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Using culture as a resource in mathematics: the case of four Mexican–American prospective teachers in a bilingual after-school program

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Abstract This paper explores Mexican–American prospective teachers' use of culture—defined as social practices and shared experiences—as an instructional resource in mathematics. The setting is an after-school mathematics program for the children of Mexican heritage. Qualitative analysis of the prospective teachers' and children's interactions reveals that the nature of the mathematical activities affected how culture was used. When working on the "binder activities," prospective teachers used culture only in non-mathematical contexts. When working on the "recipes project," however, culture was used as a resource in mathematical contexts. Implications for the mathematics teacher preparation of Latinas/os are discussed.

Keywords Culture · Latinas/os · Culturally responsive mathematics teacher preparation

Introduction

It is widely accepted that in order to improve the mathematics education of culturally diverse students, teachers must value and draw on their students' interests and every day practices with their families and in their communities (e.g., Averill et al. 2009; González et al. 2005; Lipka et al. 2005). However, there still remains a question of how to prepare teachers to use students' cultural experiences as instructional resources in mathematics (Gay 2009). The work that has been done in this area has primarily focused on helping White (usually English monolingual) prospective teachers (PSTs) to teach students who are racially and ethnically different from themselves (e.g., Ensign 2005). As a result, minority PSTs are usually left to figure out on their own how to best use their cultural knowledge as an instructional resource, as if it is assumed that simply by virtue of their backgrounds, they will have the skills and knowledge to do so (Villegas and Davis 2008). PSTs who share similar backgrounds with language minority students, such as Latinas/os, however, may need different kinds of support than their White English monolingual counterparts, to

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incorporate their home language(s) and cultural knowledge into pedagogical practices in mathematics. This is particularly relevant to Latinas/os since they are the fastest growing minority teacher group in the United States (Strizok et al. 2006), they tend to teach Latina/o students (Villegas and Davis 2008), and most of them speak Spanish. Nevertheless, the emphasis on White and English monolingual teachers in the literature on teacher preparation for culturally diverse students pays scant attention to the preparation, support, and empowerment of Latina/o teachers. The issue, therefore, becomes how to help Latina/o PSTs build on the unique strengths they bring into teaching, particularly their knowledge of Spanish and possible familiarity with their students' lived experiences. Moreover, what kinds of experiences do Latina/o PSTs need in order to develop and incorporate their knowledge of their students' home language and lived experiences into pedagogical practices in mathematics?

This paper seeks to address these issues. Specifically, this paper provides some insights that were gained on how four Mexican–American PSTs used their cultural knowledge as a resource while facilitating mathematical activities with Latina/o bilingual children in an after-school mathematics program.

As noted previously, the emphasis on White and English monolingual teachers in the literature on teacher preparation for culturally diverse students pays scant attention to the preparation, support, and empowerment of Latina/o teachers. However, studies on Latina/o teachers point out that it should not be assumed that simply because students and teachers share home language and ethnicity that the teachers will know how to connect student life to school curricula (e.g., Téllez 1999, 2005). Nor should it be assumed that Latina/o teachers, merely by virtue of their ethnicity, possess a natural aptitude for teaching Latina/o students. Although it may be beneficial if the cultural and linguistic background of the teacher is similar to that of the students' (Quiocho and Rios 2000; Valencia 2002, such a similarity is not sufficient to ensure that the teacher is able to connect to his or her students (Remillard and Cahnmann 2005) and use students' home language and culture as instructional resources in mathematics. For example, Gordon (2000) found that cultural connections were sometimes difficult because of class differences between middle class Latino/a teachers and their working class/poor Latino students. In fact, many second-generation Latina/o teachers may have little in common with life in Mexico and, as a result, little understanding of recent immigrant children and their families (Riegelhaupt and Carrasco 2000; Walker de Felix and PeÒa 1992). Third-generation Latina/o teachers in the United States whose families trace their heritage to Mexico City may have a difficult time understanding, much less legitimizing, the culture of a family that most recently emigrated from rural Mexico (Téllez 2005).

