Mathematics Education, Language, and Culture: Ponderings From a Different Geographic Context

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This paper presents snippets from a research agenda focused on the interplay of mathematics education and the language, social, cultural, and political issues that affect Mexican American communities in the USA. The lessons learned and issues raised should be of interest to other contexts with non-dominant, marginalized students. The research approach is grounded on a holistic view of education, that includes families / communities, teachers and students. The underlying goal is to develop a better understanding of the appropriate conditions for the participation of all students in mathematics classrooms.

This paper highlights some aspects of the research agenda of CEMELA (Center for the Mathematics Education of Latinos/as)[1] with the aim of engaging in a conversation about the mathematics education of marginalized students across different geographic contexts. While the research reported here is situated in low-income Mexican American communities in the Southwest USA, I believe that the issues I address are relevant to other groups of linguistically and culturally diverse students. I first present an overview of CEMELA's research agenda and then I focus on one snippet from each of its three main areas of research to illustrate some of the main issues with which we are grappling. These issues are related to the concept of participation, which I view as central in discussions of equity and mathematics education. My concern is for who participates, when and how in mathematics classrooms.

An Interdisciplinary Approach to the Mathematics Education of Non-Dominant Students

CEMELA's research centres primarily on the mathematics education of students of Mexican origin. In the USA, Latinos (which includes people of Mexican origin) are the least educated (in terms of formal schooling) among the major racial and ethnic groups. Their performance in mathematics (as measured by assessments such as the National Assessment of Educational Progress (NAEP)) continues to lag behind that of White students. For example, in 2007, the mathematics score for White fourth graders was 248, while for Hispanic (term used by NAEP to refer to Latinos) fourth graders it was 227 (the scale is 0 to 500). The average score for non English Language Learners (ELLs) fourth graders was 242 while for ELL fourth graders, it was 217.

CEMELA argues that the social, cultural, linguistic and political contexts of Latinos in the USA cannot be ignored without detrimental consequences for Latino children. Thus, our research agenda is grounded on a sociocultural perspective with a particular emphasis on community knowledge (Civil, 2007; Civil & Andrade, 2002; González, Moll, & Amanti, 2005) and language (Khisty & Chval, 2002; Moschkovich, 2002). CEMELA brings together researchers in mathematics education, mathematics, language and culture to develop an approach that is grounded on a non-deficit perspective of the communities

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where our work is located. I argue for the need for a holistic approach to the mathematics education of non-dominant, often marginalized students (Civil, 2006). Such an approach calls for research with parents, teachers and students. I address each of these areas next.

Research With Parents

For close to 15 years, I have engaged in conversations about the teaching and learning of mathematics with immigrant parents, most of them from Mexico. Our findings parallel those in other countries, for example the work of Abreu and colleagues with immigrant parents in the U.K. (Abreu & Cline, 2005). These findings indicate that immigrant parents are concerned about the lack of emphasis on the "basics" (e.g., learning the multiplication facts); believe the level of mathematics in their country of origin is more advanced than that of the receiving country; and feel that their children's schools are not as strict as those in their countries. In our more recent work we try to tease out some of these perceptions by engaging the parents with the reform mathematics their children are presumably seeing in school. This work highlights the role of valorisation of knowledge. We all bring our values to the teaching and learning of mathematics (Abreu & Cline, 2007). My concern is that the children are caught in the middle of this power struggle over different ways to do mathematics and the values assigned to these ways. This is particularly important to consider when these children come from groups who are marginalized, as is the case in our local context. As one mother explains,

> I learned a different way in Mexico…. I had to learn what he [her son] was learning in order to help him at home because I have to build the trust between my son and me because he didn't trust me at all. Because he said, "no, no, you don't know how to do it" and I know that I know, that I have the knowledge…. [Bertha]

We have many cases like Bertha's. This issue of the child not trusting that their mother knows was not an isolated instance. Bertha, like other mothers in our study, had been schooled in Mexico (in some cases up to some courses at the university level) and was confident in her knowledge of mathematics to help their children. Yet, as another mother said, "last night my son told me that school from Mexico was not valued the same as school here, that is doesn't count. What I studied there doesn't count here". Elsewhere (Civil, 2006; Civil & Planas, in press) we discuss specific examples, tied to algorithms for arithmetic operations, in which we see the different valorisations at play.

