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Incorporating out-of-school mathematics: from cultural context to embedded practice

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Abstract Connecting students' cultural and community mathematical practices to school mathematics is a critical issue in mathematics education. The goal of the study was to identify how teachers incorporate children's cultural and out-of-school mathematics in instruction. Four related practices were identified, and three drew on children's cultural or out-of-school experiences: (a) using these experiences as contexts for problems, (b) linking these experiences to school mathematics, and (c) identifying embedded mathematical practices prominent in these experiences. A fourth category, teacher initiated situated settings, focused on shared experiences using the classroom as a site of culture. Findings suggest that these practices represent varying levels of complexity and that use of this framework might support teachers in better relating students' cultural and out-of-school experiences to mathematics.

Keywords Out-of-school mathematics · Professional development · Equity · Culture

Introduction

Equity concerns in mathematics education emerge from a broad range of issues including race, identity, opportunities to learn, access for English language learners, teaching for social justice, and culture (DiME 2007). Each of these issues is affected by societal norms, national educational (and other) policies, as well as local and classroom practices. This article attends to one of these issues, culture, by offering a framework for drawing on students' out-of-school experiences to adapt what Mukhopadhyay et al. (2009) refer to as "current traditional, globalized academic mathematics" (p. 78). In examining a professional development designed to support teachers as they broaden their notions of teaching for understanding to consider the cultural and political context in which students live and learn, this study was focused on the ways in which teachers incorporated students' out-of-school and cultural mathematical practices in their classrooms.

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A widely accepted, though contested, view of mathematics assumes all students will attain academic achievement through the use of effective standards-based teaching practices (National Council of Teachers of Mathematics 2000). This view has been further elaborated and refined to offer examples of what mathematics learning and teaching should incorporate; particularly, the fundamental notion of teaching for understanding by building on the mathematical strategies students bring to the classroom (National Research Council 2001; Carpenter et al. 1989). However, scholars who take an equity perspective of teaching and learning mathematics agree that reform instruction that builds on students' understanding is not enough (DiME 2007; Gutiérrez 2002; Martin 2003; Secada and Berman 1999). One aspect of teaching for understanding that has been missing is the need to connect students' strategies to the historical, cultural, social, and political contexts in which they were developed; for example, connecting school mathematics to students' practices outside of school and thus students' identities and positioning in society (Gutiérrez 2009). This connection is critical if we are to address differential opportunities for access and participation in mathematics classrooms. Further, if we do not attend to how students use mathematics out-of-school, they may develop a narrow perspective of school mathematics that is unrelated to how they think about real problems and develop isolated mathematics systems, one that they use in school and one that is applied to solve problems outside of school. Several studies offer evidence of these separate mathematics systems (Abreu 1995; Carraher et al. 1985; Saxe 1988).

Out-of-school, cultural, and everyday mathematics

Many students do not see the connection between the mathematics in which they engage in school and the mathematics they experience out-of-school (Masingila 2002). Additionally, the failure of schools to recognize the mathematical strengths that students bring to school widens the gap between in- and out-of-school mathematical competencies. This suggests that for reform practices to be effective, we must (a) learn what mathematical practices our students engage in outside of school and (b) connect these practices to what we do in school. Scholarship connecting cultural and out-of-school practices with school mathematics includes work in culturally responsive/relevant pedagogy (Gay 2009; Ladson-Billings 1995; Leonard 2008), funds of knowledge (Civil 2002) and ethnomathematics (D'Ambrosio 1985). (For a detailed review of the literature, see Presmeg 2007). Each of these perspectives supports the notion that mathematics teachers should draw on students' community and cultural knowledge to foster academic achievement.

The mismatch between mathematical tasks and tools used in and out-of-school

Teachers are encouraged to understand the culture and ways of knowing that their students bring with them into the mathematics classroom, yet most curricula all but ignore out-of-school mathematical practices. "In order to help students connect mathematics in school and mathematics out-of-school, we need to know how students actually use—and how they perceive that they use—mathematics in everyday situations" (Masingila 2002, p. 31). The tools teachers provide to support problem solving should be meaningful and, where possible, link to the representations students use in non-school settings and how those representations are used. Scholars have shown that what we teach and the representations we use when we teach may not necessarily connect to the ways in which many students engage in mathematics outside of school. Brenner's (1998) research comparing Native Hawaiian

students' experiences with money in and out-of-school revealed that everyday context alone is not enough to build on out-of-school practices; the actual mathematics practices and meaning of the mathematics in which students engage must be considered. Taylor's (2004) study of students' practices when shopping revealed the need to examine the reasons and ways we use representations in the classroom to ensure students can make a connection to their out-of-school practices. de Abreu (1995), in comparing measurement practices of children of farmers, further illustrated the need for teachers to consider the types of representations they are using and how certain representations may privilege some students over others. Each of these studies provided examples of how the mathematics and tools that students use outside of school may be very different from the tasks and tools of school mathematics. This may be especially true when the cultural backgrounds of the students differ from that of the teacher.