Challenges in using culture as an instructional resource in mathematics have also been reported even when teachers and students are able to connect at a personal level. Aguirre (2007), for example, found that first-year Latina/o mathematics teachers, who felt strong connections with their students, faced multiple challenges when attempting to incorporate students' cultural experiences in their lessons. These challenges stemmed from lack of collegial support, lack of relevant professional development, and lack of material resources (curriculum) that would help the teachers make an explicit link between their students' cultural experiences and the mathematics lessons. The teachers in this study also reported that high-stakes accountability policies constrained their efforts to create culturally relevant mathematics lessons. Finally, they viewed mathematics as a field that is more difficult to make content culturally relevant than humanity fields such as English. In another study, Téllez (1999) found that Mexican–American student teachers who had similar backgrounds with their students used very little ethnic expression during instruction and used their cultural knowledge only in non-academic aspects of the lessons they taught.

Thus far, I have highlighted the complexity of using culture as an instructional resource even when teachers and students share—or are perceived to share—similar cultural backgrounds. If we want to prepare bilingual Latina/o teachers to use culturally responsive practices in the teaching of mathematics, there is much we need to understand. The purpose of this paper is to describe how four Mexican–American PSTs used culture—defined as shared experiences and social practices—as an instructional resource in teaching mathematics through their participation in a non-traditional field experience. The setting of the study is an after-school mathematics program, namely *Los Rayos de CEMELA,* housed in an elementary school that serves working class students of Mexican descent. First, I describe the study, its setting, the participants, and the methods employed. Next, I discuss how the nature of the mathematical activities affected the PSTs' use of culture. I close my discussion with some concluding thoughts related to the implications for mathematics teacher preparation.

Los Rayos de CEMELA

The work presented here draws on a wider dissertation study that explored how Mexican–American PSTs use language and culture as instructional resources in mathematics. It reflects current work carried out by the Center for the Mathematics Education of Latinas/os (CEMELA),[1] which focuses on the research and practice of the teaching and learning of mathematics for Latino/as in the United States through the integration of socio-cultural theory, language, and culture. CEMELA created after-school projects at two of its sites, one of which, *Los Rayos de CEMELA*, is the source of the present study. *Los Rayos* was a general adaptation of the work of the *Fifth Dimension* (e.g., Cole and the Distributed Literacy Consortium 2006) and was guided by other similar projects, such as, Gutiérrez et al. (1999) and Vásquez (2003). These works utilized after-school projects as a way of understanding literacy; CEMELA extended the work to consider mathematics. As in the work of the *Fifth Dimension* and related projects, *Los Rayos* involved PSTs who participated as facilitators.

While *Los Rayos* was designed to investigate the linguistic and cultural resources bilingual Latina/o students use and that support their mathematics learning, it simultaneously served as a non-traditional field experience for PSTs as they participated in a unique context where they formed interpersonal relationships with students, negotiated mathematical ideas, and engaged in dialog across two cultural languages (Spanish and English). *Los Rayos* was a setting where PSTs and students naturally talked about their experiences and their interests. A group of Spanish-speaking mothers often joined *Los Rayos* and participated along with the children and the PSTs in many different ways. This gave the PSTs the opportunity to interact with children's family members, thus giving them multiple opportunities to recognize and draw on the children's interests and every day practices with their families and in their communities. In addition, the mathematical activities were intended to be open-ended and to require students to experiment, develop multiple strategies, and communicate their reasoning. Furthermore, children were encouraged to work collaboratively, and PSTs were encouraged to capitalize on children's ideas, comments, and any other resources they presented. This is relevant to this study

[1] CEMELA is a Center for Learning and Teaching supported by the National Science Foundation, grant number ESI-0424983. The views expressed here are those of the authors and do not necessarily reflect the views of the funding agencies.

because the environment offered PSTs many opportunities to choose to use children's experiences and/or any shared experiences they might have since they came from the same cultural background as the students. This design feature was intended to open the way for PSTs to, in turn, draw on these experiences to support conceptual development (Khisty and Morales 2007). This work assumed that learning at any age occurs in a social context (Vygotsky 1978) that emphasizes active dialog among participants (Wells 1999). Furthermore, it assumed that what is known by an individual is the outcome of continuing co-construction processes that depend on multiple opportunities to encounter and make sense of challenging new experiences (Wells 2001).

