture these actions: cultural connecting, language matching, and relevance making. The definition and an example of each of these codes are provided in Table 4.

Table 4
Code, Definition, and Example

Code	Definition	Example
Cultural Connecting	Teacher makes reference to child(ren)'s home/out-of-school experiences with purpose of affirming and illuminating connections to particular mathematics topic, skill, concept, being explored. Does not include attempt to highlight how knowing skills will be useful; intention is to connect and affirm child(ren)'s out-of-school experience with in-school mathematics.	"This jar is filled with different colors of beads. Beads like these are good for putting on braids, just like the one's Jade is wearing in her hair. How many beads do you estimate are in this jar?"
Language Matching	Teacher makes use of child(ren)'s own language (as opposed to standardized mathematical language) when giving an instructional directive, explanation, or following up on child's comments. Purpose is to affirm child(ren)'s own ways of articulating their understanding of the mathematics, by using child's own language.	"Okay Carante, "we gon' put them two numbers together" and then, what we 'gon do next?"
Relevance Making	Teacher makes deliberate effort to help children make association between mathematics task, concept, skill, etc. (or asks child to), and then illuminates for children or asks child(ren) to demonstrate *how knowing* the task, concept, skill, etc. *will be helpful* in non-school situations.	"How many of you buy things at the "Cruizers" store just down the street? If you went to that store and wanted to buy some candy and gum, how could you use what we learned today about adding numbers?"

Reflective sessions were included as a data source for this article to add to the reliability of the findings. The purpose of the reflective session was to explore the nature of teachers' thinking about mathematics instruction. This exploration included being asked to reflect on the execution of lessons, articulation of the nature and observed evidence of students' understanding of mathematics concepts, and the role of culture in the planning and implementation of the lesson. These sessions provided another perspective (the teachers') to the analysis of the lessons. The duration of the reflective sessions ranged from 1 to 2 hours, depending on the verbosity of the participants. All sessions were analyzed using thematic content analysis (Coffey & Atkinson, 1996). A codebook was developed through theory and data driven coding that resulted in 27 codes (see DeCuir-Gunby, Marshall, & McCulloch, 2011). Once coding was completed, the codes were organized into larger themes, guided by either theory or patterns that emerged from the data. Finally, findings from the video recorded lessons and the reflective sessions were compared and interpreted.

All analyses were completed by the research team, which consisted of three principal investigators and five research assistants. With such a large research team, we found it necessary to extend Miles and Huberman's (1994) approach for establishing inter-rater reliability; therefore, we created a process focused on group "consensus" (Harry, Sturges, & Klinger, 2005). All members of the research team coded practice artifacts until interpretations of all codes reached 100%. Reliability was checked throughout the data analysis process by periodically choosing a data piece to be coded by multiple coders in order to ensure that coding remained consistent (see DeCuir-Gunby, Marshall, & McCulloch [in press] for further detail).

Results

Connecting Out-of-School Experiences to In-School Mathematics Learning During Instruction

The analysis of the video recorded mathematics lessons revealed that instances in which teachers explicitly made connections between children's out-of-school experiences and the curricular content were not commonplace. Moreover, those that were made were superficial in nature. In the 482 lessons coded, there were only 149 instances in which one of the codes associated with such actions was used. All but 12 instances of out-of-school/in-school mathematics connections occurred *after* the teachers had participated in at least two retreats. We believe the relatively late introduction of these actions suggests that the project intervention prompted the attention towards such connections for these teachers. It is important to note that even though there were 149 instances, the instances occurred in 102 different lessons, taught by 42 different teachers, spread relatively evenly over the three cohorts and years of the project. This distribution suggests that although the vast majority of the teachers engaged in out-of-school/in-school mathematics connecting, they did so infrequently. Nevertheless, the fact that the majority of them did engage in these actions suggests that the culture/mathematics focus of the intervention *was* having an impact, if only minimal.