Building on out-of-school practices

The research presented above points to the imperative for considering out-of-school experiences in the design of tasks and use of tools in the mathematics classroom. It does not, however, make explicit recommendations for how these out-of-school practices can be brought into the classroom. The scholarship in funds of knowledge (Civil 2002; González et al. 2001) and Math in a Cultural Context (Lipka et al. 2005) offer rich examples of the ways in which school mathematics can connect to students' cultural and out-of-school experiences. Although these studies offered insight into practices teachers could employ to learn about and incorporate students' out-of-school practices into their classrooms, two challenges emerged. First, some teachers experienced difficulties identifying and implementing knowledge of students' out-of-school experiences in the classroom. Even after identifying mathematical practices in students' homes, teachers in the BRIDGE project found it difficult to link those practices directly to school mathematics (Civil 2002). González et al. (2001) found that "mathematical practices cannot be disembedded from social context" (p. 130). In other words, the way out-of-school practices get translated or mathematized has to be meaningful.

The second challenge is generalizability. Although Lipka et al. (2005) study narrowed the gap in test scores and fostered wider student participation, it was set in Native Alaskan classrooms that were culturally homogeneous and their findings may not be applicable to diverse settings. The external support and time commitment required for teachers in the BRIDGE project (Civil 2002) may be difficult to replicate. Presmeg (2007) summed up these challenges when she suggested,

> The dilemma, then, is *how* to incorporate out-of-school practices in school mathematics classrooms in ways that are meaningful to students and that do not trivialize the mathematical ideas inherent in those practices. This issue remains a significant one for mathematics education research. (p. 452)

The study

This study examined the ways in which teachers in professional development respond to Presmeg's (2007) and others' call to identify meaningful ways to incorporate out-of-school practices in mathematics classrooms. In examining teachers' understandings of cultural competency and the ways they considered out-of-school practices in mathematics, the

following questions were addressed: (a) What methods do teachers use to incorporate students' out-of-school experiences in the mathematics classroom? (b) What are the affordances and constraints of the various methods?

Methods

This was a study of 17 teachers' emerging understandings as they participated in a professional development seminar in which they read, reflected, and discussed the importance of and methods to incorporate children's out-of-school mathematical practices. Qualitative methods were used to generate data from the seminar, interviews, and observations (Glesne 2006).

Professional development design

As part of a semester-long professional development, seminar focused on culturally relevant pedagogy in mathematics classrooms, teachers read about cultural competency (Ladson-Billings 2001), funds of knowledge (Civil 2002; González et al. 2001), and comparing cultural experiences with mathematics (Guberman 1996). Over the course of three of the ten three-hour sessions, teachers reflected on and discussed readings about, ideas for, and experiences with identifying and building on students' out-of-school practices. In order to support teachers in considering students out-of-school practices, they designed and administered surveys to determine how students used mathematics outside of school. Although these surveys were self-reports of 8–10 year olds, they offered insight into the types of activities in which students participated. I tabulated survey results, and teachers used information from the individual and cumulative results to plan lessons or write word problems that built on students' out-of-school mathematical experiences. In addition, teachers compared results of their own classroom surveys to those of their school and the other schools to identify individual, classroom, and school differences. This activity prompted teachers to further explore their own students' home, community, and cultural mathematical practices, as well as other ways to learn about their students. Another activity included developing a lesson with school-based groups that drew on information learned in the surveys. Teachers later taught then reflected on the lesson ideas they developed.

Participants

The participants in this study were 17 practicing teachers from three elementary schools in a mid-size school district. The participants were self-selected, as they agreed to participate in the seminar after interest from principals of their schools was solicited. All three schools served a diverse student body with a range of 27–70% of students eligible for free and reduced lunch, and 40–74% of students from Native American, African American, Latino/a, and Hmong ethnicities.

