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Embracing the Inherent Tensions in Teaching Mathematics from an Equity Stance

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TEACHER EDUCATION AND PROFESSIONAL DEVELOPMENT WITHIN CEMELA: EXPLORING THE REFLECTIONS OF TEACHERS OF LATINO/A STUDENTS

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A jointly-designed research study was undertaken with teachers from two multi-grade study groups in elementary schools with high percentage populations of Latino/a students. Teachers reflected on the implementation of a rich mathematical task, as well as their practice in general, through video interviews and study group sessions. Findings show that teachers reflected on multiple areas of their instructional practice, including those practices that teachers consider effective and specific factors that impact practice. These findings suggest that the teachers had high expectations of their Latino/a students as well as the importance of engaging in professional development as a means to reflect and examine student work.
INTRODUCTION

One of the missions of the Center for the Mathematics Education of Latino/as (CEMELA1) is to investigate the interplay among mathematics, language, and culture. In regard to teacher education the Center aims to “strengthen teachers' ability to promote Latinos' achievement in mathematics in K-8 classrooms through their expanded knowledge of mathematics and the use of linguistically and culturally responsive learning environments” (CEMELA website). Under the auspices of this mission, researchers involved with two teacher study groups from two CEMELA sites undertook a study to better understand how elementary teachers of Latino/a students reflected upon their own mathematics instructional practice. Of interest was to note what these teachers attended to in their reflections and how the findings compared across locations.

The primary goal of this work was to contribute to the emerging literature on mathematical professional development for teachers of Latino/a students. This work is of particular importance. Although improving mathematics teaching and learning for all students receives particular emphasis in the Principles and Standards for School Mathematics (National Council of Teachers of Mathematics, NCTM, 2000), the document is not explicit in regard to the cultural and linguistic needs of students. On the other hand the literature addressing multicultural education and equity pedagogy (e.g. Banks & Banks, 1995) does not take into account specific academic content domains.

THEORETICAL FRAMEWORK AND RELATED LITERATURE

Research has shown that professional development experiences should help teachers develop deep understanding of content knowledge and identify students’ conceptions and misconceptions (Franke & Kazemi, 2001; Garet, Porter, Desimone, Birman, & Yoon, 2001). However, it is also important for professional development experiences to help teachers enhance their knowledge of student diversity and of how culture and language interact with their instructional practices and student learning. One way to promote this professional growth is through reflective practice in which teachers are encouraged to intentionally critique their work through a lens of improvement (Hatten & Smith, 1995; Schön, 1983). Schön (1983) and Manouchehri (2002) argued that this type of reflection should be a central component of teacher professional development as it opens up possibilities for teachers to revisit the different dimensions of their practice. It is this framing of reflection as central to teachers’ learning process that is the focus of our work.

We drew upon research that highlighted the potential for professional development experiences such as teacher study groups to form learning communities (Ball & Cohen, 1999; Franke & Kazemi, 2001; Kazemi & Franke, 2004). These types of learning communities, argued Crespo (2006), can create a context for teachers to

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1 CEMELA is a Center for Learning and Teaching supported by the National Science Foundation, grant number ESI-0424983. Any opinions, findings, and conclusions or recommendations expressed in this document are those of the authors and do not necessarily reflect the views of the National Science Foundation.
collaborate on constructing mathematical understanding as well as reflect on their teaching practices and students’ mathematical learning.

Our study was also informed by research that proposes teaching practices that support Latino/a students and second language learners in the mathematics classroom. Participation in mathematics reform classrooms involves students making conjectures, evaluating the mathematical strategies presented by others, and using mathematical language to express their ideas (NCTM, 2000). Communication plays an important role in these classrooms as students must organize and consolidate their understandings of mathematics through discussions of their findings with peers and others. In this context, all students, especially English Language Learners (ELLs) and bilingual children, must be presented opportunities to participate in mathematical discourse practices that draw upon the multiple resources these students use to communicate mathematically (Moschkovich, 2002). Khisty’s (1997) research furthered our understanding of what teaching practices would support success in this type of environment by suggesting that teachers of students from diverse linguistic backgrounds may need to understand multiple factors that influence group interactions and thus mathematical understandings.

**METHODOLOGY**

Researchers from two different CEMELA sites jointly designed a professional development experience for teachers from two different study groups. Teacher study group 1 (TSG1) had the participation of eight teachers from grades K-5 and three different schools. The classroom experience of the two male and six female teachers, five of whom were Latino/a and three of whom were Caucasian, ranged from 5 to 20 years. Teacher study group 2 (TSG2) had 10 participating teachers; nine from grades 3-6 and one from the Gifted and Talented Education program. These teachers, seven Latina and three Caucasian, were all female, from three different schools, and ranged from 3 to 27 years of classroom experience. The schools had on a collective average a 90% Latino population and a 31% classification of English Language Learners (ELLs).

Both study groups had as a central focus the analysis of student work. TSG1 framed their professional development using the Cognitively Guided Instruction approach (CGI; Carpenter, Fennema, Peterson, Chiang, & Loef, 1989) as a way to help teachers rethink how to integrate problem solving into their mathematics instruction. Under this framing, study group sessions investigated mathematical problems and analyzed student work produced as a result of particular CGI-type problem-solving activities. The development of TSG2 was guided by previous research with teacher study groups (Arbaugh, 2003; Kazemi & Franke, 2004). This research showed that analyzing student work has the potential to influence teachers to not only investigate mathematical content on a deeper level but also to reflect on their classroom practice.

In order to develop a cross-site project, the researchers employed a strategy similar to the SATTR model (Crespo & Featherstone, 2006). Teachers within both study groups collectively engaged with and reflected on the implementation of a “rich mathematical task” (Crespo & Featherstone, 2006, p. 99). The task selected was a fourth grade National Assessment of Educational Progress (NAEP, 1996) geometry measurement problem specifically asking students to compare the areas of two figures. The particular task selection was intentional for several reasons. First, while research has shown that Latino students are out-performed by white students on the measurement
strand of the NAEP (Lubienski, 2003), others studies have shown that Latino students can participate meaningfully through their mathematical discourse (Anhalt, Fernandes, & Civil, 2007). Second, the "comparison of areas task" served to benefit both students and teachers. In the latter case, teachers would be provided multiple opportunities to reflect about the mathematical concepts students need to understand and solve the task as well as what issues of language are involved in comprehending the task. Moreover, as the nature of the task allowed for students to use a variety of strategies, teachers could reflect on such pedagogical moves as what materials to make available for students and how they discovered student misconceptions.

Two back to back sessions of the study groups were used to explore the mathematical task and reflect on its implementation in the classroom. Specifically, session one focused on having the teachers engage with the task as mathematical learners (i.e. they solved the task themselves and discussed their different solution processes) and reflect on what specific adaptations they would make for each of their own classrooms. After each teacher implemented the task, teachers met for the second study group session to discuss the specific modifications they made for their class, including how they introduced the task and what materials they made available, as well as to analyze their classes’ work on the task.