The cohort structure of the Dreamkeepers project allowed us to gain some insight into the cumulative effect of the professional development on the Dreamkeepers project teachers. For example, 100% of the teachers in Cohort 1 had at least one instance of an out-of-school/in-school mathematics connection, whereas 90% of the Cohort 2 teachers, and 83% of the Cohort 3 teachers did. At the lesson level we found that 31% of the Cohort 1 teachers' lessons had at least one instance, compared to 19% of Cohort 2 lessons, and 17% of Cohort 3 lessons. Taken together these statistics suggest that the length (number of retreats per year) and depth (years in project) of teachers' exposure and engagement with intersections between the concepts culture and mathematics did impact their incorporation of features of a culturally relevant orientation in their mathematics lessons. Our analysis of the data that fell into the three out-of-school/in-school connections codes (i.e., cultural connecting, language matching, and relevance making) revealed that in their efforts to connect mathematics lessons to children's out-of-school lives the teachers' actions fell into four categories: *clarifying mathematical context*, *making mathematics relevant*, *introduction of formal mathematics*, and *validating students' mathematical contributions*. In the next sections, we describe the Dreamkeepers project teachers' actions in each of these categories as they relate to connecting out-of-school experiences to specific mathematics lessons. Examples that typify such actions are also presented.

Clarifying mathematical context. One of the ways that the Dreamkeepers project teachers connected to children's out-of-school experiences during mathematics lessons was through use of contextual problems. When using such problems teachers were often very careful about making sure that all of the students understood the situation and/or object being discussed. For example, Teacher 3-F-27[1] presented an informal measurement task to her students that referred to a bathtub. In the task, students were asked to determine the length of a bathtub with respect to a soap bar, a toothbrush, a washcloth, and a towel (Teaching Integrated Mathematics and Science, 2004). During an initial discussion of the task she paused and stated:

> Okay, think about your bathtub at home. Everyone close your eyes and think about your bathtub at home. Okay, some of you might say I know I grew up, I didn't have

[1] Teacher ID codes were generated for project use to maintain confidentiality. The middle symbol reflects the grade taught (K = kindergarten, F = first grade, S = second grade).

> a bathtub at my dad's house; I had a stand-up shower. So I would be sitting here going Mrs. Smith I have no idea what you are talking about 'cause I got a stand up shower, I don't have a bathtub. So if you don't have a bathtub then it's kind of hard for you to think about how long it is.

She went on to explain that a bathtub is typically as long as the table that was placed at the front of the classroom. In the context of this lesson, it served as a referent for the children.

In some instances, the teacher did not immediately clarify the context as above, but instead surveyed the children to check for their understanding of an out-of-school context she planned to draw upon. For example, in preparation for an activity in which they would be asked to create different coin combinations at an imaginary store, rather than assuming the context was familiar to all of the children, teacher 3-S-16 said, "Raise your hand if you go grocery shopping or clothing shopping with your mom or dad." Such a check for understanding was typically followed either by a clarification or by continuing forward, depending on the children's responses.

Making mathematics relevant. The Dreamkeepers project teachers also tried to connect in-school mathematics learning to children's out-of-school lives by pointing out why knowing particular mathematical ideas will be important in their futures. Summarizing a lesson on doubling, teacher 1-F-8 asked: "Why do we need to learn doubles? What would be the point? How will it help me out in the world? How will doubling help one in life?" At first the children responded that they would need to know it to "do math homework." The teacher probed further: "Ok, but that's just work that I give you. What about outside of school work?" At this point, the children offered ideas such as "it will help me count my money" and "counting Pop Tarts, because they come in twos." This conversation continued with the teacher posing situations. Placing a hand on a girl's shoulder, the teacher posited: "Suppose you're going on a date and it costs $5 for a ticket. How will you figure out how much for you both?" To which the children shouted, "Double it!"