The participants included 10 third- through fifth-grade teachers, 1 fourth/fifth-grade bilingual teacher, three special education teachers, two English as a second language teachers, and one mathematics resource teacher. Three teachers were men and 14 were women. There were one African American, one Native American, and 15 white teachers. The teaching experience ranged from 1 to 30 years. Pseudonyms are used when referring to or quoting participants.

Data generation and analysis

The instruments used in this study included audiotapes of large and small group discussions that occurred during professional development sessions; audiotapes of teachers interviewing each other regarding topics discussed in the seminar; assignments in which teachers reflected on the readings; and field notes of observations in the teachers' classrooms.

Data for this study were analyzed in three phases. In Phase 1, all instances in which teachers discussed the incorporation of culture in mathematics lessons were identified. This broad code connected directly to the framework on which the professional development was based, culturally relevant pedagogy (Ladson-Billings 2001). Specifically, the code was modified from one of the indicators of cultural competence, "The teacher uses student culture as a basis for learning" (Ladson-Billings 2001, p. 98). This included particular countable events such as how often someone spoke or wrote about incorporating culture. In some of these instances, teachers were discussing how they might or did incorporate culture in their mathematics lessons, and in some cases, they were discussing the benefits, detriments, and/or difficulties associated with incorporating culture.

In Phase 2, these instances were analyzed using a grounded approach (Charmaz 2005) in which the four practices to incorporate cultural and out-of-school experiences emerged from the data: using experiences as a context for problems, linking cultural and out-of-school experiences to school mathematics, identifying embedded mathematical practices, and using shared experiences in the classroom as a site for culture. In Phase 3, the data were examined to identify the ways teachers discussed the affordances and constraints of each of the practices identified in Phase 2. Observations of the teachers' classrooms served to triangulate the data as findings came from what teachers said, what teachers wrote, and what was observed.

Findings

Analysis of the data revealed four related practices in which teachers engaged. Three drew on children's cultural or out-of-school experiences: using these experiences as contexts for problems, linking these experiences to school mathematics, and identifying embedded mathematical practices prominent in these experiences. A fourth category, teacher initiated situated settings, focused on shared experiences using the classroom as a site of culture. Table 1 sets forth examples of the activities that teachers identified and the practice under which they were coded. These examples came from the data sources mentioned above, particularly during seminar discussions related to planning lessons that connected students' out-of-school and cultural experiences. Each of the examples was coded based on the ways the teachers intended to use the ideas. A description of the four methods and an elaboration of examples from each method follow.

Cultural or out-of-school experiences: using contexts

The most common way teachers provided a link between mathematics and students' lives was using students' experiences as the context for word problems and lessons. Here, teachers used contexts to talk about the mathematics content they wanted to discuss rather than using the contexts to drive what mathematics was studied. There were eight instances when contexts were explicitly mentioned though it was a common practice in teachers'

Table 1 Codes and lesson examples

Codes and times discussed	Lesson examples
Cultural or out-of-school experiences	
Using context (8)	Measurement of a soccer field Problem-solving matching clothes Maintaining a personal money journal Using Latino context to hook students Word problems based on shopping Daily question: "where you spent money?" Using video games as context for word problems Measuring the "hot" chemical in peppers
Linking to school mathematics (6)	Measurement and Hmong story cloth Currency translation Mathematics of nutrition Fractions and cooking (handful vs. measuring cup) Playing games from home Problems using Chuck E. Cheese debit card
Identifying embedded practices (1)	Purchasing for the family
Teacher initiated situated setting (7)	Daily store Lessons based on a field trip Money around the world International bazaar Sharing cultural history of mathematics Pyramids around the world Butterfly migration to Mexico

classrooms. Teachers mentioned generically (without example), and it was observed that they often used familiar contexts in word problems or lessons in an effort to motivate students by allowing them to see their lives represented in mathematics. In one explicit example, two teachers were aware of several students' interest in soccer and decided to write word problems about measuring the area of a soccer field. In another example, a teacher created a series of problem-solving worksheets on combinatorics from which students could choose. For one of the worksheets, the teacher drew from her knowledge of some students' interest in clothes.

