Equidad en Educación Matemática: Experiencias basadas en un enfoque sociocultural

Equity in Mathematics Education: Experiences based on a sociocultural approach

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Resumen

En esta presentación compartiremos algunas características de nuestro trabajo con profesores, estudiantes y padres y madres de familia en comunidades de origen mexicano en Estados Unidos. Nos centramos en el rol de aspectos culturales y lingüísticos en la enseñanza y aprendizaje de las matemáticas. Partiendo de un enfoque que reconoce la riqueza del conocimiento y experiencias de las comunidades con las que trabajamos, primero presentamos el marco teórico basado en el concepto de fondos de conocimiento y compartimos ejemplos de la aplicación de este concepto en el aula de matemáticas. De ahí abordamos las siguientes preguntas: ¿Cómo desarrollar oportunidades para que familias y escuelas compartan experiencias matemáticas? ¿Cuáles son algunas características de una enseñanza de calidad en matemáticas con estudiantes cuya primera lengua no es la lengua de enseñanza en la escuela? Concluimos con implicaciones para investigación, formación de profesorado, y práctica en el aula de matemáticas.

Palabras Clave: Equidad; Prácticas de enseñanza en matemáticas; Fondos de conocimiento; Aspectos culturales y lingüísticos; Participación de las familias.

Abstract

In this presentation we will share some features of our work with teachers, students, and parents from communities of Mexican origin in the United States. We focus on the role of cultural and linguistic aspects in the teaching and learning of mathematics. Grounded on an approach that acknowledges the richness of knowledge and experiences in the communities with which we work, first we present the theoretical framework based on the concept of funds of knowledge and then we show application of this concept in the mathematics classroom. From there we address the following questions: How to create opportunities for families and schools to share mathematical experiences? What are some of the characteristics of quality mathematics teaching for students whose first language is not the language of instruction in school? We conclude with implications for research, teacher education, and practice in the mathematics classroom.

Keywords: Equity; Mathematics teaching practices; Funds of knowledge; Cultural and linguistic aspects; Family engagement.

Introduction

In this paper we draw on our work in mathematics education with teachers, students, and families from communities primarily of Mexican origin in the United States. Grounded on a sociocultural approach to research, we focus on linguistic and cultural diversity as assets towards the teaching and learning of mathematics. We first present the theoretical framework that guides our work and illustrate how we have applied it to the mathematics classroom. From there we move to the main questions in this paper: 1) how to develop opportunities for an authentic dialogue between home and school centered on mathematical experiences; 2) What are some of the characteristics of quality teaching for students whose first language is not the language of instruction? Throughout the paper we draw on examples from different research projects over the last thirty years. In the conclusion we offer implications for research and practice.

Theoretical Framework

The central concept for our work is that of funds of knowledge (González et al., 2005). The term was originally coined by Vélez-Ibáñez and Greenberg (1992) to refer to the "strategic and cultural resources… that households contain" (p. 313). Moll and colleagues (e.g., Moll, 1992; 2019; Moll et al., 1992) built on this concept to apply it to educational settings in particular in the context of teaching and learning of biliteracy (English-Spanish). When the first author joined the Funds of Knowledge for Teaching Project (FKTP) (see González et al., for a comprehensive description of this project), her focus was on the application of this concept to the teaching and learning of mathematics (e.g., Civil, 2002a; 2007; Civil & Andrade, 2002). The FKTP had three main components: 1) teachers conducted ethnographic visits of some of their students' homes. The point of these visits was for teachers to learn from the experiences and knowledge in the household, so to uncover their funds of knowledge; 2) study group sessions where teachers and university researchers discuss theory and practice related to the community knowledge and debrief the home visits. In these study group sessions is where the development of learning

modules takes place; 3) implementation of the learning modules in the classroom. This often involved the presence of parents or other family members as experts on the theme of the module. A fundamental concept that underlies the work in FKTP is the notion of *confianza* (mutual trust) that develops between teachers / researchers and families. As Vélez-Ibáñez and Greenberg write, "*Confianza* is a cultural construct indicating the willingness to engage in generalized reciprocity" (p. 332). The concept of *confianza* is key to the work we have been doing with parents and mathematics that we describe later in this paper.