In some instances, teachers' attempts to make mathematics relevant included highlighting examples of mathematical properties. When teacher 1-F-8 discussed symmetry, for example, she asked children to brainstorm objects that were symmetrical. Remarking on one child's braided hairstyle, she queried: "Does your hair have symmetry? If I put a line down the middle I have the same amount of braids on one side and the same amount on the other side. So, hair designers need to know symmetry." Continuing the hair reference to illustrate the importance of symmetry she asked: "What if I was a hair designer and you wanted me to do your hair for a ball you were going to. Ladies, would you want one side curled and the other side punk rock?" Similarly, during a lesson on grouping by 2's teacher 2-F-1 pointed out objects that came in groups of 2 to illustrate the mathematical concept: "What comes in groups of 2? Earrings. Some people have more than 2 earrings, but [teacher's name] only has 2." This listing of objects that the children were familiar with in their every day lives was her way of trying to connect their experiences to the mathematics being learned.

Introduction of formal mathematics. Young students often rely on terms they use regularly out-of-school to describe new phenomena and objects introduced in school. Using children's out-of-school language in the classroom was another way that teachers made connections to out-of-school experiences. Such actions demonstrated to the children that their informal mathematical ideas and ways of expressing those ideas were valued in the classroom. When this occurred, the Dreamkeepers project teachers often used the opportunity to introduce formal mathematical language. For example, when introducing an activity in which children were to sort objects based on weight, teacher 3-K-13 brought out a balance scale and asked if anyone recognized the tool. One child shared that it is a "weigher" and went on to note that she has one at home. The teacher responded, "It's a weigher, good. We can also call it a balance." This response let the student know that what she called it at home was perfectly acceptable, while also introducing her to the term that would be used for the tool in school.

Validation of students' mathematical contributions. The act of validating a mathematical contribution refers to situations in which children offered a contribution to the mathematical conversation that drew on their out-of-school lives, and the teacher acknowledged the contribution with respect to the lesson. For example, as teacher 3-K-29 began her mathematics lesson she asked the children if they remembered what they had been learning in math. One child offered that during dinner with her dad she had eaten "4 peas and 2 corn." The teacher responded: "You had 4 peas and 2 corn, so you asked the question how many do I have in all? How many did you have in all?" This response acknowledged the child's contribution and tied it to the mathematics they had been learning.

At times children's contributions were not in the form of sharing a specific experience, but instead sharing their out-of-school (informal) language. In these instances validation occurred through the teacher's restatement of the child's contribution to the mathematical conversation using the same language as the child; no corrections were made to the student's word choice. In a whole class discussion at the end of a lesson on estimation, teacher 3-S-25 asked the whole class "What does a good estimator do?" to which one child replied, "He wonders." The teacher validated this statement by repeating, in an upbeat voice, "Okay, an estimator wonders." In another example, during an introductory lesson on 3-dimensional figures, teacher 1-K-6 asked children to explain the difference between a circle and a sphere. Many of the children noted that the sphere "sticks up." The teacher then used that language to introduce a cube, wherein she noted that it (a cube) is different from a square because, "as y'all say, it is sticking up."

Drawing on the lesson rubric findings, we were quite unsettled by the scarcity *and* the overall quality of the out-of-school connections demonstrated by the teachers. This unsettled response was because based on informal conversations with the teachers during retreat sessions, it was clear to us that they were thinking about, and in some cases struggling with, how to make these connections. We wondered whether there might have been other instances (besides actual lessons) where the teachers demonstrated connections through their other pedagogical activity. The rubric created to code the lessons focused on the teachers' verbal and physical actions *during* a lesson. This restriction meant that it could not capture decisions made *prior to teaching* the lesson. We speculated about the possibility that such connections could have been considered in the context of post teaching activity. Thus, to gain a different perspective on the teachers' considerations with respect to making out-of-school/in-school connections we turned to analyses of their reflective sessions.