> Several of the girls in my classroom are always talking about their outfits. I could come up with a lesson on combinatorics where they mix and match a given number of shirts, pants, skirts, sweaters to find the possible number of combinations. (Polly, small group discussion)

In a third example, measuring the "hot" chemical in various peppers used in Hmong and Latino cooking, a teacher had discussed how hot certain ethnic dishes were that her students had shared with her. This led to a discussion of hot peppers and sparked the teacher's idea of measuring the heat. Other examples included using familiar contexts such as video games or shopping in word problems.

Cultural or out-of-school experiences: mathematical practices linked to school mathematics

Activities linked to school mathematics were situations in which teachers identified an out-of-school activity that required mathematics and then used the activity to teach the school

mathematics they thought should go with it. Here, teachers related cultural activities they identified to school mathematics rather than investigating the informal strategies students used in these activities. In other words, the activity was identified first and then a school mathematical practice was matched to that activity; this differs from using context where the mathematics was identified first and then a context was incorporated. Next, four examples of teachers' reported practices that linked school mathematics to cultural or out-of-school activities are summarized.

The first example, measurement and story cloths, is the closest to the paradigm examples of mathematical practices embedded in cultural activities. Heidi shared the following during a small group discussion on students' cultural practices.

> I was really trying to pull more out of this student of mine who is Hmong, and she hasn't been here in the United States that long. And I know that her grandmother lives here. They have a large family. It is very traditional. And I know she does paj ntaub, the story cloth. She just did not want to connect it to math. She didn't want to connect the measurement.

In this situation, the teacher had knowledge of the child's practice of regularly helping her grandmother make story cloths. Seizing upon what she viewed as a cultural practice, the teacher attempted to relate the activity to school mathematics by discussing measurement that might be required in making story cloths.

In the second example, teachers in a small group discussion noted that on the survey students had taken about out-of-school practices several had indicated they engaged in currency translation. When discussing how students would know about translating currency, one teacher stated that she had a student who had just come back from Mexico and would know what it was. The teacher suggested that the child could be "an expert on these ratios" (Heidi, small group). Although the teacher discussed this idea, she did not pursue it further.

In the third case, the mathematics of nutrition, the context was not necessarily tied to a particular ethnic or linguistic culture, but was very much a part of a certain child's out-of-school experiences. The child, who had been identified as struggling in mathematics, had been seeing a nutritionist. In discussing how to calibrate a pedometer and calculate caloric and fat intake, the student displayed mathematical competency beyond what she had previously shown in school.

The fourth example offers a common context, cooking, but reveals the different cultural practices used in cooking and the disconnect between what is often taken up in school and what is used at home. One teacher knew that some of her students were involved in assisting with cooking. She thought this would provide an opportunity to build on the students' understanding of fractions and brought in measuring cups to discuss fractions used in the preparation of rice. However, instead of providing students with a cultural mathematical context with which they were familiar, what she found was that only one of her students had ever used measuring cups or fractions in cooking. The other students' families either used handfuls to measure rice or poured it directly into a rice cooker.

Cultural or out-of-school experiences: embedded mathematical practices

Embedded practices refer to situations in which a particular context drives the mathematics. In these situations, students develop informal strategies to accomplish their tasks and these strategies often differ substantially from the mathematical strategies typically taught in school. Paradigm examples of this can be found in studies in which the

mathematics students engaged in for everyday activities or jobs was particular to the activity and did not align with the ways mathematics was presented in school (Carraher et al. 1985; Guberman 1996; Saxe 1988). In order to identify the students' informal strategies, they need to be observed in the out-of-school setting or explicitly asked to replicate the practice and explain their strategies. There was only one borderline example of mathematical practices embedded in a given cultural activity.

Readings for one of the seminar sessions included Guberman's (1984) study comparing out-of-school mathematical practices of Latino and Korean families. Guberman found that Latino families often involved children in everyday activities using mathematics, particularly shopping. In reflecting on the article, one teacher, Inga, decided to interview some of her students to better understand their experiences with money when shopping for their families. From this, Inga learned about her students in ways she did not expect, finding that those students who shopped with their families were able to quickly solve problems regarding currency. These students demonstrated a remarkable facility with these transactions that suggest they had powerful strategies for dealing with the situation. Although Inga learned much about her students' interaction with money when outside of school, she could have taken this further by exploring the specific strategies they used. The strategies children use with money are often non-routine, and this might have offered an opportunity to gain a deeper knowledge of students' understanding.

