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Translanguaging, Multilingualism, and Multimodality in Children's Mathematics Learning

Cristina Valencia Mazzanti
Smith College, cvalenciamazzanti@smith.edu

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Translanguaging, multilingualism, and multimodality in young children's mathematics learning

Cristina Valencia Mazzanti
Smith College, USA

Abstract

The purpose of this qualitative research study is to portray the complex language practices of multilingual children when learning mathematics. To do so, I draw on data collected as part of a three-year research study that was designed to understand the relationship between young children's language use and mathematics learning, focusing on students' work as well as interactions collected through research journal entries and audio recordings. I center the practice of thick description as a path to advance disruptive understanding of multimodal representations of children's language use while learning mathematics. I then consider the necessary movement from a preconceived understanding of language to enacting an understanding of language that is responsive to the experiences and diverse language practices of children. I argue that a disruptive understanding and enactment of language can foster meaningful mathematics learning by dismantling hierarchical power structures.

Keywords

early childhood, language diversity, mathematics education, multimodality, philosophical hermeneutics, thick description, translanguaging

> Soy, las ganas de vivir,
> las ganas de cruzar,
> las ganas de conocer.
>
> (Calle 13, "La vuelta al mundo")

Think for a moment of a powerful experience you had learning mathematics.

How were you learning? How were mathematical ideas being understood and communicated? What led you to interpret that experience as powerful? The experience you just evoked is unique to you and unfamiliar to me. Yet it is likely that your experience brought to mind many aspects

Corresponding author:
Cristina Valencia Mazzanti, Education and Child Study, Smith College, Morgan Hall, Northampton, MA 01063-0001, USA.
Email: cvalenciamazzanti@smith.edu

of meaningful mathematics learning that are at the core of this article. Your experience probably materialized a social context, a moment when you were interacting with a person, text, or material to understand or communicate the ideas you were learning. It is also probable that your experience evoked a sense of transformation, a moment when you recognized that you had come to see yourself or the world around you differently. In any case, the experience you evoked will necessarily involve language. Language somehow mediated the learning you remember, and language is now mediating your recollection of it by helping you recall that previous event.

In this article, I consider language as a social construct and as a practice to explore how it shapes young children's experiences when learning mathematics. The idea that language mediates learning is currently well established within educational research; it continues to be expansively studied and theorized, fundamentally shaping current pedagogical approaches. Moschkovich et al. (2017: 521) explains that "language and communication are recognized to be core components in the teaching and learning of mathematics, but there are many outstanding questions about the nature of interrelationships among language, mathematics, teaching, and learning." Yet, mathematics is still often perceived as a discipline that is devoid of culture (see Skøvmose, 2011), and thus it can be mistakenly believed to have the ability to function universally or beyond language. Researchers have challenged this perceived neutrality of mathematics to centrally position language, culture, and context as intrinsic components of mathematics learning (see Gutiérrez, 2012).

Educators and researchers advocating for more equitable mathematics teaching have systematically identified language as a crucial factor for inclusive pedagogical practices and effective teaching (e.g. Bartell et al., 2017; Barwell et al., 2016; Celedón-Pattichis et al., 2018). Moreover, language practices are increasingly diverse (Blommaert and Rampton, 2011), and thus permeate and reshape all educational contexts. Barwell et al. (2016: 4) explain that "mathematics education is always happening in the context of language diversity. In our superdiverse societies, shaped by migration, mobile technologies, social media and global trade, learners and teachers of mathematics operate in a complex linguistic landscape." The increased diversity that currently enriches societies is, then, paralleled by an urgency to advance approaches that respond to diversifying experiences and counteract biases interlinked with language practices. Yet, languages are still too often understood in ways that position monolingualism as the norm and that intersect with other oppressive discourses, leading to the unjust governance of linguistic practices and inaccurate views of students' linguistic abilities as deficient (Rosa, 2019). In contexts of formal schooling, limited perceptions of languages continue to create narrow pathways to learning and act as a barrier for success, particularly for children who are minoritized (García, 2017).