Multiple data were collected for this study. At each site, both study group sessions were videotaped as well as selected classroom sessions (three at each site). Follow-up interviews with the teachers whose classroom sessions were videotaped were also conducted. These videotaped interviews were semi-structured, followed similar protocols across all participants, and used selected video-clips of the teacher’s classroom implementation. These selected clips were essential to the interview as they provided the teachers the opportunity to reflect on different aspects of the task implementation, which in some cases took place months earlier. Relevant scenes were chosen to highlight (a) the task introduction, (b) the materials provided to students to work on the task, and (c) the different strategies students used to work on the task and some of the challenges they confronted.

Both sites analyzed the data using elements of Grounded Theory (Strauss & Corbin, 1998). First, with the help of TAMS Analyzer, each individual site team openly coded the transcripts of the follow-up interviews and the second study group session and looked for themes in the teachers’ reflections. Next, research teams refined their emerging codes, both individually and collectively, with the research teams coding one transcript from the other site to ensure data reliability. Finally, the two research teams met in person and virtually to look for cross-cutting themes.

The following seven categories were developed after the data analysis was complete: (a) Teacher Expectations, (b) Factors that impact practice, (c) Practices considered effective, (d) Issues, (e) Knowledge of students, (f) Recognition teachers have about their practice, and (g) Teacher notions about a variety of topics.

**FINDINGS**

In analyzing teachers’ reflections and subsequently organizing them into categories, data reveals that teachers reflected mainly on the multiple practices they consider effective in teaching and supporting their students to achieve mathematical
understanding (category c), as well as the factors impacting their work in the classroom (category b).

**Reflections on Practices that Foster Mathematical Understanding**

Teachers from both TSG1 and TSG2 reflected on what practices were more typical and important in their instruction and that seemed to be more effective to promote Latino/a students’ mathematical understanding. Among these practices, teachers identified: using appropriate mathematical vocabulary, creating learning situations that foster peer interaction, supporting students to become active thinkers and independent decision makers, providing varied materials and resources to solve problems, and supporting student learning through the review of concepts, the validation of their responses and strategies, and when needed, using students’ native language. It is important to consider that language policies are different at each site. Whereas the state of TSG1 promotes bilingual education, the state of TSG2 does not. Teachers’ words clearly illustrate the significance of the most relevant practices identified at both TSGs:

1. About the importance of developing students’ academic language and using appropriate mathematical vocabulary, Ms. Alvarez from TSG2 explained in the interview:

   > I think about the language. As I’m saying things I’m trying to think of the correct language. And to make sure that I’m using the mathematical terms […] so I go slow because I’m always trying to think of how to say it correctly and using the vocabulary, so that they in turn will use it also. (Interview, May 2007)

2. In relation to developing students’ mathematical vocabulary and the need of using their native language as a way to support students’ learning, Ms. Salas from TSG1 commented:

   > A lot of the kids in here would need [Spanish] and it would help them. And because you just can’t give it to them all in English because then it would hinder their learning, this way you explain both English and Spanish and “I can do that, I understand what she is talking about now…” (Interview, May 2007)

3. Teachers underscored the importance of creating learning situations that would encourage students to interact and learn from each other. They drew on the belief that students benefit from collaborative work within problem solving contexts. Mr. Sloan, from TSG1 explained:

   > If the environment is set up correctly, the children will learn just as much or more from each other than they will from your instruction. […] In something like this, I remember there were a couple of places where kids were doing as well or better a job than I would be doing explaining to another child how they got the answer. (Interview, May 2007)

4. In connection to teachers valuing students to learn from each other is their emphasis in promoting learning situations that would support students to be active thinkers, to
develop and apply higher thinking skills that they could transfer to other situations in which they are required to problem solve. Ms. Alvarez from TSG2 explains her expectations:

I want them to be able to think on their own. …I’ve always told them, when you are solving a problem try and, I try and teach them different ways, different strategies, to solve something. And I want them to be able to reason and think, okay here I have a problem, what can I do to figure this out? (Interview, May 2007)

Reflections on Factors that Influence Practice

Data indicated that among the most influential factors on what teachers teach, what they do in the classroom, and what they consider relevant for students learning are (a) the adopted reform curriculum, (b) their knowledge of students in terms of dispositions for learning, language, prior knowledge, and mathematical understanding, (c) their previous personal and professional experiences as learners and teachers of mathematics, (d) their expectations or what they value for students to learn and understand, and (e) the TSG professional development experience.

It is important to notice that both groups of teachers identified the adopted reform curriculum as their referent to decide what to teach. In addition, these teachers reflected on the importance to have high expectations and to build knowledge about their students, especially to be able to understand what students are able to accomplish, what their struggles are, and what they know that might help them to be successful with problem-solving. Mr. Sloan (TSG1) thinks that teachers

should never go into something with a… predetermined notion of whether or not the kids will be able to solve the problem. My attitude is… anything I give them they should be able to do it, and if they can’t do it immediately then maybe you just need to be give them a few more tools, a little more background knowledge. But I think way too often we kind of have preconceived notions of what they’re capable of and so they’ll live up to those expectations. So if they are low expectations, they live up to them. (Interview, May 2007)

Teachers’ personal, educational, cultural and linguistic experiences, as well as their experiences in the classroom, seemed to affect the way they perceived effective teaching and the conditions that foster students’ learning. Ms. Alvarez’s (TSG2) memories illustrate this point:

You know we didn’t grow up that way. Where we had . . . to memorize everything, and some things I’m learning along with them. I told them, you know I memorized, like when we were working with fractions, especially with division I told them, you know all I memorized, was you turn them and you multiply. And I go “I didn’t understand why. And now you guys are lucky because you are understanding ‘why,’” and I learned along with them. (Interview, May 2007)
Professional development was a relevant factor affecting the way teachers interpreted students’ work and the instructional decisions they made to provide for students’ learning needs. Teachers’ raised questions, expressed doubts, and understandings they have gained through the TSG process. For instance, Ms. Segovia (TSG1) revisits her practice based on her insights of students’ understandings:

You see what they did and what they didn’t get and it shows you how you taught it or what you didn’t teach, … for some reason they just didn’t understand it the way you taught it. Or maybe something in your thinking, [you need to ask yourself], what am I not doing? Do I need to go back and review myself to see what’s missing? (Interview, May 2007)

DISCUSSION AND IMPLICATIONS

The findings from our study highlight several important findings and implications for future research. First, as the results from the study show, teachers reflected on various components of their instructional practices with Latino/a students. Of particular relevance is that teachers at both sites reflected on their deliberate focus to model academic language in their instruction, specifically referring to their use of and their students’ development of appropriate mathematical vocabulary. Additionally, teachers reflected on their practice of using Spanish to support students’ mathematical understanding. Through their explanations we can see that the teachers use and incorporate Spanish into their mathematics teaching as a means to support students’ comprehension of mathematical concepts, a method congruent with suggestions from leading researchers in the field (e.g. Khisty, 1997). These explicit reflections showcase that teachers of Latino/a students can and do have high expectations of their students and support them in the manner set forth by the NCTM (2000).