The situation has to be understood within the larger context of immigration. Paralleling the situation in other countries (see Civil, 2008b, for a survey of the mathematics education of immigrant students), there is an anti-immigration sentiment that in our local context has resulted into restrictive employment and school language policies. Since 2000, through a voter-approved proposition, bilingual education has been severely restricted in our state. This has clearly limited the participation of immigrant parents (most of whom speak Spanish) in their children's schooling as they feel they cannot understand the instruction or the homework:

> There are things that I really cannot help him with. He [son] tells me, "mom, I'm going to read it here, let's see, you tell me". He translates it into Spanish; sometimes I understand what he's telling me in English, but others, definitely I don't understand anything, that's why I'm going to English classes. [Selena]

Although these children may have a good command of social Spanish, as the years of schooling go by, whatever academic Spanish they may have brought with them is being lost, hence making this translation process much harder. The language becomes such a

prominent theme that it may obscure issues of learning of content, as the case of Emilia shows. This mother appeared to be satisfied with the fact that her son was being taught mathematical content that he had already studied in Mexico, because this way he would not feel so overwhelmed by having to learn both content and language (Civil, 2008a). I question the equity implications of such decisions. A further development in the theme of school language policy has resulted in a mandate as of the 2008-09 academic year for a 4-hour block (per day) for ELLs to learn English. This means that for 4 periods a day ELL students are to learn English with no content attached. I will come back to this implementation in the section on research with students.

Our research with parents reveals a strong desire for their children to succeed in school but not necessarily an understanding of what this entails. There seem to be communication gaps between schools and parents. It is not clear to us that parents have an accurate assessment of how their children are doing in mathematics and whether they are being taught the mathematics they are expected to. For example Emilia after two years of familiarity with the school started questioning in one of the interviews how come her two sons who were in different grades were sometimes bringing the same homework. What seemed to be happening is that her oldest son was receiving an extra period of mathematics per day because he needed more support in this subject. In that extra period there was a mixture of grade levels, hence the common homework. What is perhaps most important to point out is the difference in perceptions that teachers and parents have of each other. Having parents and teachers come together to explore mathematics provides a possible model to address these different perceptions, but there are certainly challenges in establishing a productive communication (Civil & Bernier, 2006). In the next section I look at some of the work with teachers as we explore issues of language and culture and their interplay with the teaching and learning of mathematics.

Research With Teachers

Our work with teachers takes place in the setting of Teacher Study Groups (TSGs) and is inspired in part by the work of researchers such as Crespo (2006) and Kazemi and Franke (2004). We engage the teachers in looking at students' work as well as in doing mathematics themselves. Crucial to this approach is the concept of reflecting on practice. A further focus of our TSGs is on the role of language and culture in the teaching and learning of mathematics. In particular two research questions that we address are "what are the issues of language and culture with which teachers grapple while engaged in reflecting on Latino children's thinking about mathematics?" and "how do teachers understand the role of language and the cultural resources of Latino students in the learning and teaching of mathematics?" To address these questions one approach has been to conduct task-based interviews (using, for example, NAEP questions) with students from the teachers' schools and then engage the teachers in a discussion of issues of language and culture around the tasks (Kahn, Kondek McLeman, Menéndez-Gómez, & Trujillo, 2008). Engaging teachers in conversations about language and culture with a focus on mathematics is not easy. In our experience, teachers tend to focus on content (e.g., students' understanding of area and perimeter) and pedagogy (e.g., need to provide them with more experiences with manipulatives). However, having specific interviews with children on which to focus the discussion did help open up a conversation about language though less so about cultural elements. We have also conducted interviews with the teachers as a way to further inform the research questions I posed earlier. For about three years we had a TSG that brought teachers in from three elementary schools. We had a total of 19 teachers going through at

least one semester of TSG (not all participating during the same time frame). Ten of these 19 teachers were Latino, some immigrant themselves or first generation. Most of the teachers had been at their school for over five years. What the interviews pointed to is an awareness in some cases of the issues that their students brought to school, whether it was a language issue as Nadia points to, or that parents may have other ways to approach mathematics, as Caroline describes:

> Nadia: Here (at school) they're doing everything in English and at home the parents don't know English. So, there is a disconnect right there. There is a disconnect as to what they're doing. So I have to think and I have to kind of really understand how to work that out. How can you go about asking your child certain things if what he or she has is all in English and at home it's all in Spanish? There is that disconnect.

> Caroline: Part of the problem I think that the students are facing is parents didn't learn that way…. We tell them to go home do homework and the parents are looking at it completely different…. The Latino children, if their parents come from Mexico, then they probably did it a different way… and even the algorithms maybe look a little different. If you're looking at algorithms, they're going to be like "my dad does it this way" or "my mom does it this way." And so then you're bringing in another way so that they're seeing maybe even a third or a fourth or a fifth way to attack a problem.

Nadia and Caroline view these issues as a learning opportunity. Nadia says, "I have to think and I have to kind of really understand how to work that out" and she has some resources in that she is bilingual herself. Nadia meets with the Spanish-peaking parents and tries to reach out to them; she sees it as her responsibility. Furthermore, she sees the advantages of bilingual education:

> The English speakers are picking up the Spanish. The Spanish speakers are picking up the English. So everybody is getting something and they're getting two of it, not just one, two of it. You have more by which to build one and this way [the current language policy], it's like you've got to learn English…. So, we're taking away some of their language that they already have, some of their culture; it almost feels like it's not valued. [Nadia]

Caroline sees the different ways of doing mathematics as an opportunity for her students to learn other ways to do the same problem. However, not all teachers were as positive about the advantages of different ways as Caroline was. Dalia presents a different picture. Her narrative of her experience with parents at her current school is marked by a deficit tone, "parents here need more education and last year we educated some parents on how to be parents." Her take on the different ways to the do mathematics that parents may have was as follows:

> Eliseo (a student) said "oh no, my mama did it different". And he went to the board and did it that way, and I say, "yes, but that's in mama's home. Let's do it the way that we do it in the school".

Dalia then tones down what could be perceived as a negative comment by saying that they do tell the children to invite their parents to come to school and show them (the teachers) the way they do the computations. But there is no indication that this invitation was going to be carried through.

Our current work in a TSG with a different group of teachers continues to probe teachers' perceptions of linguistic and cultural issues in the teaching and learning of mathematics. We are doing this through an approach that builds on the work in "complex instruction" (Boaler & Staples, 2008; Cohen & Lotan, 1997) as this allows us to address issues of status and power, and hence participation in the classroom. Our sessions with the teachers point once again to the need for teachers to become learners of their students' communities, which is a key premise in the Funds of Knowledge work (Civil & Andrade, 2002; González, Moll, & Amanti, 2005). The following excerpts from the first TSG

session after the semester break illustrate the complexity in the views. Here we see them beginning to think about status and collaborative learning.

> Roberto: I've learned to let them have their time. I used to get frustrated when they didn't get to the task and were laughing too much. Now I realize that's part of how they interact with each other…. They do seem to need that time to be kids with each other, to laugh with each other…. And it seems like each one of my groups has a low status kid and as I let them interact more, those kids seem to just come out a little more each time. Just a little bit more. Where they said nothing before, now they're saying something…. Before they were completely silent.
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> Olivia: About status, I never thought about status till this, our sessions. As an adult it was really hard for me to understand how kids could take negative status or low status and think that that was good, like that was cool. But now I kind of see it, how they hold on to even like status as a poor performer…. They hold onto their status and it's really important as far as their identity.