Teacher initiated situated setting

Although not necessarily related to cultural or out-of-school activities per se, this category reflects rich lessons or units that drew from a common experience shared by all students in a classroom. The context was a school-related activity in which all students participated and from which the teachers identified the mathematics content embedded in activity. Here, the teacher either created the activity or drew on a shared activity and made the link to school mathematics. The setting was either designed specifically for the mathematics classroom or was another activity in which students engaged in as a community. Teachers acknowledged the importance of discussing diverse experiences as succinctly captured in Gutiérrez's (2002) analogy of windows and mirrors wherein she suggested that seeing one's own cultural practices in a mathematics lesson provides a mirror for a child to see his/her own experiences reflected in school and that seeing other children's cultural practices in a mathematics lesson provides a window into others' cultural practices. Yet, discussions around teacher initiated situated settings grew from a desire on the teachers' parts to identify a single shared practice of students from diverse cultures. Two of the seven activities identified are elaborated below.

In a discussion of the difficulty in identifying a single shared cultural practice of students from a diverse classroom, teachers from one school felt the shared experience of an upcoming field trip to a bowling alley would provide a mathematically rich and motivating setting for mathematics lessons. The teachers planned a series of lessons around the bowling context that included story problems about ordering food, beat the clock (racing the electronic score board using mental mathematics to calculate the score), and graphing and data analysis of the scores for each frame. In reflecting on the lessons, the teachers thought the lessons offered a "motivating context for all students to share" (Glenn, reflection).

In a more sophisticated example, Caroline created a situated setting within her fifth-grade classroom by designing a unit she called the *International Bazaar*. The unit started

with an exploration of several world currencies. Students then worked in groups to manage stores. Each group had an imaginary currency and exchange rates that fluctuated daily. The many iterations of shopping and store management over a three-week period covered geometry, fractions, decimals, percentage, and ratio. This example is stronger than the bowling example because in addition to the shared experience of the bazaar, it wove in multiple cultural referents. Field notes from observing one day of the international bazaar reflect the ways in which the situated setting drew on both external cultural referents and the situated setting itself.

> The project on currency allowed students to explore monetary issues in a country of their choosing. Several chose countries their families were from. It also highlighted the people countries feel should be placed on their currency and begged the question (discussed in an earlier class) why the U.S. has the people we have on our currency. The teacher shared that in a previous discussion, students shared who they thought should be on our currency. This unit assessed student understanding on a variety of content areas and allowed them to express this in a variety of ways.

During the two class periods in which this activity was observed, students were highly engaged throughout the lessons.

Discussion

In analyzing the discussions and reflections on how to build on students' cultural experiences, some critical distinctions arose among the four ways that teachers attempted to relate mathematics to out-of-school experience. These distinctions are important as they each offer a different motivation for students' learning of mathematics, a different relationship to out-of-school practices, and varying levels of complexity for the teacher. In particular, embedded cultural mathematical practices deal explicitly with actual mathematical practices while the other three focus on context. Although honoring the strategies that students bring and the cultural histories for those practices reside mostly in exploring embedded practices, the others play an important role in providing a link between school mathematics and students' everyday lives. The three practices connected to students' out-of-school and cultural experiences are presented in order from least complex to most complex as regards understanding of students' experiences and time commitment. As discussed below, the fourth practice, teacher initiated situated settings, has an inherent hierarchy of complexity depending on the activities. Table 2 sets forth the affordances and constraints of each practice for both students and teachers. The distinctions between the practices, their potential to address equity in mathematics education, and inherent tensions of each are discussed below.

Using out-of-school context

As noted, the most common incorporation of out-of-school practices in mathematics classrooms is using cultural context in word problems; it is also the least complex practice and requires the least time commitment. Similar to using students' names in word problems, teachers use cultural context to provide motivation. One challenge in using students' experiences as the context for problems is that teachers should attend to the mathematics they ascribe to the problems. The motivation provided by this practice is diminished when the mathematics used is foreign to the context as might have occurred in the