One underlying purpose of the task implementation was to understand how teachers discuss issues of language and culture. Given this focus, it was interesting to note that the teachers rarely discussed these elements in regard to students’ mathematical understanding. We hypothesize that perhaps these teachers internalized the identity of their students as Latino/a students, thus making it difficult for them to explicitly reflect on certain components of this identity in relation to the teaching and learning process. We suggest that further research be done in this area.

Although the purpose of this study was not to explore the impact of doing cross-site research, the opportunity to reflect about the limitations, strengths, and challenges of doing this type of research served as an unexpected outcome that benefited all researchers involved. Through this research, we were able to explore the methodological implications of designing and developing research in two ongoing teacher study groups that were pedagogically and contextually different (meaning they had slightly different purposes, content and were situated in different social and educational contexts). In relation to this, the work done throughout this study informs us as researchers and collaborators about:

- how cross-site, cross-specialty collaboration can occur, including the time required to construct a common project, the negotiation of theoretical perspective, and the methodological approach taken;
• the importance of constructing a common approach to data collection such as the interview protocol;

• the benefits of using technology (such as TAMS Analyzer, Skype, and Google Documents) as a means to virtually discuss, negotiate, and document the different conceptual and methodological aspects of the study;

• the challenges of writing and authorship; and

• the strength of collecting data from different sites and the potential to generalize some of the conclusions while taking into consideration the limitations embedded in comparing and contrasting data collected in different contexts.

Ultimately our study, highlighted by the teachers’ reflections, explicates the value teachers of Latino/a students placed on participating in a professional development community. The teachers in this study were able to gain both an individual and a collective understanding of how their students made sense of the concept of area and what might be ways to promote student understanding. Furthermore, through the context of a professional learning community, the teachers were able to draw upon each others’ insights regarding both their successes and challenges during the task implementation which was evident when teachers commented on specific strategies they wished they had incorporated. Thus, the findings of this study underscore the importance of engaging in professional development as a means to reflect and examine student work in an intellectually engaging manner.

References


USING CULTURE AS A RESOURCE IN MATHEMATICS:
THE CASE OF MEXICAN AMERICAN PRE-SERVICE TEACHERS
IN A BILINGUAL AFTER-SCHOOL PROGRAM

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This paper explores Mexican American pre-service 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 children of Mexican heritage. Qualitative analysis of the pre-service teachers and children’s interactions reveals that the nature of the mathematical activities affected how culture was used. When working on the “binder activities,” pre-service teachers used culture only in non-mathematical context and mathematical discussions were English dominant. When working on the “recipes project”, however, culture was used as a resource in mathematical context and the amount of Spanish used in mathematical discussions increased significantly. Implications for mathematics teacher preparation of Latinas/os are discussed.
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, Anderson, Easton, Te Maro, Smith, & Hynds, 2009; Gonzalez, Moll, & Amanti, 2005; Lipka, Webster, & Yanez, 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) pre-service teachers to teach students who are racially and ethnically different from themselves (e.g. Ensign, 2005). As a result, minority pre-service teachers 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 & Davis, 2008). Pre-service teachers who share similar backgrounds with language minority students (LMS), such as Latinas/os, however, may need different kinds of support than their White English monolingual counterparts, to 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 (Strizok et al., 2006), they tend to teach Latina/o students (Villegas & 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 pre-service teachers build on the unique strengths they bring into teaching, particularly their knowledge of Spanish and possible familiarity of their students’ living experiences. Moreover, what kinds of experiences do Latina/o pre-service teachers 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 pre-service teachers 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’ (Quiocoh & Rios, 2000, Valencia, 2004) such a similarity is not sufficient to ensure that the teacher is able to connect to his or her students (Cahmann & Remillard, 2002) 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 & Carrasco, 2000; Walker de Felix & PeOa, 1992). Third generation Latina/o teachers whose family traces its 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 student’s cultural experiences in their lessons. 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 further. The purpose of this paper is to describe how a group of Mexican American pre-service teachers used culture - defined as shared experiences and social practices - as an instructional resource in mathematics through their participation in a non-traditional field experience. The setting of the study was 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, participants, and the methods employed. Next I discuss how the nature of the mathematical activities affected the pre-service teacher’s use of culture. I close my discussion with some concluding thoughts related to the implications for the mathematics teacher preparation of Latinas/os.

LOS RAYOS DE CEMELA

The work presented here draws on a wider dissertation study that explored how Mexican American pre-service teachers 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)[2], 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 has 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 is a general adaptation of the work of the Fifth Dimension (e.g., Cole and the Distributed Literacy Consortium, 2006) and is guided by other similar projects (e.g., Gutierrez, Baquedano-Lopez, & Alvarez, 2001; Vasquez, 2003). These works have utilized the after-school as a way of understanding literacy; CEMELA has extended the work to consider mathematics. As in the work of the Fifth Dimension and related projects, Los Rayos involves pre-service teachers who participate as facilitators.

While Los Rayos was designed to investigate the linguistic and cultural resources bilingual Latina/o students use in mathematics and that support their mathematics learning, it simultaneously serves as a non-traditional field experience for pre-service teachers as they participate in a unique context where they must form interpersonal relationships with students, negotiate mathematical ideas, and engage in dialogue across two cultural languages (Spanish and English). Los Rayos is a setting where pre-service teachers and students naturally talk about their experiences and their interests. A group of Spanish speaking mothers often join Los Rayos and participate along with the children and the pre-service teachers in many different ways. This
Vomvoridi-Ivanovic gives the pre-service teachers the opportunity to interact with children’s family members, thus giving them multiple opportunities to recognize and draw on the children’s interests and everyday practices with their families and in their communities. In addition, the mathematical activities are intended to be open-ended and to require students to experiment, develop multiple strategies, and communicate their reasoning. Children can choose what activities to work on, with whom, and could change or redirect activities as they wished but within the limits of being part of a group. Furthermore, they are encouraged to work collaboratively and pre-service teachers are encouraged to capitalize on childrens’ ideas, comments, and any other resources they presented. This is relevant to this study because, again, the environment offered the pre-service teachers many opportunities to choose to use childrens’ 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 facilitators to, in turn, draw on these experiences to support conceptual development (Khisty & Morales, 2007). This work assumes that learning at any age occurs in a social context (Vygotsky, 1978) that emphasizes active dialogue among participants (Wells, 2001). Furthermore, it assumes 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 pre-service teachers are not expected to teach or tutor in the traditional sense. They are 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 and because it was not a typical field experience context, the pre-service teachers 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 me with opportunities to observe, in essence, the decisions they made that relate 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.