Reflecting on Lessons and Out-of-School Connections

Analysis of the teachers' reflective sessions revealed that most of them *did* in fact consider their students' out-of-school experiences in the planning of their lessons. In many cases, the enacted lessons reflected decisions they had made regarding how to best set up a task and the structure of the lesson as a whole with students' out-of-school experiences in mind. For example, when reflecting on a task referring to a yak teacher 3-F-1 noted that she knew many of her students had not ever heard of a yak: "So you know, I went on the Internet real quick and showed them what a yak was." Though she was aware that many children were not familiar with yaks, the term itself was left in the task intentionally. She explained, "I know they're not going to know; but I leave it in there so that they can be exposed to different words." In contrast, some teachers very carefully chose the context of problems to carefully match children's out-of-school experiences. Teacher 3-S-26 intentionally chose to include buttons for a task, noting: "Well, with the buttons, some of the students could relate. You know, they had said, 'Oh, my grandmother has a box of buttons.' And they were really interested in the buttons." While this teacher was relatively certain most of the children were familiar with buttons, her assumption about the extent of their familiarity was obviously measured:

> We talked about how buttons are sewn on. And we even looked at how people used buttons—you know, in the past. We had some pictures from a book that we had read. So [I'm] just kind of building on some of their background experiences.

There were some situations in which teachers engaged children in lengthy discussion at the beginning of a mathematics lesson about the context of the lesson (not the mathematics) to set the stage appropriately for all students. For example, when reflecting on one of her first lessons involving money, teacher 2-K-2 explained why she spent so much time at the beginning of the lesson talking with the children about money, and how they spend it:

> Different cultures interpret money differently. Some children don't touch money, don't own any money. But some other cultures may give it to them as a reward and different celebration types. It just depends on how they use it at home.

She felt this time was well spent as they moved forward with the money unit. According to the teacher, it provided an opportunity for all of the children to share experiences with money, and it informed her decisions about future lessons in the unit. Notably, this teacher explicitly mentioned culture in her explanation, suggesting that the expected interconnection between culture and mathematics promoted in the Dreamkeepers project had influenced her pedagogy.

While we saw evidence of teachers' using children's informal language in the context of mathematical discussions, one of the main concerns and considerations of the Dreamkeepers project teachers was how to work with children for which English is a second language (ESL). Connecting the out-of-school language experiences with in-school mathematics language and curriculum proved to be challenging in such cases. Analyses of reflection sessions revealed that when discussing the context of a problem that students might be unfamiliar with, teachers asked children with non-English home languages to share the names/words used in their homes for particular objects. For instance, discussing a lesson on number modeling, teacher 3-K-5 explained that she tried to make sure to include number words in all the various languages represented in her class: "They were brainstorming all the ways to model that number. We did the Spanish word. And then one of the kids said, 'We need to do French' and the students all turned to Charlotte and asked her. Then we also did Arabic."

In addition to drawing on home languages when setting up problems, teachers also focused on classroom interactions that would be most helpful in providing ESL students the structure needed to engage in mathematical activities with English-dominant peers. Some teachers made deliberate decisions about seating arrangements with ESL students in mind. Teacher 3-K-12, who discussed small group seating and interaction strategies for ESL students during a lesson on sorting, provides an example of this decision-making process:

> Just that they're able to watch what somebody else is doing. And see, and pick up, and—you know, for them I think sometimes it's better for them to sit back and listen and watch and observe, and absorb things. Because they're picking up on terms that the kids are using when they're talking to each other. And you know, they're learning well, what is shiny. Because they—you know, in their language shiny is some other word. …In that sense I think it was good for them to do it with their group, ra-

> ther than trying to do it by themselves. Because if they were doing it by themselves, they would have no one to feed off of. They wouldn't have anybody to prompt them, or—you know, to physically show them what they're supposed to be doing.

Many of the teachers shared such strategies for their ESL students. In addition, they also noted intentional use of pictures and objects, "so if their English wasn't that good, they could see the visual" and the adaptation of curriculum materials. Teacher 2-F-1 noted: "On that homework sheet, I did see it was a little too wordy. I mean, it was describing the hand span and the cubit and the directions were a little bit wordy too." She went on to explain in detail the words she cut out and the illustrations she added to facilitate the children's ability to complete their homework assignment.