The main premise behind a funds of knowledge orientation is a rejection of deficit views of minoritized communities. As Moll (2019) writes, "it represents, one could say, an opportunity for teachers, as part and parcel of their pedagogy, to identify and establish the *educational capital* of families often assumed to be lacking any such resources" (p. 132). While the funds of knowledge orientation was developed in the Southwest of the United States, the concept is now been widely used in many places across the world. For example, Moll provides an overview of the application of the funds of knowledge concept in four different countries (Australia, New Zealand, Spain, and Uganda). While there are clear differences among the four projects, as well as with the original FKTP, Moll writes that they all share the goal "to document empirically and represent pedagogically families and students as resourceful and help educators arrange environments that are academically sound and strongly oriented to building on such resources for learning" (p. 137).

This focus on "families and students as resourceful" extends to our orientation when working with students whose home language is different from the language on instruction (in our context English). At the basis of our research in multilingual contexts is a sociocultural perspective of language (Mosckhovich, 2002). This perspective draws attention to the multiple resources that students use to communicate in a mathematics setting, such as using their home language(s), gestures, drawings, tools. Furthermore, this perspective emphasizes the importance of students engaging in discourse practices; that is, students whose home language is different from the language of instruction need to be engage in rich mathematical tasks where they are encouraged to use multiple communicative resources (Moschkovich, 2013). In the next section we present two very brief examples from prior work to illustrate an application of funds of knowledge and of a sociocultural view of language in mathematics contexts.

Some Examples

Over the years, the first author has written about several applications of the funds of knowledge concept in the mathematics classroom. In particular, the garden project (Civil, 2007; Civil & Kahn, 2001) shows the trajectory of going from the teacher learning about the wealth of knowledge about gardening that several of her students' parents had to the development of a garden module largely inspired by the teacher's question, "can rigorous mathematics be developed from household visits?" We capitalize on this question as it reflects some of the tensions encountered in connecting everyday situations and school mathematics (Civil, 2002a; 2002b; 2007; 2016). In the garden module students had to address a real-life problem in which they had to maximize the area of their gardens enclosed with a limited amount of chicken wire. We used this situation to engage in an exploration of area and perimeter, which we further explored by using individual task-based interviews with a small group of students to see what

they had taken away from the experience. This approach allowed us to better connect what students may be learning from a funds of knowledge based activity to the required school mathematics curriculum. The work showed the value of students' experiences with their gardens in developing an understanding of area and perimeter. It also allowed us to see possible issues with confusing linear and area units, and how the real-life experiences help but also may bring additional challenges (Civil & Kahn, 2001).

We have been conducting research in settings where many of the students do not have English (the language of instruction) as their home language. We refer to these students as bilingual learners to emphasize the fact that they have knowledge of (at least) two languages, English and Spanish, even though they may not still be considered proficient in English by the school system. Once again this is a non-deficit view of students: instead of labeling them as English learners, we emphasize the fact that they know two (or more) languages. In one of the projects with bilingual learners, the first author worked for a whole school year with a group of students (12-year-olds) and their mathematics teacher. Everybody in the setting (students, the teacher, and the researcher) had Spanish as their home language. But the study took place during a restrictive language policy period by which instruction had to be in English (though Spanish could be used occasionally for clarification and students used Spanish and English in their small groups). In Civil (2011a; 2011b; 2012), we illustrate the difference in richness of mathematical communication when students were allowed to switch from English to Spanish. Not only were the students presenting their work able to explain themselves through multiple resources, but also the other students in the class engaged in lively mathematical discussions challenging what their peers were presenting. Planas and Civil (2013) also draw on data from that same group of students to show how students' participation in the mathematical discussions was enhanced when using Spanish as a resource, "while at the same time experiencing the political dimension of language when, for instance, they switch to English to report their mathematical thinking" (p. 370). As we highlight in Civil and Hunter (2015), at the heart of the work with students from minoritized communities is the need for teacher and researchers to "to learn from and build on the students' cultural ways of being" (p. 308). In our work with this group of students, they had access to their home language, but they also felt free to use social chat and humor as part of their problem-solving discussions. Students often interacted in our problem sessions as they would in a family setting. Hence *confianza* was again key.