The mathematical tasks in Los Rayos revolve around several dimensions of play, they are open-ended, and require students to experiment, find patterns, develop multiple strategies, and to communicate their solutions. During the time of the study presented here, 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 challenging problems that were non-remedial and focused on various topics such as fractions, logic, geometry, patterns, etc. These tasks were provided in both Spanish and English, were grouped according to the topic they addressed, they were placed in binders, and everyone referred to them as “the binder activities” and this is how I will refer to them as well. 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 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,” and this is how I will refer to from now on, 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 at random from a list of five dishes given to the students: guacamole, salsa, cupcakes, jello, and lemonade. Project activities involved finding out which orange juice recipe from a list of different orange juice recipes is more orangey, 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, making mole – a special and favorite dish among Mexican families - with a group of mothers who posed mathematical problems in the process, figuring out how to magnify the recipe to serve all participants in the party, and finally making the dish for the party.

I now turn to describe the pre-service teachers who were observed at the time of the study.

THE PRE-SERVICE TEACHERS

Jose, Juanita, Maria, and Lupe[3], the four pre-service teachers were undergraduate students at a large University in the Midwest. 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 who, at the time of the study, was strongly considering entering the elementary education program. For the purposes of this study I refer to her as a pre-service teacher even though she was not officially an education major during the period she was observed.

Jose and Juanita self identified as Mexican American, while Maria and Lupe 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 pre-service teachers 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 all pre-service teachers were required to take detailed field-notes of their interactions with the students. Finally, during this nine-week period, all participants met in weekly a two-hour 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 video-taped and transcribed.

Data were analyzed using a constant comparative method (Glasier & Straus, 1976) in which 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 pre-service teachers’ use of culture in their interactions with the children, I focused on pre-service teachers’ and students’ shared lived experiences. These shared experiences were revealed through discussions that participants - pre-service teachers and children - had about their daily practices and interests. For example, new shared experiences also emerged as participants worked together in Los Rayos. Thus, my unit of analysis was how pre-service teachers 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 entire sessions since children discussed their experiences and interests with the pre-service teachers before, during, and after the mathematical activities. Next I identified sections in the pre-service teachers’ field-notes and the transcriptions from the debriefing meetings where pre-service teachers noted students’ interests and experiences. I also identified sections where pre-service teachers 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 pre-service teacher had mentioned. 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, etc. During the second round of coding I divided the codes into two categories: those which reflected childrens’ experiences and interests, and those which reflected shared experiences with the pre-service teachers.

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 pre-service teachers used culture as a resource in their mathematical interactions with the children. I now turn to describe the findings.

**PRE-SERVICE TEACHERS’ USE OF CULTURE**

As noted earlier, the after-school is a setting where pre-service teachers 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 & Morales, 2007). The data suggests that the nature of the mathematical activities affected how pre-service teachers used culture as a resource. Specifically, when doing activities from the binders, pre-service teachers 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 alternatives to the activities from the binder. During the recipes project, however, students’ experiences were naturally used in mathematical contexts and used their shared experiences with the students’ as a resource in mathematical context.
Their 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 their interactions with the children in their group and was something the pre-service teachers 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 such as *Pokemosn, the Simpsons, Sponge Bob Square Pants, Family guy*; and using the internet to connect with other students through *My Space*. They would also talk about other experiences such as getting their nails or hair done, and other 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, pre-service teachers would try to interrupt these side conversations, as they were seen as irrelevant to the task, and try to get the students back to focusing on the mathematical task they were working on.

There were very few instances where pre-service teachers attempted to relate the mathematical tasks with 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 pre-service teacher, 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*) appears to be three-dimensional.

Andre:     It’s all like 3D and everything!
Jose:        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!
Jose:        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!
Jose:        Yeah and they found him in the garbage can.
Andre:     (laughs) Yeah!
Jose:        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 pre-service teacher, 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.

Thus far, I have described two patterns regarding the pre-service teachers’ 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, pre-service teachers would rarely make 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 pre-service teachers’ use of culture that emerged during the recipes project.

**Their Use of Culture During “the Recipes Project”**

As described in a previous chapter, 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 would regularly bring their experiences from grocery shopping, or cooking to do the recipes and would naturally draw from them to work on the mathematics in the activities. In essence, pre-service teachers 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 would cost. When 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 was only 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...]
Maria: 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 was the case then buying two gallon 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 pre-service teachers 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 not the best example because both Maria and Juanita jump in to correct Lisbeth. One might see this as a missed opportunity to have a rich mathematical discussion. However, the pre-service teachers’ approach to pedagogy is not the unit of analysis here. Instead, the point is that mathematical discussions that were based on students’ and pre-service teachers’ 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 pre-service teachers and students used these experiences in mathematical contexts. In essence, pre-service teachers 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 pre-service teachers to have students recall on their experiences in previous sessions to make sense of and solve the activities.
In the example below, Juanita has Griselda recall the measurements they used during the previous session to make el Maga’s orange juice. During that session, as part of an activity that called to compare the strength of different recipes, amongst other things they had mixed certain quantities of orange concentrate and water to make “el Maga’s” (the magician’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?

Griselda: Five

Juanita: Five, ¿verdad? Five eran para dos…la cantidad que hicimos era para dos personas.

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?

Griselda: I’ll put six teaspoons of orange juice and six teaspoons of water.

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?

Griselda: Medium…medium a cup only, medium

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 cinco medidas en cada uno. 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 suggests that she is focusing on the fact that the recipe has to stay the same and therefore use equal measurements of each ingredient. Juanita however is trying to get Griselda to say that they will need half of what they used last time so she uses the measuring cup they used last time and reformulates her original question. Eventually another student, Monica figures out that they will need half of five, which is two and a half teaspoons of each ingredient and the rest of the students agree with her. In other words Juanita re-creates 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 pre-service teachers 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 pre-service teachers 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 pre-service teacher’s use of culture as a resource in an after-school mathematics program, Los Rayos de CEMELA. Data analysis revealed that the nature of the mathematical activities influenced the pre-service teachers’ use of culture as an instructional resource in mathematics. During the first half of the study, the curriculum in Los Rayos included the activities from the binder. During the second half of the study the curriculum included a series of activities that together made up the recipes project. When facilitating the activities from the binder, the pre-service teachers did not connect these activities to students’ interests and experiences. The few times such connections between students’ interests and the activities, the connections were focusing on the aesthetic aspect of the activities rather than the mathematical content. During the recipes project, however, the activities were built around students’ interests and experiences and as a result pre-service teachers 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 build on one another and functioned as a sequence, each session served as a shared experience between the pre-service teachers and the students and pre-service teachers consistently drew on these shared experiences to help the students make sense of the following activities.