In *Los Rayos*, the PSTs were not expected to teach or tutor in the traditional sense. They were afforded the opportunity to experiment and to use a multiplicity of resources with small groups of students while doing mathematical activities, unlike in a student-teaching experience where there are constraints due to the mentor teacher, the curriculum, or the size of the class. Furthermore, because of the nature of the after-school program and because it was not a typical field experience context, the PSTs had a good deal of freedom to engage with children as they wished or to make decisions about how to use culture as a resource for doing mathematics. This open-ended environment provided many opportunities to observe, in essence, the decisions PSTs made that related to the purpose of this study.

Thus far, I have provided a general overview of *Los Rayos*. However, every semester was unique in the sense that the mathematical activities were different, the group of facilitators was different, the level of the mothers' participation was different, etc. Thus, I will now turn to describe the kinds of activities that took place in *Los Rayos* during the time of the study, since they are most relevant to the findings presented in this paper.

During the first half of the duration of the study, the mathematical activities in *Los Rayos* consisted of a collection of mathematical tasks adapted from existing curricula that emphasize problem solving and included non-routine problems that focused on various topics such as fractions, logic, geometry, patterns, etc. These tasks did not build on one another. They were grouped according to the topic they addressed, they were placed in binders, and everyone referred to them as the "binder activities." Each group had the freedom to choose which task to work on in any given session.

On the second half of the duration of the study, however, the context and content of the mathematical activities changed. During this time, all students had to work on the same project whose mathematical goal was to support children's proportional reasoning. This project, which everyone came to refer to as the "recipes project," consisted of a sequence of activities designed to ultimately lead each group to create a recipe and prepare a dish for the end-of-year party in *Los Rayos*. Each group was responsible for creating a unique dish, which was chosen from a list of five dishes: guacamole, salsa, cupcakes, jello, and limeade. Project activities involved finding out which orange juice recipe from a list of different orange juice recipes is more orangey, making mole—a special and favorite dish among Mexican families—with a group of mothers who posed mathematical problems in the process, creating a perfect recipe for the groups' dish, going to the local grocery store to buy ingredients for that recipe after deciding which items were the best bargain, figuring out how to magnify the recipe to serve all participants in the party, and finally making the dish for the party. The "recipes project" was a community-based project, in a sense, as it revolved around students' and PSTs' experiences with Mexican food, with cooking and with purchasing food items; involved going out in the community grocery store; and involved a group of Spanish-speaking mothers who were involved at various stages of the

project. In other words, the project revolved around social practices in which both PSTs and children regularly engaged.

Throughout the duration of the study, the PSTs were asked to take descriptive and reflective field-notes on their interactions with the children in *Los Rayos* and focus on their own and the children's use of language, the students' mathematical strategies, their own assistance strategies, and the students' interests and experiences with their families and in their communities. The same topics or items were addressed in weekly debriefing meetings where the PSTs met with university researchers—including myself—and discussed the happenings of *Los Rayos* by reflecting on their interactions with the children. These discussions were open-ended in that the PSTs could easily and naturally raise questions, offer suggestions, and try to make sense of their own and their students' mathematical behaviors as related to the issues of language, culture, and identity, to name a few. Often, during these meetings, the PSTs solved and discussed the mathematical activities that were part of the *Los Rayos* curriculum in order to familiarize themselves with the mathematical content of the activities. Finally, as part of their participation in the after-school program, the PSTs were asked to read *La Clase Mágica: Imagining Optimal Possibilities in a Bilingual Community of Learners.* (Vásquez 2003) and *Funds of Knowledge: Theorizing Practices in Households and Classrooms* (González et al. 2005) and discussed these readings in the weekly debriefing meetings. Through these discussions, we developed common working definitions for culture, language, and identity. The PSTs were asked to incorporate students' interests and experiences in their mathematical interactions but were not given any guidelines as to how to do this. I now turn to describe the PSTs who were observed at the time of the study.

The prospective teachers

Jose, Juanita, Maria, and Lupe,[2] the four PSTs, were undergraduate students at a large university in the Midwest of the United States. At the time of the study, Jose was a junior in the elementary education program, Maria was a sophomore in the secondary mathematics education program, and Lupe was a freshman in the elementary education program. Juanita was an undeclared major in her sophomore year, at the time of the study, who was strongly considering entering the elementary education program. For the purposes of this study, I refer to her as a PST even though she was not officially an education major during the period she was observed.