Discussion

Analysis of video recorded lessons revealed that the number of explicit out-of-school connections made during mathematics lessons was low. Furthermore, many of the connections were quite simplistic and were clearly not effectively capitalizing on the children's out-of-school prior knowledge and experiences in mathematically meaningful ways. However, we see in the teachers' reflections that indeed they were seriously considering, and often struggling with, how to make connections between the school mathematics curriculum and out-of-school experiences. We recognized that our teachers generated few out-of-school connections in their lessons that were mathematically meaningful. So the question we were faced with was: What might be some reasons so few of the teachers demonstrated facility with making connections? This question surfaced because there are outstanding examples in the literature of teachers who are successful in this venture. Descriptions of these successful teachers however, reveal that they often engage in curriculum *development* activity drawing on their students' out-of-school realities and experiences (e.g., Boykin et al, 2004; Civil, 2002; Civil & Andrade, 2002; Gutstein, 2003; Gutstein, et al., 1997; Lipka, 2005; Moses & Cobb, 2001). For our teachers, we believe at least one factor precluded their willingness to modify their curriculum in any manner, including engaging in substantive out-of-school/in-school connecting. This factor was the district-wide "pacing guide" that the teachers perceived they were required to implement. Our teachers were acutely aware that they were expected to teach particular topics on particular days, and to cover a certain amount of material by a certain point in the academic year. For them, the power of the orthodoxy surrounding the pacing guide was reinforced by district-wide standardized testing that occurred during and at the conclusion of each academic year.

We theorize that another explanation for teachers' minimal acknowledgement of students' out-of-school experiences in the enactment of their lessons may have been their lack of deep understanding and/or comfort with mathematics. Opening up to students' informal understanding is risky for teachers who do not have deep understanding of the mathematics themselves. All of this, coupled with knowing that their lessons were being video recorded, might have resulted in less receptivity to encourage children to share their informal mathematical understandings. Scholars report that teachers whose mathematical knowledge background is slight are far less likely to engage in mathematical conversations or unconventional mathematical teaching, that have the potential to reveal and affirm the knowledge capital that students bring with them to school (Hilliard, 2003; Leonard, Brooks, Barnes-Johnson, & Berry, 2010). Nevertheless, those Dreamkeepers project teachers who *were* successful in drawing on children's experiences to make mathematics more meaningful were successful in making the thick borders (metaphorical walls) between school and home more permeable. Whereas those who were not might have inadvertently erected an additional border that served to even further separate school mathematics from out-of-school experiences.

In hindsight, we have reason to believe that the creation of additional borders as noted above would have been less likely to occur in the context of literacy instruction. This is because for most of the Dreamkeepers project teachers, literacy was an area with which they felt comfortable and knowledgeable. Similarly, many held the common (mis)perception that literacy is necessarily a more "natural" content area fit with which to make out-of-school cultural connections.[2] It is true that literacy often provides obvious out-of-school connections, yet some of the teachers made effective connections to mathematics topics that are commonly recognized as directly applicable to real life. Among these were counting money, telling time, measurement, and fair shares. Not only did these types of concepts seem easier for the teachers to engage children in conversations about mathematics with respect to their previous experiences but also the teachers were quite familiar with stories (literature) in which characters were in situations that required use of the mathematics. These stories were often used to begin such conversations. On the other hand, teachers seemed to have more difficulty finding the out-of-school connections with concepts they viewed as "school mathematics" (e.g., addition and subtraction algorithms) (Civil & Andrade, 2002).

An unexpected issue we encountered during data collection was that some teachers tended to maintain a somewhat narrow understanding of the concept of culture despite the broader definition used in the project. During the reflective sessions, teachers were asked to discuss the role of culture in their lessons. In part, this question was intended to elicit their perspectives on how they attempted to draw upon the children's out-of-school realities in mathematics lessons. When

[2] Such misconceptions may be owing to the fact that early content integration as a dimension of multicultural education (Banks, 2002) often focused on literacy/literature and social studies curriculum (Marshall, 2002).

responding to the question however, some teachers tended to highlight and isolate race without considering its complex relationship to culture. Typically they would indicate that they did not consider race (for them a proxy for culture), in their mathematics teaching. Thus, we believe one critical block that prevented teachers from making connections to children's culture was the simplistic connections they drew between race and culture. Indeed discomfort with the issue of race manifested in some teachers embracing a "colorblind perspective." Doing so meant that they would ignore and/or avoid reflection session questions where they were being asked to describe the influence of children's backgrounds on the teaching and learning process. This avoidance coupled with their deeply entrenched beliefs that mathematics is culture free, and in turn, translated to mathematics is race free. For teachers who understand culture as a euphemism for race, a child's cultural (racial) background is irrelevant to the teaching-learning process. Likewise, for such teachers making cultural (racial) connections to early mathematics is an unnecessary, if not impossible, undertaking.