So what does this mean for mathematics teacher preparation? I now turn to draw implications for the mathematics teacher preparation of Latinas/os.

CONCLUSION AND IMPLICATIONS FOR MATHEMATICS TEACHER 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 an instructional resource, we cannot assume that teachers can use their cultural knowledge for pedagogical purposes in mathematic. In other words, Latina/o pre-service teachers need experiences working with Latina/o children on mathematical activities that are conducive to using both theirs and student’s cultural knowledge.

Teacher preparation programs should provide opportunities to work on open-ended community based mathematical projects with Latina/o children. 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 pre-service teachers with project-based mathematical activities. Furthermore, Téllez (1999; 2005) has found that Latina/o pre-service teachers 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 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 pre-service teachers to draw on their own and the students’ experiences and therefore use their cultural knowledge while doing mathematics. In addition to affording opportunities 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 require going in the children’s community, naturally lends itself to privileging home culture.

In other words, providing Latina/o pre-service teachers with opportunities to engage with Latina/o children in community based mathematical projects, that involve meaningful parental involvement and activities inside their community, afford great possibilities for them to use their cultural knowledge as a resource in mathematics content.

References


[1] This is a draft. Please do not cite without the author’s permission.
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[3] These are pseudonyms.
Dorothy White

I'm going to organize my reaction in a way that may be a little different. What I'm going to do is just highlight what I found were some of the key things that informed my thinking and pose three questions for each presenter and then somehow talk about next directions that I'm thinking we should go into... So let me tell you a little bit about where I am in this place Math Education Research and Professional Development. I wear several hats. One hat is a teacher educator. I work with pre-service teachers preparing them to teach students of diverse backgrounds, both culturally, linguistically, and socioeconomically... and place; I think place is important. I'm also a professional developer. I work with teachers in schools, in districts across the country, so I get the opportunity to learn first hand what it is that we're facing in our schools. I also research how do we support teachers at every level to infuse issues of equity and diversity and culture into the classrooms and teachers. I'm, last but not least, a parent of African-American children in public schools, because I really believe in public education. So I have a host of things that are working either together, or in opposition as I go about my work everyday, so that's the lens by which I am phrasing my comments and suggestions.

I want to say that all of the papers and presentations have challenged me to think more critically about what it means to educate Latino students in particular and all students in general. They've challenged my assumptions and the way we go about this thing called "mathematics education." So I'd like to hopefully share that. Embracing the inherent tensions help us think critically about the achievement gap, and Rochelle (Gutiérrez) and Laura have talked about this and Jeremy (Kilpatrick), and so when Rochelle tells us that the achievement gap is not the be-all, end-all, that it is a slice that we critically need to analyze, I listen. I listen because too often we use the gap as an excuse, and opposed to as a solution or an assessment. It is an excuse to keep certain students marginalized, while uplifting other students. So her work on embracing the tensions talks about this dimensions of equity in playing and changing the game of school mathematics. Playing in the game is making sure that children are passing standardized tests, having high expectations, keeping the mathematics and integrity of tasks and opportunities there; at the same time changing, changing it for the next generation, and for all students, so that the game does not continue. So these tensions for me have helped me think about how I can realistically help pre-service teachers see the reality in schools. Too often, at the university we tell them these things and they go out to schools and they hear very different things and we don't take the time to set up the tension that exists between knowing the students and not knowing them, or teaching mathematics, not
teaching mathematics, and also this notion of control. For me, in classrooms, control is a big issue, but as (Name - incomprehensible) told us back in '95, that it's a false sense of control, because kids have control; they can make a break that day just like that. (Snaps her fingers - laughter) So these tensions help us think about what it is to do and learn about teaching mathematics.

So here are some questions that I'm wondering about. How do we help other teacher educators embrace these ideas and incorporate them into teacher education classes and programs? How do I get my colleagues at the University of Georgia to understand that this is important (incomprehensible) that we need to have both in faculty meetings and in our classrooms? How do I help others do that? How do we create a shared language around district personnel and teacher educators/professional developers to move our agenda forward? And I bring this up because I meet mostly with the current district that I'm working with, and we are speaking very different languages. They are speaking the language of student achievement and I'm talking student learning. We are not talking... We don't share the same thing. The achievement gap is the way that they speak and I don't think they're going to change their speak, so how can we change our speak so that they can hear us, because once they are listening, then we can change... and how do we identify and support practitioners to do this work? The nice thing about conferences and hearing the wonderful things is that you see teachers are doing it. You have hope when I go back into my classrooms, and in my classrooms I still see whites are privileged, blacks are reprimanded, and Latinos are ignored... So how do we create a larger pool of teachers who can (incomprehensible) support students, but our pre-service teachers as well. So those are some of the questions (inaudible). Thank you, Rochelle.

Eugenia (Vomvoridi-Ivanovic) talked about using culture as a resource, and what her work did was challenge my assumptions about the needs of pre-service teachers of color, and she puts it right out there in my face and say "Hey, wait a minute. We are assuming that if you are a person of color, then you know how to teach people of color because you're colored!" (Laughter) And it does a disservice to everyone involved... because it doesn't help teachers of color, pre-service teachers, learn how to do the job that they're going to be expected to know how to do, and it makes assumptions about their experiences as being shared, and I think about the two teachers that self-identified as Mexican-American and the other two teachers in the study identified as Mexican. Yet, in the classroom we see them all the same. They're just going out there... or worse yet, because you're (incomprehensible) you can teach all Latinos! It doesn't matter if they're from Chile... so it challenges those assumptions. It examines this whole nation of a shared culture and if there are shared cultures, but then when we deal with mathematics, those things can be convoluted at times. The task can either support or hinder pre-service teachers’ ability to infuse cultures (inaudible)... And I think we saw that with the binder task versus the (inaudible) task. (Inaudible) one of my questions. How do we incorporate students' in-class experiences within these new spaces? So we have this out-of-school experience, which is still in the school, because it's after-school, but the kids know it's not really school, but how do we make the connections for them, that these experiences can be useful as they learn school mathematics? I think we have to make that explicit. Kids don't make the leap nor do teachers. How does the self-identified cultural
identity of the teacher influence the intentions of students' cultural identities and mathematical needs? I was really wondering about that. I have a lot of African-American teachers who believe the same discourse about students: "They're poor; therefore, they can't learn." They don't share up an identity. They don't share a socioeconomic identity and they've adopted the school's cultural identity of who can and cannot do mathematics. I need help, 'cause this is really a problem. Too often, kids are in classrooms...