Jose and Juanita were self-identified as Mexican–American, while Maria and Lupe were self-identified as Mexican. All four participants' home language is Spanish, and their parents are immigrants from Mexico. Moreover, all four participants were brought up in predominantly Latino communities. In fact, Maria grew up in the same community with the children in *Los Rayos.*

Methods

The four PSTs were observed as they worked with small groups of fourth- and fifth-grade Mexican–American students in *Los Rayos* twice a week for one and a half hours each time for approximately nine weeks. All sessions were videotaped and transcribed. Additionally,

[2] These are pseudonyms.

all PSTs were required to take detailed field-notes of their interactions with the students. Finally, during this 9-week period, all participants met in a weekly 2-h debriefing seminar where they discussed the happenings in *Los Rayos* and worked on the mathematical tasks that were part of the *Los Rayos* curriculum. All seminars were also videotaped and transcribed.

Data were analyzed using a constant comparative method (Glaser and Strauss 1967) in which the patterns of how participants used culture as they facilitated mathematical tasks became apparent as the data were continuously examined. In conceptualizing culture, I adopted a "process approach" (Moore 1987, p. 729) by which culture is understood and examined as lived experience. Thus, the emphasis is on social practices. In this view, the processes of everyday life, in the form of daily activities, emerge as important. These daily activities are "a manifestation of particular historically accumulated funds of knowledge that households and communities possess and actually transform through their daily activity" (González 2008, p. 96). In other words, culture is not understood as being static or of being composed by a collection of traits that are used to characterize and categorize groups of people. Instead, it is viewed as being dynamic, multidimensional, and as constantly changing as people constantly draw on multiple cultural systems in their daily activities.

When examining PSTs' use of culture in their interactions with the children, I focused on the PSTs' and students' shared lived experiences. These shared experiences were revealed through discussions that participants—PSTs and children—had about their daily practices and interests. New shared experiences also emerged as participants worked together in *Los Rayos*. Thus, my unit of analysis was how PSTs used these shared experiences as tools in their mathematical interactions with the students.

My data analysis followed the four cycles outlined in Creswell's (1998) *data analysis spiral*. During the first stage, I went through the video summaries and transcriptions of the after-school sessions and identified the sections in which students talked about their experiences and interests. Here, I did not isolate sections that took place when the groups were working on the mathematical activities. Instead, I looked at the sessions in their entirety, since children discussed their experiences and interests with the PSTs before, during, and after the mathematical activities. Next, I identified sections in the PSTs' field-notes and the transcriptions from the debriefing meetings where the PSTs noted students' interests and experiences. I also identified sections where the PSTs described their own experiences as relating to the children's experiences.

During the second stage, I read through the selected pieces of data as described above and made a list of the experiences and interests that each child and PST had mentioned. The categories in the list included experiences with friends, with family members, at home in the community and in school. Examples of items in the list include mention of cartoon shows, playing/listening to music, purchasing and eating food, playing games, cooking, doing household chores, incidents from the after-school program, incidents from classroom lessons, family relationships, and friend relationships, to name a few. I used this list for my codes in the next stage. During the third stage, I coded the transcripts from the after-school sessions that revolved around the mathematical activities using the list generated in the previous stage. Here, I focused on coding for the apparent purpose each experience or interest was used. For example, I looked at whether it was used to motivate the students, or to relate the activity to students' lives, or to better explain a concept, or for some other purpose.

During the second round of coding, I divided the codes into two categories: those that reflected children's experiences and interests and those that reflected shared experiences

with the PSTs. The first category included codes such as use of students' interests to motivate students or use of students' experiences to better explain a concept. An example of use of students' interests to motivate students can be seen in the following quote: "they (the students) keep talking about going on *My Space* so I told them that they could show me their *My Space* pages if they focus on the activity." An example of using students' experience to better explain a concept is a PST using two different student's home recipes for *limeade* to help them understand how the different ratios of lime juice to sugar affected each recipe's sweetness. The second category included codes such as use of shared experiences to relate activity to students or use of shared experiences to explain a concept. Examples of using shared experiences to relate an activity to students can be seen in a PST's use of cartoon characters or episodes that both PSTs and students were familiar with, to help students connect with the mathematical activity at a personal level. Examples of using shared experiences to explain a concept can be seen in instances where a PST referred to a previous after-school session where the students were to magnify El Maga's orange juice, in order to help the students understand how to magnify their own recipes for the party.