Through these two brief examples, we want to highlight that an important aspect of our work is the development of relationships with the communities with whom we work. We learn from them and they learn from us. We seek to establish a two-way dialogue (Civil, 2002a). As part of this process is the concept of parents as intellectual resources (Civil & Andrade, 2003), by which we capitalize on parents' richness of experiences and knowledge and its relevance to school teaching and learning. How can we create opportunities for parents and teachers to share mathematical experiences so that they can each learn together and from each other? We discuss this in the next section.

Parents and Teachers Learning From Each Other

For several years we have been working closely with parents through several mathematics projects, including courses on topics such as whole numbers and fractions, geometry and measurement, data, and algebra (https://mappsua.wordpress.com/). Other components of this work included parents and teachers as co-facilitators of mathematics workshops for other parents, parents and university researchers engaged in "tertulias matemáticas" where we not only explored mathematics, but we also engaged in critical dialogues about mathematics education, and parents and children doing mathematics together (Civil & Bernier, 2006; Quintos et al., 2019). While teachers were involved in some of this work, most of the focus was on parents and researchers. More recently we have been working more closely on how to develop a mathematics dialogue between parents and teachers to strengthen the connection home-school. In what follows we present snippets from two activities in this direction.

Quotes Activity

In this activity parents and teachers read a series of quotes from parents and teachers from prior projects and then they stand by the quote that speaks to them the most for whatever reason; it could be that they agree or disagree with it or that it brings up some kind of reaction. The point of this activity is to have a dialogue between parents and teachers on topics such as different ways to do mathematics, the value of these different ways, the role of memorization. Through this activity we uncover beliefs about teaching and learning mathematics that we all have. For example, one of the quotes reads:

We are teaching division and multiplication, and the children are doing it the way we ask. This Wednesday when we did it, Eliseo said, "my mama did it different." And he went to the board and did it that way, and I said, "yes, but that's in mama's home. Let's do it the way that we do it in the school.

Here is what one mother and one teacher said when they chose to stand by this quote:

> Magali (mother): I identify with this quote because this happened to me with my oldest son. I taught him the way I thought it was right but it seems that no, I feel like I confused him and so this part of "let's do it the way we do it in the school," I think that we need to get involved to see how they teach here so that we can follow up.
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> Kassandra (teacher): I chose this quote because I guess in my classroom I do have some students who would say "mom and dad taught me this way" and for me, I do have to teach those certain ways but I do encourage them if mom and dad want to teach a different way, then my student has the strategy from school and the one from mom and dad and they can check and make sure that both answers match up.

In this exchange we can see that while the mother defers to the school way and sees it as the parents' responsibility to learn the school way, the teacher sees the values in the parents' way and sees it from a resource perspective, where the child will have more than one way to approach a problem.

In yet another implementation of this activity, Bárbara, a mother reacting to the same quote, said:

> I do not agree with how the teacher [in the quote] handled the situation. I feel like he discredited what the mom had taught. I understand they are ways, rules on how to do things, but it is not right to say "no, we have to do it like I say and not like your mom said." I am in complete disagreement with this.

This mother was visibly upset when commenting on the quote. Here we see issues related to valorization of knowledge and which knowledge (school? home?) gets privileged.

And in another implementation of this same activity, two teachers, reacting to the same quote said:

> Lucy: It is ridiculous. Why would you ever tell a child? Why would you ever discount a child's strategy? I don't care where they get it from. If the child understands it, that's what is important. If they can explain it, better still. And what I am constantly telling my students is: "Here is a way to do it, here is another way to do it, here is another way to do it… choose the one that works for you."
>
> Mercedes: I agree with Lucy. Parents often tell me that they cannot help their children because they didn't learn it this way. And I tell them "it doesn't matter to me; you should help them in any way you can; sometimes they understand it better when you teach them, other times when I teach them."… "So, parents [talking to the mothers in the group in the workshop], if you don't understand me or your child's teachers, help them anyway you can because that way they'll see different ways and they can choose "this works for me" or "this doesn't work for me."