(Incomprehensible) We have a new discipline policy, 'cause that's all we do with discipline. We just… we can't get his up and right. So we don't want to show that we have in-school suspensions, right? We have (inaudible). So now, what we do is we take Sean and we say "Sean. Get your books. You got to go... but don't go to in-school suspension. Just go to the other teacher's classroom."

So, on the books we're down with the numbers of in-school suspensions. Sean goes to the classroom and Sean (incomprehensible). Right? There's nothing done! The teacher, "Welcome, Sean! Come on, grab a seat right here," and Sean is ignored the rest of the day. Can we afford that? Even though the teacher looks the same as the student, Sean, but they don't view themselves as having a shared cultural identity with the students. So, how do we do that? 'Cause it interferes with the mathematical needs and therefore, ability to assess. So, how do we help pre-service teachers learn when to infuse students' culture in mathematics lessons? I think that's still unchallenged. (Incomprehensible) for some time and it's not that simple. And so, is it that we need them, “When you get here, do that”? That's what our district does a lot of. It's just a recipe. Or do we help them become critical interrogators of curriculum and classroom? And I'm going to argue that we need to do that, and that we need to help them find out how to find information to support their needs.

"Exploring teacher reflections," and in this study they examined teacher study groups from two different CEMELA sites over time and I think that's powerful because a lot of times we have this individual projects and we don't take the time to really see where we intercept or, more importantly, design it so that we are looking at these different sites; recognizing that the sites have different elements, but what are the shared ways as both researchers and professional developers? It highlights the teacher's reflections about effective practices. We need to continue to be our teachers' voice, both the good, the bad and the indifferent. In this case, we hear voices of, "What is effective teaching?" This is a shift in our model, because often we tell them what to do and we study how well they did it. So now this is, maybe they should tell us what to do and we should study how well we're listening. (Laughter)

It also provides opportunities for teachers to solve mathematical tasks, reflect on how the students would engage in a task, and discuss what happened in classroom, and to me this is a challenge, because right now we're studying what happens in common planning times, and a lot of time it's not a lot of planning that's productive. "One day I'm going to teach 1.1. What are you going to teach?" "1.2" "OK, and then we're going to do (incomprehensible) test on (incomprehensible)," right? But that's not productive use of time. So engaging them in mathematical tasks can be faced with resistance. "I don't want to do the task. I'm a teacher. I don't have time for this. You're eating up my planning time." So having them understand how important it is. I don't know how well
you should know the task before you teach it, but more importantly, to think about how
students are going to engage in this task, and then to come back and discuss what
happens. I've seen models where we (incomprehensible) student work, but they don't
have a collective group of work that we're bringing in. So we deal with the whole notion
of "Well, I don't know how this other teacher is going to feel about what I'm presenting,"
and we're territorial because it is a reflection on us. Maybe we want to say "No, it's not.
It's just the students..." No, it's your students, and when you leave, they're going to let you
know. So we have that.

So here are my questions that I'm wondering about. "How did the discourse change over
time across the two groups?" Did it become more about the mathematics? Did it become
more about the students? How did that change over time and what's important about that?
I was very concerned that they didn't talk about district constraints, because our teachers
are constantly talking about how the district is imposing these things on them, and that's a
reality. That's a tension, that if we don't acknowledge, we won't be heard. So what types
of districts constraints have they talked about? And given the teachers really discussed
issues of language and culture, how should we interpret this? I think a lot of times we're
looking for "Oh, they should be saying..." What would we say? What would they say?
How do we (incomprehensible)? And I think you've addressed, and I just didn't want to
change my slide. (Laughter) And then, our practitioners... That was really hard,
because this was on (incomprehensible)... but the thing that I heard was that their
experiences changed their perceptions about students and teaching... their experiences;
that pre-service teachers need to learn about immigration and political views, and one of
the things that we're doing now, in our teacher education, is we're bringing in the state
district attorney to talk about educational law. We're seeing, our students are seeing
things... We are having our pre-service teachers see things in schools that they think are
really hurting kids. What's the law? What is that? How do we help them understand? But
also, what's the (inaudible) in schools? School cultures can be hostile. They are
becoming more hostile because of all the ways that No Child Left Behind, AYP, all of
these mandates are imposing, which goes to my next... Assessment practices are stifling
teachers and students. (Researcher's name) in the 80's talked about “assessment is the
new academic lynching...” that the more you have lower economic status kids, the more
testing that we give them. It's stifling both the teacher's ability to teach, but not just teach
something but to reflect on what happened and adapt their instruction accordingly
because by the time you do that you got to assess again, and it's stifling students' ability
to feel good at any time. I don't know about you but I had to play monopoly for a couple
of years to really get good at it, and I think I can say most of you were the same way.
(Laughter) Same things with mathematics. It's a set of skills, (incomprehensible). So,
how do we do that?

All the school’s (incomprehensible) professional development must be relevant, and
professional learning can be (incomprehensible) to support professional conversations.
So here are my questions: How do we provide experiences for teachers to transform their
views within existing professional development models? Districts are doing professional
development all the time, but as (incomprehensible), they may be not be relevant. How
do we encourage teachers to become leaders in the schools, districts, and math community, to continue and support these efforts?

And then finally, how can we as teacher educators, professional developers, researchers, become what (Name) talks about as these "educational brokers," between teachers and administrators? We can say things that teachers can't say, and so how do we become those brokers? So, as we move forward and think about it and dream about what can be, here are my four next steps. (1) We have to convince all stakeholders that the strategies that we are seeing work well for all students. I'm tired of my students saying that, "If I get some Latino students I'm going to do that!" (Laughter) We have to explicitly help them understand, all stakeholders: teachers, administrators, parents, teacher educators, that these strategies are good for all students. (2) We have to change the discourse in our schools and districts. It's not "these kids;" it's "our kids," and until they belong to us, we will not teach them. The parent is (incomprehensible), because when I'm in a classroom, they are all my kids and they always say "Do you have kids?" "Yes, I do. How can you tell?" We have to change the discourse. (3) We have to engage in cross-cultural research to broaden our knowledge base. We have research on African-American students. We have research on Latino students. How can we start broadening that? Or will we back here in ten years and we will ask the same questions with different people? Instead of "How do prepare White pre-service teachers to deal with Latino and African-American students, how do we prepare Latino teachers to deal with African-American and White students? So we need to really start broadening that, and finally, (4) how do we create models that can be tested in different contexts, cross-cultural, linguistic and socioeconomic? The political landscape is not going to change with the discourse around education. It works (incomprehensible). So we need models that we are testing. What do we agree with those models? Large-scale. It's time to start taking it all. I hope that you have felt, like I have, that we come together to celebrate our successes, (incomprehensible) challenges, and rejuvenate our spirits and missions to move forward. I hope we can continue these conversations and that we will continue the good work.