Barwell et al. (2017) contend that noticing students' mathematical ideas should go beyond the ability to communicate in traditionally valued ways and include ideas that are expressed through an array of diverse language practices. Young bilingual students, for instance, actively support their mathematics learning and communication of complex ideas through non-verbal modes of representation (Domínguez, 2005). Attentive noticing of alternative expressions of mathematical ideas is particularly necessary for young multilingual students, since their language practices are often unjustly and arbitrarily policed. As multilingual speakers deploy their rich and complex linguistic resources to communicate and understand, they do so based on purpose and experience as to what is effective in the context. The fact that such interactions are recognized as forms of Spanish, English, or bilingualism reflects social conventions that have been historically constructed. Otheguy et al. (2015) explain that multilingual speakers are recognized as such through the social construction of languages, not because named languages such as Spanish and English exist as fixed or preexistent categories. Yet, as much as these social categories are not predetermined or fixed, they often become an argument to restrict or police the multiplicity of ways multilingual speakers use to communicate.

Supporting young multilingual children's learning requires responsive noticing of a multitude of modes of expression and language practices, overcoming the constraints inscribed in the social construction of languages as distinct from each other. Across disciplines, multimodality has been identified as a key linguistic and semiotic practice that students intrinsically deploy to make meaning and communicate (García, 2011). In the case of mathematics, learning is intrinsically tied to the ability to represent and experience abstract concepts through different modes of expression and embodied communicative acts (Radford et al., 2017). Moreover, multimodal representations of mathematics are often positioned as able to enact more authentic, contextual, and culturally diverse views of mathematics knowledge and practice. For instance, Aroca Araújo (2018) drew on multimodal representation to illustrate the complex mathematical underpinnings of artisanal practices in Colombia. Likewise, in her ethnographic study, Takeuchi (2015) concluded that multimodal resources were integral to the participation of diverse and emergent bilingual students in mathematics learning. Karsli-Calamak and Allexsaht-Snider (2020) found that multimodality and embodiment can disrupt the power imbalances in formal teaching and support young children's authentic learning of mathematical ideas.

Although the importance of multimodality for learning is well established, it has rarely been studied in relation to multilingualism, even in fields outside of mathematics. Blackledge and Creese (2017: 251) found that "studies of multimodal communication have tended to focus on monolingual settings, while studies of multilingualism and translanguaging have paid little attention to multimodality." In this article, I build on the potential that translanguaging practices and perspectives afford for learning to consider how their conceptualization of multilingualism and multimodality may afford disruptive understandings that support children's mathematics learning. To this end, I consider the following research question: How are young children supporting their mathematics learning in classrooms through multilingual and multimodal uses of language? To answer this question, I first offer a short overview of translanguaging, focusing on ideas about multimodality and multilingualism. Second, I explain my analytical approach, drawing on philosophical hermeneutics, the practice of thick description, and my positionality. Third, I offer a brief description of the data, design, and context of the study. I then offer an analysis of instances of children's mathematics learning involving multimodal and multilingual uses of language, and close with a short "moving forward" section that discusses the power dynamics embedded in language and their implications for education.

Translanguaging

García and Wei (2014: 45) define translanguaging as the "multiple discursive practices in which bilinguals engage in order to make sense of their bilingual worlds." In other words, translanguaging can be understood as the fluid ability of multilingual people to use their full linguistic repertoires to make meaning of the world around them and communicate with others about it. Thus, in defining translanguaging, it is important to know that it extends across disciplines and goes beyond the idea of a language practice to provide multilayered approaches and understandings. Flores and Schissel (2014: 461–462) explain that "[f]rom a sociolinguistic perspective [translanguaging] describes the fluid language practices of bilingual communities. From a pedagogical perspective it describes the process whereby teachers build bridges between these language practices and the language practices desired in formal school settings." More recently, Wei (2018) added to these perspectives of translanguaging by making an argument as to how it can also be understood as a practical theory of language.

These multiple ways of defining translanguaging point to the complexities in its practice and conceptualization. In this sense, it is sometimes easier to consider it through concrete examples

of how translanguaging may be performed and experienced. Later in this article, I will interpret different interactions between myself and different children, all of which can be recognized as translanguaging. To better understand what translanguaging is, we may consider an example of one of these interactions, in which I used Spanish to ask Kira (a student) what her answer was to a question about addition.[1] She responded by saying: "I think it was dieciocho." This interaction is an example of translanguaging, not simply because the child and I were fluidly using features of both English and Spanish to communicate with one another, but also because it drew on our full linguistic repertoires and previous experiences to make meaning of a complex mathematics question. In this instance, the student used the features of Spanish to name the number because it paralleled the way we more commonly counted in the classroom, and consequently the word had a certain meaning and experience embedded in it—an act that further highlights her understanding of language and skillful communication. At the same time, the student chose to express her answer in English as this was the language that she was more comfortable using, and thus opened different possibilities to understand and communicate. It is these complex ways of using languages to communicate, to understand, and to transform that make this interaction an example of translanguaging.