Later in the session, the narrative took on a deficit view, one that seems to be based more on public discourse on non-dominant students than on first-hand knowledge of these particular students (see Zevenbergen, 2003). Teachers had been talking in pairs about what they would like to see addressed in the TSG sessions this semester. When reporting to the whole group the issue of making connections and having closure (in the lessons) came up in the context of the reform mathematics curricula they are using and how they thought that students had to see that multiplying is repeated addition but that the book never really said that, that this was something that the students had to put together themselves:

> Olivia: Multiplying is repeated addition. It never tells you that, but you're supposed to kind of spiral from doing your work with the activities to kind of come up with that idea on your own and you're supposed to investigate. Well our kids, and I think it's true with kids in poverty, they don't make that leap. So they do the activity and they think it's fun…. But they can't get to the end point, which is the content material.

Olivia then elaborates on how children of poverty compartmentalize and how they could not go from the arrays (in the activity) to the concept of multiplication. In many aspects reform curricula are more mathematically demanding (of the teachers too). Olivia's explanation for the lack of connections as attributed to poverty is certainly worth deconstructing, as it puts the blame on their students' circumstances (helplessness) and could lead to a watering down of the curriculum as if these children are not capable of handling reform mathematics. After a few minutes spent trying to understand what the curriculum does and does not in terms of these connections within multiplication, I asked, "Do you think that kids in a middle class, upper class school would have an easier time?" Olivia was quick to respond "absolutely" and used the experience of her son's school. This topic had all the teachers chime in with explanations such as "better foundation," "discipline in the families", and "expectations of learning in the household." Roberto brought up the idea of compartmentalization again:

> Roberto: you [Olivia] said something earlier about compartmentalizing things. And I think that's very true. They think that what they do at school stays at school, it only belongs at school…. They don't apply it to their daily lives. I remember growing up in this community, learning a second language, having this experience that my students are having. So that when I finished high school, I was accepted to a school in the Midwest and my stress was, did the math that I learned here apply there? I was terrified. I thought that the algebra that I had learned, the trigonometry that I learned, I'm going to have to learn it all new…. And when I got there and saw that it was the same, I couldn't believe it. (…)
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> Olivia: why would you think it didn't?
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> Roberto: Because I thought it only belonged at my high school… When I went home, we never talked about any of the math…. Specifically with math… Math I thought just belonged at that

> school with those teachers…. So I think these kids, they think that they what they're learning here with us is just for us.

Although there are parts of the narrative marked by a deficit view, the experiences these teachers are having with aspects of complex instruction, as well as the counter-narrative offered in the readings and by different teachers at different moments allow us to probe into the images they have of their students and their contexts. One of our goals is to develop an attitude of looking for the strengths that students bring to the classroom. I turn next to an example of our work with students.

Research With Students

The teachers in our current TSG often focus on what their students cannot do. To a certain extent, this is to be expected as they most likely want ideas from the TSG on how to work on these areas. One of my goals in our work with students is to develop a repertoire of examples that show non-dominant students as doers of mathematics. I have a particular interest in understanding the conditions for students' successful participation in mathematical discourse (Moschkovich, 2002), the form of discourse that involves argumentation and justification (Hunter, 2008). Here I draw on data collected in a 7th grade class (12 year-olds). The class had only eight students, all classified as ELLs. The school was piloting a model close to the 4-hour block for English language I mentioned earlier, which resulted in ELL students being segregated by attending classes with only other ELL students for six out of seven periods. From February to May 2008 we videotaped the mathematics class 30 times. I also collected students' work and interviewed 7 of the 8 students. These interviews underscored how aware students were of the segregation by language. The teacher (from Mexico and an ELL herself at that point) tended to use English, but sometimes would clarify some things in Spanish. I tended to encourage students to use whatever language they wanted since I was interested in their participation in mathematical discourse. Towards the end of the semester, we spent about one week on two situations that involved interpreting graphs. As I noticed that students were having a hard time interpreting a horizontal line in a graph of distance and time, I asked them to make a graph to show the following story (written in English as shown here):

> You leave your house at 7 am to go to school. You walk at a regular pace for about 15 minutes. At that point you see the ice cream vendor and you stop to buy "una paleta[2]". You stay there, by the ice cream vendor, chatting to some of your friends for about 10 minutes. You then realize that you may be late to school and walk really fast for 5 minutes. You make it to school, barely on time.