Table 2 A framework for incorporating cultural and out-of-school practices

Method	Description	Affordances	Constraints
Out-of-school context	Using students' experiences as a context for word problems Starts with the mathematics, finds a context to fit	*Student*: Engagement *Teacher*: Easy way to modify lesson Minimal time required	*Student*: Not mathematics in practice
Out-of-school activities related to mathematics	Teacher selects (guesses) what mathematics is in the activity (activity first, mathematics second) Embedded mathematics not identified	*Student*: Make connection See out-of-school reflected in school *Teacher*: May signal need to explore students' informal strategy	*Student*: Not necessarily the mathematics practiced in the activity
Embedded cultural mathematical practices	The context drives the mathematics Informal strategies students use in everyday activities	*Student*: Mathematics in practice Connections See out-of-school reflected in school	*Teacher*: Time Opportunity
Teacher initiated situation setting	Teacher-/school-developed activity that all students share	*Student*: Shared experience for diverse class *Teacher*: May not require significant time	*Student*: Not necessarily connect to out-of-school *Teacher*: Can require significant time

aforementioned examples. Although several children in a class may play or watch soccer, the mathematics they engage with relative to soccer does not likely include measuring the field. In the clothing/combinatorics example, the teacher did not have evidence that students counted the number of possible outfits; rather, she used her knowledge of their interest in clothing to create an activity to learn about combinatorics. The example of measuring hot peppers provided a context for using mathematics but does not replicate or adapt a mathematical activity students would necessarily engage in outside of school.

In addressing equity, the use of students' cultural and out-of-school experiences as a context for problems provides the opportunity for students to see their experiences reflected in school mathematics. In offering familiar contexts, students' cultural and out-of-school experiences are validated, but if the contexts are entirely the teachers', they may have less meaning for students. On the other hand, this practice does offer the opportunity for teachers to quickly modify a lesson or activity to make it more relevant to students' experiences.

Cultural and out-of-school activities linked to school mathematics

Cultural activities related to mathematics have the potential to address equity in mathematics education as it allows students to see how they can apply school mathematics to

their own out-of-school experiences, a goal of generativity (Carpenter and Lehrer 1999). Although this practice afforded students the opportunity to see familiar out-of-school contexts in the classroom, it did not necessarily enable students to connect school and out-of-school mathematics because it failed to use mathematics in the ways students do outside of school (Masingila 2002). This practice is distinguished from embedded practices, as children's informal strategies are not explored. In the aforementioned examples, there may have been embedded mathematics in the activities, but they were not identified by the teachers. Rather, the teachers used these out-of-school activities to teach school mathematics.

In the case of the story cloth, Heidi identified the way school mathematics could be used in creating story cloths, but it is unclear whether the strategies the child used for measurement in making story cloth would differ from strategies the child learned in school. In order to understand the embedded mathematics involved in the activity, the teacher would have had to learn how the child and her grandmother actually used measurement themselves in making the story cloth. In both the currency translation and nutrition examples, it is possible that the children might use strategies very different from the academic mathematics. One way to explore this further would have been to have the students explain the strategies they actually used in the practice.

Teachers infrequently discussed the informal strategies students used to solve mathematical problems outside of school in order to identify the embedded practices. Yet, in some cases, the outcomes teachers experienced with their students highlighted for the teachers the need to explore the embedded practice. Heidi's case of using cooking to learn about fractions was a good example. After learning how students actually cooked rice at home, she realized that "using proportions made more sense," as students were comparing the size of their own handfuls of rice to those of their mother's or grandmother's (Heidi, reflection).

Embedded mathematical practices

This is the most authentic integration of out-of-school practice as it builds on the informal strategies students use and explicitly addresses equity issues raised by scholars about the importance of connecting to practice (Masingila 2002; Presmeg 2007). Despite readings and discussions about potential ways to investigate and incorporate out-of-school practices, it is not surprising that the opportunity to identify embedded practices was not always available to or explored by the teachers. Earlier studies in which teachers have taken on the role of researcher reveal the need for significant support necessary for teachers to be able to identify and build on embedded practices (Civil 2002, González et al. 2001; Lipka et al. 2005). Further, given the time constraints of the professional development, I was unable to provide the space for teachers to explore these ideas further. One way to address this issue is to consider how teachers could transform an activity that is related to mathematics into one that considers informal strategies. Several of the activities discussed in the prior section lent themselves to further exploration to determine the embedded practices. For example, once Heidi became aware of the ways her students prepared rice, she could have explored how ratio or proportion was used when measuring rice by handfuls. As noted, the methods for this exploration varied from time-consuming ethnographic-type work to simply having further discussions with children about their informal strategies. This suggests that moving from one practice to the next requires differing levels of time commitment and complexity.