The complexity of the interaction I have just discussed also highlights one of the defining characteristics of translanguaging: a way to see the language use of people as transformative for people and the inherent power dynamics embedded in it. García and Leiva (2014: 200) explain that "what makes translanguaging different from these other fluid languaging practices is that it is transformative, attempting to wipe out the hierarchy of languaging practices to deem some more valuable than others." This conscientious use of language that systematically challenges established and biased perspectives of language affords possibilities for mathematics education, particularly in the way that "translanguaging empowers both the learner and the teacher, transforms the power relations, and focuses the process of teaching and learning on making meaning, enhancing experience, and developing identity" (Wei, 2018: 16).

Translanguaging and multimodality

The language use of multilingual children in mathematics classrooms indicates that it is also necessary to go beyond ideas about named languages to account for the complex language practices that children draw on to understand and communicate. García (2011) positions multimodality as intrinsically tied to translanguaging in classrooms; she explains that translanguaging "goes beyond code-switching and translation in education because it refers to the process by which bilingual students perform bilingually in the myriad of multimodal ways of classrooms" (147). Although multimodality constitutes its own field of study (see Adami, 2017), translanguaging supports a multilingual practical approach that focuses on pedagogical practices and perspectives of multimodality.

In attending to the intersections across multimodality and translanguaging, García and Wei (2014) describe multimodality as an essential resource for meaning-making and, as such, a form of translanguaging since translanguaging inherently includes all resources for meaning-making. Blackledge and Creese (2017) have further explained the connection between multimodality and translanguaging with a similar argument. They argue that other academics have already offered a clear understanding of translanguaging as the ability of multilingual speakers to draw on their full linguistic repertoire to make meaning and communicate. The acknowledgment of a full linguistic repertoire can then be developed into a natural connection to multimodality since any repertoire for meaning-making and communication is necessarily multimodal and always embodied.

Adami (2017: 452) explains that "multimodality as a field of research conceives of representation and communication as relying on a multiplicity of modes, all of which have been socially

developed as resources to make meaning." These modes can include "gesture, oral performance, artistic, linguistic, digital, electronic, graphic, and artifact-related" (Pahl and Rowsell, 2006: 6). Although these modes are distinctive from one another, Canals (2021: 648) explains that the potential for meaning arises through the simultaneous use of several modes that complement each other. Accordingly, multimodality has been positioned as core to all educational contexts. From a pedagogical perspective, multimodality is an effective resource for learning that weaves together a multitude of mediums and supports authentic engagement with multicultural and multilingual dimensions of communication for minoritized students (e.g. Bengochea et al., 2018; Pacheco and Smith, 2015; Rowe, 2018).

In understanding multimodality as an intrinsic part of translanguaging and educational encounters, it is helpful to come back to Wei's (2018) argument to understand translanguaging as a practical theory of language. If translanguaging can be positioned as a practical theory of language, then it is not simply that multimodality is part of translanguaging but that translanguaging understands language as intrinsically multimodal. In Wei's (2018: 20) words: "Language, then, is a multisensory and multimodal semiotic system interconnected with other *identifiable* but *inseparable* cognitive systems. Translanguaging for me means transcending the traditional divides between linguistic and non-linguistic cognitive and semiotic systems." This argument has important implications for the way we may consider the communicative practices in children's mathematics learning; a salient perspective is that isolating different modes of communication closes possibilities for a more meaningful understanding.