After this exchange a mother shares who she had taught how to do division the way they do it in Mexico (which is different from how it is usually done in the United States), and later on her son came back saying that he had also learned the school way. The mother seemed pleased that her son had two different ways to do division.

This activity is quite powerful as it draws on real quotes from parents and teachers in similar contexts which allows for the participants to related to them and in sharing their thoughts it opens up a dialogue on what they value about the teaching and learning of mathematics.

Parents and Teachers Doing Mathematics Together

In prior work (Civil & Bernier, 2006), one issue of concern was the power differential when parents and teachers were co-facilitating a mathematics workshop. A challenge for us was when the teachers took the leading role with the mathematics content presentation, while the parents were relegated to handing out papers or taking care of the opening ice-breaker activity. How can we bring parents and teachers to explore mathematics together in ways that do not privilege the school knowledge that teachers are likely to bring with them? The choice of task

becomes key. We have been working with open ended, modeling type tasks, often grounded in culturally relevant contexts that draw on parents' expertise with the activity. One such example is making paper flowers (Civil et al, 2021; 2022). In this activity the participants are shown a package of tissue paper (for example, one with 24 sheets and each sheet is 20" by 20") and they get to decide how many flowers of different sizes can be made. The task is open ended in that participants can decide if they want different sizes, how to cut and fold the paper, whether they want to have any left-over paper (in one group they thought they could make confetti out the left over to add to the decoration they had in mind). From the point of view of mathematics, usually this task leads to ideas of measurement and fractions (in the folding of the sheets).

What tasks like the paper flower bring up is an opportunity for the participants, parents and teachers, to draw on different kinds of expertise. From a research point of view, they also inform us of what the participants value about doing mathematics. In a sense the question of "what counts as mathematics?" emerges in the discussions and in our analysis. It is worth noting the fluidity of expertise, that is, in these tasks we cannot predict that the teachers "will do the math" while the parents "will do the flowers." In fact, in one of the groups, with two mothers (Isabel and Victoria) and one teacher (Sabina), after they were done with the computations, the following exchange happened:

> Isabel: Ok, we already wrote everything; now let's do the flowers. For that part, I'm not good anymore.
> Victoria shakes her head, agreeing.
> Sabina: it's just a matter of folding them to put the stem and just [gestures to indicate how to get the leaves]

Sabina had made flowers like these before, so for her this part was easier and something that she enjoyed doing. For Isabel, the mathematics part is what attracted her more. Similarly in another implementation of this task, one of the mothers was trying to come up with a general formula that would yield the number of flowers given the number of folds and the number of layers. As she said, "I am more interested in solving the mathematics problems than in making the flower." We do not know the reason for her wanting to come up with a formula, but it reminded us of prior work with a group of mother who wanted to learn algebra as they wanted to gain a better understanding of symbols and formulas often used in algebra (Civil & Andrade, 2003). What do participants view as mathematics? Some of them were very uncomfortable with the open-ended nature of tasks such as the paper flower and the fact that there were many possible answers depending on the assumptions made.

Our work is situated in primarily bilingual communities. When we work with parents only, often the main language used is Spanish; but in the work with parents and teachers, English and Spanish are fluidly used in the interactions. In the classrooms the language situation is largely dependent on the language policy in place as we have mentioned earlier. In the next section, we describe teaching practices used by teachers in bilingual classrooms with students at different levels of English proficiency that attend to language demands while learning mathematics.

Quality of Linguistically Diverse Classrooms

The quality of mathematics education for bilingual students goes beyond good teaching practices identified in monolingual settings (Celedón-Pattichis & Ramirez, 2012). Taking the non-deficit view discussed above, Sorto and Bower (2017) provide an example of a teacher implementing a set of teaching practices in a middle-grade classroom where about a third of the students are bilingual and becoming proficient in English. These practices include the teacher creating a safe intellectual environment where the native language is honored; even differences among the same language are acknowledged and accepted as valid modes of communication. There is recognition or noticing that the meaning of words is fundamental to approaching a mathematical task. Other strategies include the context of the task being based on a real-life situation (comparing prices while shopping), providing a visual representation of the objects, and the use of cognates. These sets of practices are part of a more extensive set outlined by Chval and Chávez (2011) and based on research in this area.