In hindsight, we recognize that there were a few limitations to aspects of the design of our study. For example, the wording of a question intended to prompt conversation about the ways the teachers' drew upon children's out-of-school experiences (i.e., explicit use of the term "culture") may have inadvertently resulted in a conflict for many teachers. Also, the substance of the data resulting from the reflection sessions relied heavily on the ability of the research assistants to ask meaningful follow-up questions to teachers' initial responses. As is the case with most research teams involving graduate students as emerging researchers, some of them completed this task better than others. Another limitation was the nature of the video data collected. Each lesson was recorded using one stationary camera aimed at the teacher. As a result, we did not capture individual or small group discussions that took place more than a few feet from the camera. Hence, it is possible that our teachers' *did* engage in one-on-one or small group conversations (in addition to the whole group discussions analyzed here) in which connections were made, but not captured by the camera. These limitations notwithstanding, the data (both video recorded lessons and reflection sessions) reveal that the Dreamkeepers project teachers were indeed attempting to reach across the borders of school to capitalize on children's culture-based outside-of-school experiences with mathematics. Furthermore, the increased frequency with which this occurred as the project progressed suggests that our project was the impetus for making out-of-school/in-school connections.

Conclusion

The Nurturing Mathematics Dreamkeepers project sought to facilitate teachers' ability to make connections between in-school mathematical content and students' out-of-school mathematical experiences. In short, we sought to promote cultural relevance in early mathematics teaching and learning. Our findings suggest that adopting a culturally relevant orientation towards teaching early elementary mathematics does not come easily for many teachers. Still, the promising results of other scholars (e.g., Boykin, et al., 2004; Civil, 2002; Cobb & Nasir, 2002; Gutstein, 2003; Lipka, 2005; Moschkovich, 2002; Moses & Cobb, 2001) along with our findings suggest that more professional development focused specifically on making out-of-school connections to in-school mathematics is needed.

Similarly, the cohort structure of the Nurturing Mathematics Dreamkeepers project suggests that such professional development needs to be intensive and long term. We found that the longer the teachers participated in our project, the more likely they were to make out-of-school/in-school connections in mathematics lessons. The struggles the Dreamkeepers project teachers experienced with the term culture and its relation to mathematics teaching and learning suggests that connections between culture and mathematics may need to be more explicitly grounded in the realities of practice. While we do not believe that critical orientations towards teaching, such as cultural relevance, can be (or should be) fully prescriptive, our results suggest that some "real-world evidences" may be warranted. Likewise, we suggest that teachers be challenged to think creatively to make connections with concepts that are not as obviously associated with children's real-life experiences. Finally, professional development that aims to promote a culturally relevant pedagogy must also aim to improve teachers' own mathematical understanding.

Acknowledgments

The research reported was supported by a grant from the National Science Foundation Grant No. 0353412. Any opinions, findings, and conclusions or recommendations reported herein are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

Banilower, E., & Shimkus, E. (2004). *Professional development observation study*. Chapel Hill, NC: Horizon Research.

Banks, J. A. (2002). Race, knowledge construction, and education in the USA: Lessons from history. *Race Ethnicity and Education, 5*, 7–27.

Boykin, A. W., Coleman, S. T., Lilja, A. J., & Tyler, K. M. (2004). Building on children's cultural assets in simulated classroom performance environments: Research vistas in the communal learning paradigm. Center for Research on the Education of Students Placed at Risk (CRESPAR) Technical Report 68. Retrieved from: http://www.csos.jhu.edu/crespar/techReports/Report68.pdf.