Teacher initiated situated setting

Another distinction that emerged from the data was that some teachers developed new contexts for giving meaning to mathematics—contextual situations that they created. Much of the literature on culture and mathematics focused on ethnically homogeneous classrooms (Civil 2002; González et al. 2001; Lipka et al. 2005). This homogeneity afforded an opportunity to identify contexts and practices that had meaning for all students in a class. The teachers in this study all taught in classrooms with ethnically and economically diverse populations, thus requiring different approaches. To address their concern that some lessons should be based on a common experience shared by all students, the teachers conceived of lessons and units based on a situated setting they created.

In using teacher initiated situated settings, students have a common experience in which to learn and apply mathematics. This practice can vary greatly regarding complexity and time required to develop activities. A basic approach to this practice would be to incorporate ideas from a shared reading into word problems. A far more sophisticated example of a teacher created situated setting was the *International Bazaar*. This was a multi-week activity in which students explored a variety of mathematical content areas in a simulated shopping mall. This activity went well beyond the typical school store, in that students dealt with rent, insurance, currency fluctuations, and remodeling. Much like the aims of Guberman and Saxe's (2000) *Treasure Hunt* game in which a division of labor resulted in collective problem solving, the *International Bazaar* was designed as a shared experience from which students could develop their own mathematical understanding to accomplish goals in the activity. In addition, the *International Bazaar* explored the cultural features of a variety of foreign currencies, thus bringing culture into mathematics.

Inherent tensions

Any time teachers draw on their own knowledge of students' out-of-school experiences tensions arise. As has been noted by earlier work in funds of knowledge (Civil 2002; González et al. 2001) doing ethnographic work to understand embedded practice represents a commitment of time that teachers might not have. The teachers read about these difficulties and discussed how time constraints were a significant barrier for them but did not necessarily identify and discuss other constraints.

A second tension I observed is in understanding cultural practices. This was exemplified by one teachers' perspective that making story cloths was a part of the Hmong culture. However, she was not aware that it is not a deeply grounded historical practice. The Hmong have a history of oral tradition and adorning clothing and textiles with needlework, but not a long history of sharing stories through cloth. This practice emerged in the refugee camps in Thailand in the mid1970s as a way to make money. This example highlights the need to investigate historical practices in order to be aware of how the practices are perceived within cultures or risk making assumptions that essentialize cultural practices.

Implications

This framework provides a powerful tool for use in both professional development and methods courses with prospective teachers. As the framework emerged from this study, I was not able to use it in a purposeful way as part of the professional development design. A more explicit use of the framework in designing a course or professional development might address some of the tensions and issues that arose in this study. In particular,

I suggest supporting teachers in developing a greater understanding of cultural practices beyond the mathematics and considering ways to shift activities from those related to mathematics to unearthing embedded practices.

Conclusions

This manuscript starts with the supposition that connecting school and out-of-school mathematics is a critical equity issue in mathematics education. Attending to and validating students' out-of-school experiences are not ends in themselves. School mathematics offer powerful practices that, when connected to out-of-school practices, provide meaning. Drawing connections between out-of-school practice and school mathematics practices and notation is essential. This study offers a framework for teachers to consider ways to approach incorporating students' out-of-school experiences. Each of the four practices in the framework is important and contributes to students' understanding in different ways. As teachers begin to consider students' experiences with mathematics outside of school, they may follow a trajectory in which they begin with the least demanding practice, incorporating context in problems, and advance to identifying embedded practices and creating situated settings. Due to the varying levels of complexity within each practice, movement between practices should be scaffolded.

By attending to each practice, teachers support students in making connections and seeing the ways that school mathematics is used out-of-school and that out-of-school mathematics are used in school. Although there are distinctions between the four categories, they are not necessarily independent. For example, out-of-school practices could be compared and contrasted with practices students learned in a teacher developed context, and school-based notation could be used to record out-of-school practices.

The discussions of culture and mathematics provided evidence of the challenges of identifying and incorporating students' out-of-school practices. An explicit focus on the four methods set forth here might support teachers in better relating students' cultural and out-of-school experiences to mathematics. Knowing how a focus on cultural practice differs from the other categories may help teachers to appreciate the limitations of other approaches. By focusing first on cultural and out-of-school activities related to school mathematics and then considering ways to explore the embedded mathematics, teachers would be provided a roadmap to get beyond a superficial incorporation of culture (Civil 2002) and address the first challenge raised in the introduction. The teachers' struggles to identify embedded mathematical practices portray the complexity of this work and calls for further study using this framework as a tool to work toward incorporating embedded practices.

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