By this point in the semester, the students had developed a disposition of tackling the problems in their groups and knew that they were expected to use each other as resources first, rather than turning to the teacher or myself right away for help. At one point I asked two students to draw their graphs on the white boards in the classroom. Larissa (the only girl in the classroom and one of the strongest students in mathematics according to her peers) drew a graph that showed a straight line from 7 to 7:15, then a vertical drop to the x-axis and 10 minutes of straight line there ("by the ice cream vendor) and a vertical line to get to the school. Octavio (a student who up to then had not talked much in the mathematics class and who described himself as an average student) explained his graph, which although still problematic in some parts, did show the graph going up for 15 minutes and explained that this corresponded to the walk till the ice cream vendor. Because the two

[2] popsicle

graphs were quite different, I invited the students to comment on the differences. Octavio and Larissa then got into a mathematical argument that eventually led to their being the first two students who all of sudden understood the meaning of a horizontal line in a distance versus time graph. The two students were yelling at each other, but their arguments were mathematical, as when Octavio is critiquing Larissa's first horizontal line: "Yes but, he doesn't lose any distance because this is straight and it has to go up so that he has the distance of fifteen minutes". During the analysis of Octavio's graph, Larissa pointed to the first horizontal segment in Octavio's graph, which I had interpreted as time spent in his house prior to leaving for school. Larissa challenged me: "But he has it straight here, why didn't you say anything to him?" As I looked closely at the graph I realized that it was not clear what was happening in that straight segment. Larissa pointed out that "he would have to run like this" (gesturing on the graph going up from 7 am when he leaves the house, till 7:15). Octavio argued that "he had to leave the house". Larissa said, "But the house is here at zero". Octavio seemed to be at a loss and with some help on my part ended up saying that the straight segment represented his being in the house from 6 to 7 am.

This is very brief snippet of one of several instances in which the students engaged in mathematical argumentation. Spanish was the dominant language in the session I just described. Earlier in the semester we have examples of students providing explanations in English but these were largely based on their reading from their papers and did not involve much argumentation. This back and forth between English and Spanish poses a dilemma for me, especially after I realized that some of these students wanted to have more opportunities to use English. Yet, the difference in mathematical richness when students used Spanish over English was remarkable. For example, in an activity on finding volume of prisms two students had used the dimensions of the 2cm-cube to find the volume. So, instead of just giving the number of cubes like their peers did, if the volume was 14 cubes, for them it was 14 x 8 cubic centimetres. Carlos attempted to explain their approach in English. When he finished I was not sure that the students had understood (not necessarily because of his English though it was clear that it was difficult for him to explain). He then asked if he could explain it in Spanish. Their whole explanation (he was doing this with Larissa) took on a different tone. They appeared more relaxed and were able to elaborate further. I actually continued to ask them questions in English, but the conversation was now more a back and forth between English and Spanish, which opened up the participation of several other students in the class as one of them questioned the origin of the 8 (in the 8 cm^3) and others then joined in. This was less than a month after we had started promoting that students explain their work publicly after they had had a chance to work in their small groups. It shows these students as willing and successful at engaging in a mathematical discussion, in which we (the teacher and I) did not say much at all.

Closing Remarks

What will it take to develop an integrated model that connects mathematics teaching and learning to the cultural, social, linguistic, and political contexts of non-dominant students? This paper raises several issues such as a need for stronger and meaningful communication between parents and schools (teachers); a need to continue probing the effects of language policies on the mathematics education of students directly affected by these policies; a need to engage with teachers in conversations about the teaching and learning of mathematics with non-dominant students; a need to continue developing narratives of successful participation of non-dominant students in mathematical discussions to counter the pervasive deficit narratives that so often surround us.

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