Thank you.
Teacher Education and Professional Development Group Discussion

The participants involved or interested in teacher education, were divided into small groups (6 to 8 people) to discuss the current situation and unsolved issues in the domain of teacher education. The members of the groups were teachers, school administrators, mathematics educators, mathematicians, bilingual/ESL educators, and policy makers. The group discussions were structured by the following questions:

- What do we know?
- What are the implications for practice and research?
- What else do we need to know?
- What connections exist between this strand and the other strands at this conference?

The connections question became embedded in the discussions of the other questions. This summary represents common themes identified within and across the working groups.

What do we know and what are the implications for practice and research?

Combining the presented research studies from the Teacher Education Strand, the provided poster sessions, and our own background knowledge and experiences, we are able to state what we believe to be the issues involved in teacher education of mathematics with English Language Learners (ELLs) and particularly with Latino/as.

An overarching theme of identifying and addressing equity issues for marginalized students learning mathematics predominated the presentations and discussions. With an excessive focus on the “achievement gap,” the need to close the gap (“gap gazing”), and the need to have schools and students make adequate yearly progress (AYP), certain dominant perspectives about schooling, achievement and equality are reified “with little concern for issues of identity and power or broadened notions of learning from a critical perspective” (Gutiérrez, 2009, p. 9). How we address this as teacher educators became a central piece of the conversations.

There were three predominant areas debated during the group discussions: teacher preparation program development, pre-service teachers’ preparation, and in-service teachers’ professional development. The main ideas and the common themes discussed within and across the working groups are divided into the three areas mentioned above.

Teacher preparation programs development

A common concern among the participants in the teacher education strand was the lack of agreement among teacher educators regarding the basic knowledge needed for teaching. Teaching is a complex profession that requires skills, abilities and knowledge that are not yet fully understood by many of the members of the communities of educators, administrators, policy makers, and teachers. For this reason, it is a difficult task to develop a common set of guidelines for learning to teach mathematics.
The need to understand what it means to be a teacher in our society created an open space to discuss teachers’ lives in actual school systems. To be a mathematics teacher today means not only to facilitate students’ learning of mathematical content but also to be able to deal with social issues, parents’ and administration’s expectations, a multicultural and diverse population of students, overpopulated classrooms, and a perpetual testing system. In this rather unproductive environment, teachers should have a toolkit of diverse and specialized knowledge, which needs to be discovered and debated.

One of the main concerns of the contemporary teacher profession, discussed by the participants at the conference, was the “teachers’ political knowledge for teaching.” Because of the many social and political issues teachers have to negotiate, teacher educators need to prepare pre-service teachers to navigate the systems while keeping fidelity for mathematical content and staying accountable to the students.

For example, teachers should be prepared to include curriculum projects that address social justice and equity issues relevant to their students’ lives using rigorous mathematics as an investigative tool in their teaching. By implementing this critical pedagogy, teachers develop agency among disadvantaged groups of students and push back against privileging the dominant culture (Gutstein, 2006). However, teachers must be prepared to defend such teaching to administrators, parents and students, articulating the connections to the standards and ensuring that the mathematics is rigorous. Also, they must be prepared for student resistance due to a narrowly held definition of what mathematics is as defined by previous experiences in school and the community at large.

Consequently, teachers should be able to create and maintain a continuous connection between the mathematical content, which usually is developed in a closed classroom environment, and the outside social reality in which students and teachers live. Teachers have to be flexible to adapt and use knowledge and strategies from different content areas in their mathematics teaching. These types of adaptations may ease the transition from knowing mathematics to teaching mathematics to teaching mathematics for ELLs. This is a long process that has to begin in the pre-service teacher preparation programs and continue throughout one’s teaching career.

At this moment in teacher education, there are no straightforward methods and resources that provide teachers with all the tools needed for their work in today’s schools. It may not even be possible to have or create all of these tools. Instead, perhaps teacher preparation programs should focus on creating a disposition in teachers of wanting to continue learning how to teach. Teacher preparation programs need to develop prospective teachers’ analytic competence to systematically analyze teaching. Teaching then becomes an “an object of study” and prospective teachers develop the habit of mind of reflecting on their teaching to continually improve it and view themselves as teacher-researchers (Hiebert et. al., 2007).

Another problematic area in teacher preparation program development is the alternative certification route. Often teachers who are certified through such programs
are not well prepared and require added support from their peers and administrators. They also often leave the profession after a few years. Teaching requirements vary from state to state and this also can cause difficulty. There may need to be a screening process to identify pre-service teacher candidates that are most likely to be committed to education, open to new ideas, flexible, and life-long learners.

The tensions present in creating more equitable mathematics classrooms for Latina/o students are not understood by many of the teachers, school administrators, mathematics educators, mathematicians, bilingual/ESL educators, and policy makers. These communities need to be brought together in professional development settings and conferences to address coherence in teacher preparation programs, curriculum, assessment and pedagogical practices that are required for addressing equity issues in the teaching of mathematics for Latina/o students and other marginalized groups of students.

Pre-service teachers’ preparation

Every small group of participants in the teacher education strand discussions highlighted the essential impact that the pre-service teachers programs have on teachers’ professional development. It was unanimously recognized that if we want to make a change we should start from pre-service teacher preparation programs. These essential experiences for the students were identified:

- experience different ways to teach mathematics;
- experience how ELL students feel and learn in a mathematics classroom;
- experience what happens in a real classroom environment.

It is critically important that pre-service teachers experience new approaches to learning mathematics. Without new strategies, teachers often rely on their own past learning experiences for teaching. This often reduces teaching mathematics to basic procedures. Pre-service teachers need to build their mathematical knowledge in order to understand that mathematics does make sense. Only when this confidence is built will mathematics teaching move beyond procedural knowledge. Having deep mathematical understanding will also allow teachers to pursue and uncover students’ thinking and possible misconceptions.

Before starting their teaching profession, pre-service teachers should be ready to use students’ experiences and culture as resources for teaching mathematics. It cannot be assumed that because a teacher has the same ethnicity or language background as his/her students, the teacher is prepared to teach using culture as an instructional resource in the mathematics curriculum. Therefore, “pre-service teachers need experiences working with Latina/o children on mathematical activities that are conducive to using both theirs and students’ cultural knowledge” (Vomvoridi-Ivanovic, 2010, p. 14).

The second area discussed as an important experience for the pre-service teachers was to develop an understanding of how students feel about and learn mathematics. To encourage pre-service teachers to consider and analyze students’ thinking, instructors of pre-service teachers have to create realistic experiences of how students learn
mathematics. The pre-service teachers need to experience how the ELL students feel and identify what strategies are effective in supporting their learning. The future teachers should experience first-hand how certain strategies such as just speaking slower, using more gestures, or more pictures are supportive to the second language learner. For example, giving live lessons in another language can provide such an experience. These live lessons in another language provide an even richer experience than just giving students’ a test in another language.