Finally, during the fourth stage, I selected the relevant data along with my notes to represent the themes that emerged and began drafting my interpretations of how the PSTs used culture as a resource in their mathematical interactions with the children. I now turn to describe the findings.

Prospective teachers' use of culture

As noted earlier, the after school is a setting where PSTs and students form interpersonal relationships and naturally talk about their experiences and their interests. This design feature was intended to open the way for facilitators to naturally, in turn, draw on these experiences to support conceptual development (Khisty and Morales 2007). The data suggest that the nature of the mathematical activities affected how PSTs used culture as a resource. Specifically, when doing activities from "the binders," PSTs used students' interests only in non-mathematical contexts as a way to connect with the students, and they used games that involved mathematics as culturally relevant alternatives to the activities from the binder. During the "recipes project," however, students' experiences were naturally used in mathematical contexts. In addition, PSTs used their shared experiences with the students as a resource in mathematical context.

The PSTs' Use of Culture While Working on the "Binder Activities."

During the after-school sessions, students often talked about their interests and experiences. This occurred naturally as part of the PSTs' interactions with the students in their group and was something the PSTs encouraged. Whether it was before, during, or after the groups worked on a mathematical task, students talked about several things that were part of their regular social practices such as: playing video games, soccer, basketball, music; watching cartoons (e.g., *Pokemon, The Simpsons, Sponge Bob Square Pants, Family Guy*); and using the Internet to connect with other students through *My Space*. They also talked about other experiences such as getting their nails or hair done and experiences that involved their friends and family members. Usually, these discussions around students' interests and experiences were demarked from the tasks; that is, they were not related in any way to the mathematics involved. Even when these discussions took place as the groups worked on a task, they were irrelevant to the specific mathematics and were

simply side conversations. When this happened, the PSTs tried to interrupt these side conversations, as they were seen as irrelevant to the task, and tried to get the students back to focusing on the mathematical task on which they were working.

There were very few instances where the PSTs attempted to relate the mathematical tasks to the students' interests. When they did, the relationship with the task was superficial in the sense that it did not directly relate to the mathematics involved in the task. For example, there was one instance where Jose, a PST, brought up an episode from *The Simpsons*. Andre, one of the students, was working on a task which involved creating a circle through drawing a series of lines on a grid. Andre thought that the design looked three dimensional so Jose brought up an episode where Homer (from *The Simpsons*) appeared to be three dimensional.

Andre It's all like 3D and everything!
José Have you ever seen that Simpson episode cuando Homer se hace 3D que [*where Homer turns into 3D that*] he throws (inaudible) and falls into the media hole?
Andre Oh! That's the Halloween episode when he went through the wall!
José Yeah! Exactly that one, that one, that's the one I'm talking about. Que se tira Bart [*where Bart throws himself*] and (inaudible) but he has a rope around him. Remember?
Andre Yeah, they all look 3D and when Homer goes to Earth!
José Yeah and they found him in the garbage can
Andre (laughs) Yeah!
José Yeah, that's the one. All right

In the above excerpt, Jose, related a shared experience he had with Andre, namely an episode from *the Simpsons,* to the aesthetic aspect of the task that Andre pointed to, that is the appearance of the three-dimensional design. However, none of the discussion related to the mathematical content involved in the task. In other words, Jose used this shared experience to connect to Andre and both of them connected with the task in a personal level, but this shared experience did not enhance the mathematics involved. Similarly in another session, where Juanita, another PST, and her group were assembling a collection of shapes to make a perfect five-point star, she commented that the star that one of the students, Katia, had made looked like *Sponge Bob's* friend.

Juanita Aww that's cute. It reminds me of the star from Sponge Bob
Katia Patricio!
Juanita I think that's the starfish, right?
Miriam Patrick!