Carpenter, T. P., Fennema, E., Peterson, P. L., Chiang, C., & Loef, M. (1989). Using knowledge of children's mathematical thinking in classroom teaching: An experimental study. *American Educational Research Journal, 26*, 499–531.

Civil, M. (2002). Culture and mathematics: A community approach. *Journal of Intercultural Studies*, *23*, 133–148.

Civil, M., & Andrade, R. (2002). Transitions between home and school mathematics: Rays of hope amidst the passing clouds. In G. de Abreu, A. J. Bishop, & N. C. Presmeg (Eds.), *Transitions between contexts of mathematical practices* (pp. 149–169). New York: Springer

Cobb, P., & Nasir, N. (2002). Diversity, equity and mathematical learning. *Mathematical Thinking and Learning*, 4(2/3), 91–102.

Coffey, A., & Atkinson, P. (1996). *Making sense of qualitative data: Complementary research designs*. Thousand Oaks, CA: Sage.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research* (3rd ed.). Thousand Oaks, CA: Sage.

Darling-Hammond, L., Wei, R. C., Andree, A., Richardson, N., & Orphanos, S. (2009). Professional learning in the learning profession: A status report on teacher development in the United States and abroad. *National Staff Development Council and The School Redesign Network*. Stanford, CA: Stanford University.

DeCuir-Gunby, J. T., Marshall, P. L., & McCulloch, A. W. (2011). Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field Methods*, *23*, 136–155.

DeCuir-Gunby, J. T., Marshall, P. L., & McCulloch, A. W. (in press). Using mixed methods to analyze video data: A mathematics teacher professional development example. *Journal of Mixed Methods Research.*

Foster, M., Lewis, J., & Onafowora, L. (2003). Anthropology, culture, and research on teaching and learning: Applying what we have learned to improve practice. *Teachers College Record*, *105*, 261–277.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, *38*, 915–945.

Gay, G. (Speaker). (2002). *Culturally responsive teaching*. (DVD). Washington, DC: National Association for Multicultural Education.

Gonzales, P., Williams, T., Jocelyn, L., Roey, S., Kastberg, D., & Brenwald, S. (2009). Highlights from TIMSS 2007: Mathematics and science achievement of U.S. forth- and eighth-grade students in an international context. Retrieved from: http://nces.ed.gov/pubs2009/2009001.pdf.

Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education*, *34*, 37–73.

Gutstein, E., Lipman, P., Hernandez, P., & de los Reyes, R. (1997). Culturally relevant mathematics teaching in a Mexican American context. *Journal for Research in Mathematics Education*, *28*, 709–737.

Haberman, M. (1995). *Star teachers of children in poverty*. West Lafayette, IN: Kappa Delta Pi.

Harry, B., Sturges, K., & Klinger, J. (2005). Mapping the process: An exemplar of process and challenge in grounded theory analysis. *Educational Researcher*, *34*(2), 3–13.

Helms, J. E. (Ed.) (1993). *Black and white racial identity: Theory, research, and practice*. Westport, CT: Praeger.

Hiebert, J., & Grouws, D. A. (2007). The effects of classroom teaching on students' learning. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (p. 371–404). Charlotte, NC: Information Age.

Hilliard, A., III. (1992). Behavioral styles, culture, and teaching and learning. *The Journal of Negro Education*, *61*, 370–377.

Hilliard, A., III (2003). No mystery: Closing the achievement gap between Africans and excellence. In T. Perry, C. Steele, & A. Hilliard, III, *Young, gifted and black: Promoting high achievement among African-American students* (pp. 131–166). Boston, MA: Beacon Press.

hooks, b. (1994). *Teaching to transgress: Education as the practice of freedom*. New York: Routledge.

Kazemi, E., & Franke, M. (2004). Teacher learning in mathematics: Using student work to promote collective inquiry. *Journal of Mathematics Teacher Education*, *7*, 203–235.

Ladson-Billings, G. (1994). *The Dreamkeepers: Successful teachers for African American Children*. San Francisco, CA: Jossey-Bass.

Leonard, J., Napp, C., & Adeleke, S. (2009). The complexities of culturally relevant pedagogy: A case study of two secondary mathematics teachers and their ESOL students. *The High School Journal*, 93(1), 3–22.