To test the relationship between the implementation of these practices and student learning gains, Sorto et al., (2018) developed an observational rubric that included these practices (see Table 1), analyzed 99 middle-grade lessons from 34 teachers in 11 middle schools from a southern state in the United States, and measured the impact of the use of these practices on students learning gains (difference in mathematical scores from standardized tests from two consecutive years).

Table 1
Observational rubric to measure the quality of linguistically diverse teaching

Segment Codes	Description
Connections of mathematics with students' life experiences and prior knowledge	This code captures instances by which the teacher activates students' prior mathematical knowledge by explicitly referencing skills learned in a previous lesson or grade. This code includes references by the teacher to mathematics found in daily life by students such as money and shopping.
Connections of mathematics with language	Teachers or students connect language (words) with mathematical representations such as pictures, tables, graphs, and mathematical symbols. This code captures the extent to which the teacher reinforces a mathematical representation with its meaning.
Meaning and multiple meanings of words	Teacher or students communicate meaning by using synonyms, gestures, drawings, cognates, or translations to students' first language that supports learning. This code includes reading strategies meant to increase comprehension. Meaning that occurs between students that is correct can adjust the score upward.
Use of visual aids or support	Concrete objects, videos, and illustrations are used by the teacher or students in classroom conversations. Concrete objects may include times tables, formula charts, protractors, 2D models, or dynamic foldables.

Record of written essential ideas and concepts on board	Teacher displays a written record of the lesson's essential ideas and concepts without erasing so students can refer to them throughout the lesson. The score may be adjusted downward if some important/essential information is never recorded.
Discussion of students' mathematical writing	Teacher use students' written work as an instructional tool and point of discussion.

Source: Sorto et al., 2018

Results from this study showed evidence that teachers that tend to use these particular teaching strategies and the general quality of mathematical practices (Hill, 2014) have bilingual students growing academically from the previous year. Furthermore, the impact of the practices is only significant for bilingual students, which indicates that their implementation of them could be one way to close the opportunity gap.

Although these results are promising, they cannot be generalized beyond the population of the teachers and students that participated. To test the validity of the impact of these practices in other contexts, we have extended the geographical scope, grade level, and languages. The new population involves 22 elementary classroom lessons in the southwestern and northeastern states of the United States. Preliminary results from this new study indicate that the rubric (see Table 1) also applies to this population and we hypothesize that these practices will also have an impact on multilingual learners' academic growth.

Conclusion

The central idea in the work presented in this paper is the importance of researchers, teachers, and teacher educators focusing on the richness of mathematical experiences and knowledge that all communities have and in particular, minoritized communities. By providing opportunities for parents and teachers to engage in joint mathematical explorations and conversations, both parents and teachers learn about each other's views about mathematics teaching and learning which can help break down the barriers that often exist between home and school. Furthermore, in exploring mathematics together, parents and teachers learn about different approaches to doing mathematics, thus opening to a broader view of what counts as mathematics. As illustrated in the funds of knowledge work, teachers can collaborate with parents and community members to develop learning activities that build on the students' and their community's knowledge. By having parents and teachers co-facilitate mathematics workshops, the power differential between home and school can be addressed, as parents and teachers bring in their different strengths to the preparation and facilitation of the workshop.

At the center of this work is the concept of *confianza* (mutual trust), which allows for all involved to feel safe to share their ideas. This is key to keep in mind at all levels, as researchers when we work with the community and with teachers; as teacher educators when we work with teachers; and as teachers when we work with students in the classroom. In working with culturally and linguistically diverse communities, this diversity becomes an asset. In the mathematics classroom, this means encouraging students to use their culturally and linguistically

grounded ways of interacting and doing mathematics, whether it is their use of their home language(s) or the methods they may have learned at home. Teachers can utilize these assets as resources to be integrated into mathematical tasks and interactions while keeping the quality of instruction high for all students.

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