In the above excerpt, Juanita also connected a shared experience, that is, a character from *Sponge Bob Square Pants,* to an aesthetic aspect of the task rather than to the mathematics involved. Again, this shared experience was not used as a resource in mathematics but rather to connect the task with the students at a personal level. In both of the examples mentioned above, none of these cultural connections related or connected to the mathematics involved in the tasks. The nature of the "binder activities" made it difficult for the PSTs to make meaningful connections between students' interests and experiences and the mathematics involved in the task.

Thus far, I have described one pattern regarding the PSTs' use of culture during the first few weeks of the after-school sessions when the primary curriculum was the activities from the binders. During this time, PSTs rarely made connections between the activities and the students' experiences and interests, and when they tried to make connections, these had

little relevance to the mathematics involved in the given activity. Now, I turn to two more patterns of PSTs' use of culture that emerged during the "recipes project."

The PSTs'Use of Culture During the "Recipes Project."

As noted earlier, the "recipes project" was intended to have students deal with proportional reasoning. During the "recipes project," all the activities were concerned with some aspect of the students' experiences and were initiated with these experiences. Students started with a common activity in which they experimented with mixing juice concentrate with water to create their own orange juice. This exploratory work served to raise awareness about important mathematical concepts related to the preparation of recipes, such as measurement, estimation, and proportions. As they started working on their selected recipe, students were challenged with fractions and proportions problems embedded in realistic situations, for example, preparing a list of ingredients with a limited budget and then enlarging the recipe for an end-of-year party. During the "recipes project," students regularly brought their experiences from grocery shopping or cooking to do the recipes and naturally drew from them to work on the mathematics in the activities. In essence, the PSTs did not have to look for additional ways to connect the activities with students' experiences because that was already part of the activities.

For example, during the "recipes project," students were to ask their mothers how much certain ingredients cost. While Juanita and Maria's group was estimating the cost of milk prior to buying it from the grocery store, both Griselda and Lisbeth (students) used their prior knowledge to estimate how much it will cost, and this led to a mathematical discussion.

Lisbeth	Oh mi mamá hoy en la mañana compró leche y costó uno noventa y nueve. [*Oh my mom bought milk in the morning and it cost one ninety nine*.]
Griselda	Mine, three twenty nine. How expensive is that!?
Lisbeth	No por que son dos galones por cinco dolares. [*No because two gallons are five dollars*]
Griselda	Oh, dos galones!
Lisbeth	Pero nomás compro uno…dos dólares.. [*but she only bought one for two dollars*.]
Griselda	I don't get it
Juanita	Dos dólares por un galón? [*Two dollars for one gallon?*]
Griselda	I think it was half a gallon
Lisbeth	Dos por cinco dólares y uno por uno noventa y nueve. [*Two for five dollars and one for one ninety nine?*]
Juanita	Pero es un mejor acuerdo para comprar– pero no sería mejor– [*But, it is a better deal to buy- wouldn't it be better*] are you sure? Porque no saldría… Tiene que ser más de uno noventa y nueve porque si es el especial…[*Wouldn't it be… It has to be more than one ninety nine because if it was the special…*]
María	Yeah, porque si los compras separados sale cuatro dólares [*Because if you buy them separately, it's four dollars*] so what's the point of buying two for five when you can get two separated for two dollars each

In the above excerpt, Lisbeth and Griselda shared their experiences of how much milk costs. Lisbeth's remark, however, that one gallon costs $1.99 while two gallons cost $5 led both Juanita and Maria to counter that remark by explaining that if that were the case, then buying two gallons would not be a good deal. From Juanita's and Maria's experience, any

time there is a special offer at a store, buying more than one item at once would reduce the per item cost. It appears that Griselda was also puzzled by Lisbeth's remark and suggested that, maybe, the milk that cost $1.99 was half a gallon instead of one which would then make two gallons for $5 a deal.