Leonard, J., Brooks, W., Barnes-Johnson, J., & Berry, R. Q. III (2010). The nuances and complexities of teaching mathematics for cultural relevance and social justice. *Journal of Teacher Education, 61*, 261–270.

Lipka, J. (2005) Math in cultural context: Two case studies of a successful culturally based math project. *Anthropology & Education Quarterly, 36*, 367–385.

Loucks-Horsley, S., Hewson, P., Love, N., & Stiles, K. (1998). *Designing Professional Development for Teachers of Science and Mathematics.* Thousand Oaks, CA: Sage.

Marshall, P. L. (2002). Cultural diversity in our schools. Belmont, CA. Wadsworth.

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

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage.

Moschkovich, J. N. (2002). A situated and sociocultural perspective on bilingual mathematics learners. *Mathematical Thinking and Learning.* 4(2/3), 189–212.

Moses, R., & Cobb, C. E., Jr. (2001). Radical equations: Mathematics literacy and civil rights. Boston: Beacon.

Nasir, N. S., Hand, V., & Taylor, E. V. (2008). Culture and mathematics in school: Boundaries between 'cultural' and 'domain' knowledge in the mathematics classroom and beyond. In J. Green, G. J. Kelly, & A. Luke (Eds.), *Review of research in education* (Vol. 32, pp. 187–240). Washington, DC: American Educational Research Association.

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

Perry, T. (2003). Up from the parched earth: Toward a theory of African-American achievement. In T. Perry, C. Steele, & A. G. Hilliard, III, *Young, gifted, and Black: Promoting high achievement among African-American students* (pp. 1–86). Boston: Beacon Press.

Perry, T., Steele, C., & Hilliard, A., III (2003). *Young, gifted, and black: Promoting high achievement among African-American students*. Boston, MA: Beacon Press.

Shirts, R. G. (1977). *BaFá BaFá: A cross culture simulation*. [Simulation activity]. Del Mar, CA: Simulation Training Systems.

Simon, M. A., Tzur, R., Heinz, K., Kinzel, M., & Smith, M. S. (2000). Characterizing a perspective underlying the practice of mathematics teachers in transition. *Journal for Research in Mathematics Education, 31*, 579–601.

Simon, M. A., Tzur, R., Heinz, K., & Kinzel, M. (2004). Explicating a mechanism for conceptual learning: Elaborating the construct of reflective abstraction. *Journal for Research in Mathematics Education, 35*, 305–329.

Smith, T. (2000). Bridging the research-practice gap: Developing a pedagogical framework that promotes mathematical thinking and understanding. *Mathematics Teacher Education and Development*, *2*(1), 4–16.

Stigler, J. W., Gonzales, P., Kawanaka, T., Knoll, S., & Serrano, A. (1999). *The TIMSS videotape classroom study: Methods and findings from an exploratory research project on eighth-grade mathematics instruction in Germany, Japan, and the United States.* Washington, DC: National Center for Educational Statistics.

Tashakkori, A., & Creswell, J. W. (2007). The new era of mixed methods. *Journal of Mixed Methods Research, 1,* 3–7.

Teaching Integrated Mathematics and Science. (2004). *Math Trailblazers: Grade 1*. Dubuque, IA: Kendall Hunt.

van Es, E. A., & Sherin, M. G. (2008). Mathematics teachers' "learning to notice" in the context of a video club. *Teaching and Teacher Education, 24,* 244–276.

Wearne, D., & Hiebert, J. (1989). Cognitive changes during conceptually based instruction on decimal fractions. *Journal of Educational Psychology, 81*, 507–513.

Zumwalt, K., & Craig, E. (2008). Who is teaching?: Does it matter? In M. Cochran-Smith, S. Feiman-Nemser, D. J. McIntyre, & K. E. Demers (Eds.), *Handbook of research on teacher education: Enduring questions in changing contexts* (3rd ed., pp. 134–156). New York: Routledge/Taylor & Francis Group & Association of Teacher Educators.