The third area of experiences that pre-service teachers should have during their training is field and in-school experiences. The participants considered lobbying for earlier field experiences, possibly apprenticeship programs, and carefully selected placements that are reflective of known best practices in the teaching of mathematics. A framework for reflection to be used by the mentor and student teacher together is a powerful tool. The Instructional Context guidelines from the National Board Certification Workbook (Mack-Kirschner, 2005) can help pre-service teachers “see” their class and their students, and then inform their instruction. Videotaping the classroom and then reflecting on the sub-groups in the classroom are helpful in identifying and meeting the needs of all students.

Research shows teachers need to build classroom trust, so students feel the teacher cares about them (Gutiérrez, 2009). Pre-service teachers need to explore the dynamics of developing teacher-student relationships through home visits and meeting families. Pre-service teachers need to be aware of and confront their own biases, cultural stereotypes and deficit thinking that may interfere with having high expectations for all students. Implementing task-based interviews using a cognitively guided instruction framework can help identify strengths that the child has and can be used as an instructional resource.

Through these field experiences, the pre-service teachers may become aware of student resistance and the complex spectrum of students’ issues. They need to have strategies that help lessen resistance and students issues. Heather Cavell’s (2010) poster presentation documented that the presence of students’ resistance and acceptance behaviors were influenced by language use, mathematical identity, connections to culture, and peer relationships.

**In-service teacher professional development**

The main topics that arose from the discussions about in-service teacher professional development were:
- current teachers’ professional development programs;
- new mathematics teaching strategies and approaches;
- new ways to enhance teachers’ professional development.

Though these topics were interconnected through a cause-effect relationship, the ideas expressed by the participants become more relevant if they are classified by these three topics.
Many current available professional development programs were criticized for not being productive or relevant to what teachers do and for not focusing on what is needed. For example, some professional development programs for implementing the reform curricula present how to use the websites with textbooks. This is not the inservice needed for teachers to understand the pedagogical underpinnings of these reform mathematics curricula and to change their teaching to enact the curricula in the classroom. Without developing teachers’ pedagogical understanding of reform curricula, they do not always recognize new strategies for teaching mathematics as valuable and may reject ideas and continue teaching as they have in the past. Or they may find them too difficult to implement. Then the curriculum often is deemed as a failure, when in actuality the fault lies in the implementation and lack of appropriate professional support.

Standardized testing determines what and how mathematics is taught, stifling both teachers and students (White, 2010). When we closely examine these tests they do not present drilling problems. Because open-ended tests are expensive to grade, most tests are multiple-choice. These tests are high-stakes but it is not understood if these tests assess what the students know or do not know. Because of the pressures of AYP, marginalized students are subjected to even more testing, further reducing the amount of time teachers have to teach, reflect on student learning, and make adaptations.

The metaphor for teaching needs to change from “a race to the top to exploring the mathematics landscape” to ensure marginalized students have access to deep mathematical problems and thinking (Wood et. al., 2010). By changing the metaphor, the current deficit conversations that reify these students’ identity may shift to focusing on student thinking and allowing for the possibility that these students will succeed.

Being aware of and addressing the tensions that are a reality for teachers within a school's climate is another important piece in professional development. Teachers’ difficulties in implementing reform curricula need to be explored and discussed. Teachers trying implementation of reform curricula, social justice projects, etc. may find resistance and criticism among their peers or even administrators. These teachers will need support on how to navigate these politics. Researchers, teacher educators, and professional developers need to become “educational brokers” between administrators and teachers (White, 2010).

Recognizing the complexity of teachers’ lives and the constraints placed on their time is critical. Authentic project-based teaching that is relevant to students’ lives and culture will require support to identify resources and connect the mathematics to required syllabi.

Stronger connections between the research community and practitioners are vital. To honor the issue of teacher time, research articles need to be available that are written more “teacher friendly” in terms of length and difficulty. Teachers must also be afforded time in their teaching day to reflect on and discuss the research.

Teaching mathematics with an equity stance is a complex phenomenon, one that cannot be mastered before one begins a teaching career. Learning to teach is a life-long process. The novice teachers’ professional development needs will be very different from those of teachers with more experience. When designing professional development, these needs must be addressed. Therefore, professional development needs to be thought of as...
a continuum and be long-term. Teachers must have support during the implementation of reform curricula. The challenge is how the process of “professional development implementation” becomes a cycle, an ongoing process. Using technology to sustain professional development programs or constructing professional development trajectories may assist in overcoming the challenge.

Participants of this discussion group identified several successful professional development models. These included having teachers involved in:

- focused observations with reflection;
- reflection on videos of their own classes, thinking about what happened with any sub-group of students in their classroom and questioning if they met the needs of all students;
- action research projects with possible collaboration with a researcher;
- interpreting classroom data to inform classroom practices; and
- professional learning communities.

These models can be supported from the outside, using resources provided by universities, and from the inside, using teacher leaders as a resource. Teacher leaders who have the greatest potential for being perceived as leaders by their colleagues need to be identified. They will need a support system to help them become comfortable with this role and to develop their knowledge base for working with adults. A long-term commitment from those that take these positions helps ensure that districts’ investment will produce a positive return. Moreover, to maintain the “within system” characteristic of teacher-leader, models should be developed that create leaders without taking them out of the classroom.

Research indicates that an effective professional development model has teachers involved in learning communities (Kondek McLeman, et al. 2010). Therefore, there is a need to design professional development models in which mathematics teachers can be part of a team. Developing communities of teachers who work together to investigate their own strategies may assure that the learned strategies and teacher agency will be more sustainable. For example, Lesson study might be a model to look at for professional development. However, there are some challenges with any learning-community model. It is costly and time-consuming, although the benefits can be dramatic and empowering for teachers.

The reality is that when funding ends on a successful and/or meaningful project, the project comes to an end. Sustainability of programs with less funding is a must to further teacher professional development. Technology may be utilized to help reduce the cost of professional development by having it administered concurrently to a variety of sites or through the use of social networking sites.

One more important consideration in professional development is the support that administrators need. They should be encouraged to attend teachers’ professional development, but they must also have professional development that is designed specifically for them. Images of what classrooms, teaching, and learning look like when...
reform curriculum is being implemented should be included. The messages that administrators receive need to be consistent with those that teachers and teacher leaders receive in professional development.

**What questions do we need to research further?**

Participants identified the following questions as needing further research and investigation:

- What are the qualities of a good task when culture is a consideration?
- How do we prepare teachers from all cultures to teach students from all cultures?
- Based on analysis of novice teachers’ practice, what is most important to teach pre-service teachers? What will be most helpful to them?
- How do you determine if a task is authentic and meaningful? What negotiations must take place in order to create and implement an authentic task?
- How do we change the conversation from the deficit model of education that determines our education policy and denies our students the opportunity to learn?

**References**