The above example is typical of the many instances during the "recipes project" where both PSTs and students naturally drew from their experiences in a mathematical context and used them to argue their point. I should note here that pedagogically speaking this is not the best example because both Maria and Juanita jumped into correct Lisbeth. One might see this as a missed opportunity to have a rich mathematical discussion. However, the PSTs' approach to pedagogy is not the unit of analysis here. Instead, the point is that mathematical discussions that were based on students' and PSTs' daily experiences were the norm during the "recipes project." Unlike the activities from "the binders," which did not connect to the students' experiences, the "recipes project" was built around the students' experiences, and this led to many instances where PSTs and students used these experiences in mathematical contexts. In essence, the PSTs did not have to search for additional ways to connect students' experiences to the activities or the mathematics involved in the activities because this was already part of the project.

Another dimension of using shared experiences to facilitate the activities during the "recipes project" was recalling a shared experience from a previous session. This is something that did not occur when the groups worked on the activities from "the binders" as those activities did not build on each other. Due to the fact that the activities during the "recipes project" were designed in a way that built on each other, they naturally led the PSTs to have students recall their experiences from previous sessions to make sense of and solve the activities.

In the example below, Juanita has Griselda recalled the measurements they used during the previous session to make el Maga's[3] orange juice. During that session, as part of an activity that required students to compare the strength of different recipes, among other things, they had mixed certain quantities of orange concentrate and water to make el Maga's orange juice. The recipe made orange juice for two people. During the following session, the group had to decide which recipe out of a list would taste the same as el Maga's. In order to do so, the group decided to re-create el Maga's orange juice but reduce the recipe to one person. In order to assist the students in figuring out which quantities to use Juanita kept reminding them what they did during the previous session.

Juanita	La otra vez que hicimos el jugo, ¿cuántas medidas le pusimos? [*The other time we did juice, how many teaspoons did we put?*]
Griselda	Five
Juanita	Five, ¿verdad? Five eran para dos…la cantidad que hicimos era para dos personas. [*Five, right? Five were for two…the amount we did serves two people.*]
Griselda	No…oh yeah!
Juanita	Vamos a suponer. Pero él está diciendo que él quiere para una. Si vas hacer nada más para una, que vas a hacer con las cantidades que usaste? [*Let's suppose. But he's telling you that he wants it for one person. If you are going to make only for one, what are you going to do to the quantities you used?*]
Griselda	I'll put six teaspoons of orange juice and six teaspoons of water

[3] El Maga is a Spanish–English bilingual mathematics "wizard" of ambiguous gender who posed mathematics problems to the children in *Los Rayos*.

Juanita Ok. (she lifts a measuring cup) Pero vamos a decir que vamos a agarrar un vaso y le vamos a poner agua, y es para…para dos personas. Pero si nomás la queremos para una persona: ¿Qué vamos hacer con las demás medidas? [*But let's say that we are going to get one cup and we pour water in, and it is for two people. But if we want it only for one person, what are we going to do with the rest of measurements?*]

Griselda Medio…medio vaso nomás…medio [*half, half a cup only, half*]

Juanita Yeah. Umm, what was it? One thing we used—we used this measuring cup and we did…and we used teaspoons, right? We used five teaspoons of concentrate and five teaspoons of water, pero cada cup tenía five teaspoons en cada uno. [*But each cup had five teaspoons in each one.*] So, let's say that that was enough for two people, pero, *[but]* we want to cut it down to one person. What would we do to our measurements?

Griselda Two and a half

In the excerpt above, Juanita not only keeps referring to what the group did in the previous session, she also physically points to the measuring devices they had used. She first reminds Griselda that during the previous session, they had used five teaspoons of orange concentrate for two people, and now, they need to make the same orange juice recipe for one person. Griselda's response that they need to use six teaspoons of orange concentrate and six teaspoons of water suggested that she was focusing on the fact that the recipe has to stay the same and therefore use equal measurements of each ingredient. Juanita, however, was trying to get Griselda to say that they will need half of what they used last time, so she used the measuring cup they used last time and reformulated her original question. Eventually, another student, Monica figured out that they needed half of five, which is two and half teaspoons of each ingredient, and the rest of the students agreed with her. In other words, Juanita re-created the group's shared experience of the previous session by using both verbal expressions to recall this experience and the measuring devices previously used as tools to assist the students in solving the task.

Just like Juanita, the other PSTs also used this strategy of recalling shared experiences from previous activities regularly during the "recipes project." In essence, the way each activity in the "recipes project" built on the previous ones naturally led the PSTs to keep referring to the previous sessions as a tool to help the students make sense of and complete each new activity.

Summary

In this paper, I described a study of four Mexican–American PSTs' use of culture as a resource in an after-school mathematics program, *Los Rayos de CEMELA*. Findings revealed that the nature of the mathematical activities influenced the PSTs' use of culture as an instructional resource in mathematics. When facilitating the "binder activities," the PSTs did not connect these activities to students' interests and experiences. The few times such connections between students' interests and the activities were made the connections were focusing on the aesthetic aspect of the activities rather than on the mathematical content. During the "recipes project," however, the activities were built around students' interests and experiences, and as a result, the PSTs did not have to make an additional effort to make cultural connections with the activities and the students because these connections already existed. Also, because of the fact that these activities built on one

another and functioned as a sequence, each session served as a shared experience between the PSTs and the students, and PSTs consistently drew on these shared experiences to help the students make sense of the activities that followed. So what does this all mean for mathematics teacher preparation? I now conclude with implications for the mathematics teacher preparation of Latinas/os.

Conclusion and implications for mathematics teacher preparation

"Culturally responsive [mathematics] teacher education is as essential as culturally responsive [mathematics] teaching in K-12 schools" (Villegas and Davis 2008, p. 600), and more attention should be given to providing relevant preparation for Latina/o teachers and other teachers of color and to studying such preparation. If we want to prepare Latina/o teachers to use culturally responsive practices in the teaching of mathematics, there is much we need to understand further. An insight that was gained from this study is that if the curriculum does not naturally draw on students' experiences with their families and in their communities and does not lend itself to creating shared experiences that teachers can use as instructional resources, we cannot assume that the teachers can use their cultural knowledge for pedagogical purposes in mathematics, even when they share similar backgrounds with their students. This study's finding supports the existing literature that suggests that merely sharing cultural backgrounds does not ensure that teachers will effectively utilize their cultural knowledge as an instructional resource (e.g., Remillard and Cahnmann 2005; Téllez 1999, 2005).

Also, this study's findings add to the existing literature by suggesting that one way for Latina/o PSTs to use their cultural knowledge for pedagogical practices in mathematics is by working with Latina/o children on mathematical activities that are conducive to using both theirs and students' cultural knowledge. In other words, teacher preparation programs should provide opportunities for Latina/o PSTs to work on open-ended community-based mathematical projects with Latina/o children such as the "recipes project" or other community-based projects in the literature (Turner et al. 2009; Simic-Muller et al. 2009). Even though there has been a great amount of work on project-based learning (e.g., Thomas 2000), teacher preparation programs do not typically provide opportunities for PSTs with project-based mathematical activities. Furthermore, Téllez (1999, 2005) has found that Latina/o PSTs did not use their cultural knowledge in the formal curriculum and has argued that they need more opportunities to explore ways of using their cultural knowledge during instruction. The findings of this study suggest that working on a community-based mathematical project with the children in *Los Rayos*, such as the "recipes project," enabled the PSTs to draw on their own and the students' experiences, and therefore use their cultural knowledge while doing mathematics. In addition to affording opportunities for Latina/o PSTs to use their cultural knowledge, a community-based project, such as the "recipes project" that involves meaningful parental involvement and out-of-school activities that requires going in the children's community, naturally lends itself to privileging home culture.

The implications of this study, however, apply beyond the preparation of Latina/o PSTs. Selecting and working on mathematical tasks that have natural connections to students' experiences, for example, should be important components of teacher preparation programs. All PSTs should learn how to select mathematics tasks that naturally draw on students' cultures and should also gain experience using these types of tasks with children. Furthermore, since not all mathematical tasks have natural cultural connections, PSTs

should also learn how to incorporate students' interests and experiences with the mathematics involved in these tasks in meaningful—rather than superficial—ways. The findings of this study suggest that simply sharing similar cultural backgrounds with students does not ensure that teachers will make meaningful connections between their shared cultural knowledge and the mathematics. Thus, learning how to select tasks that naturally draw on students' experiences and learning how to make meaningful cultural connections with the mathematics involved in other tasks should be central components of mathematics teacher preparation programs.

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