Thick description: a multimodal approach for disruptive understandings of children's language use

I drew on philosophical hermeneutics to shape the data collection and data analysis processes in this study because it provides a focus on transformative understanding. Moules et al. explain that

> unlike some other qualitative methods, the practice of hermeneutics is not aimed at inducing themes, semantic codes, constructs, or theories, but rather seeks to deepen understanding of a topic in such a way that it can be seen differently, and ultimately, can be practiced differently. (Moules et al., 2015: 119)

The hermeneutic way of positioning the practice of research through a focus on understanding aligns with the goals proposed in this study—to portray disruptive understandings of the language practice of multilingual children while learning mathematics. The research study that generated the data was intentionally designed to promote understanding through repeated engagement with the multilingual practices of children. Thus, a hermeneutic perspective informs my stance to look closely at those experiences and data and to disrupt them through purposeful interpretation, questioning taken-for-granted notions about language in the context of mathematics learning.

The practice of thick description has been identified as a way to foster a hermeneutic encounter that invites understanding (Freeman, 2014). Denzin (2001) designated thick description as an interpretative and creative system of analysis that involves multiple dimensions of experience to support thick interpretation. Simply put, thick description is an approach to analysis that involves dense descriptions and explanations of events, calling for a focus on context and meaning (Harrison, 2013; Ponterotto, 2006). In this article, I develop the understandings that grew through my repeated experiences with multilingual children into thick descriptions. To do so, I draw on multiple data sources that reflect everyday events in bilingual mathematics teaching and learning. In alignment with the research question in this article, I center on instances where children communicated

their mathematical understanding through language practices that included multilingualism and multimodality.

Freeman (2014) argues that the opportunity to engage with a phenomenon in aesthetic and multidimensional ways is what gives thick description its ability to foster deep and disruptive hermeneutic understandings. She concludes that "when we venture in the multiple aesthetic manifestations of meaning, we cannot separate out the meaning from the lived experience of the journey" (832). Hence, I turned to instances that portrayed multiple dimensions of young multilingual children's experiences with mathematics learning, focusing on the complex meanings that can only be brought forward when considered in context. As I developed the thick descriptions through multiple modalities and a diversity of experiences, I intentionally pursued thick interpretation of children's language use while learning mathematics. To support my analysis, I drew on findings from previous research as added contexts for understanding, foregrounding perspectives from mathematics education as well as literature on multimodality, translanguaging, and multilingualism.

Positionality

The understandings developed in this article stem from my own experiences as a multilingual, immigrant, multicultural Latina. I have never known the world in just one language and I had most of my formative schooling experiences in settings where being multilingual was seen as an asset. My experience of being multilingual as a powerful and advantageous way of being that fosters learning is a perspective that remains prevalent in my research and work as an educator. As a scholar, I am committed to develop research that helps address the structural and systemic injustices children face when learning, particularly children who are Latine, linguistically diverse, and have been historically minoritized.

In this article, I have identified children as multilingual and Latine. Hence, I would like to explicitly acknowledge the heterogeneous nature of Latine and multilingual people, and that neither way of being implies the other. Words such as "Latine" and "multilingual" can help us understand our identities as part of a community, yet they should not be used to erase the uniqueness of our experiences. It is important to acknowledge that the word "multilingual" has been problematized for failing to oppose the hegemony of named languages, and thus failing to reflect a truly heteroglossic and integrated view of linguistic repertoires (see Canagarajah, 2013; Otheguy et al., 2015). In other words, the word "multilingual" can go against the integrative view of languaging that translanguaging aims to foster by implying the existence of multiple languages. I use the word "multilingual" because it allows me to indicate in an easily recognizable way the necessary distinction of people who are not socially recognized as monolingual, while still representing a plurality of language experiences and identities.

Design and context of the study

The data I consider in this article was generated through a three-year study to understand young children's experiences as these related to the connections between languages and mathematics learning. Data was collected across three years in two kindergarten classrooms in two public schools in a town in the southeast of the USA. I joined the classrooms as a participant-observer, taking the role of a volunteer teacher and working with the classes on average two to three times a week. As part of my role as a volunteer teacher, I actively participated in all instruction I was present for, as well as special school events and field trips. Because the focus of the study was the language use of the children while learning mathematics, during mathematics instruction I regularly taught the whole group, worked with small groups and individual students, performed

mathematics assessments, and observed mathematics instruction. Since I was often working with the children while in the classroom, the data was generated in journal entries and by collecting students' work. For the second and third years of the study, I also introduced audio recordings during mathematics instruction of the children and periodic field notes taken by a second researcher through the role of reactive observer.

In this article, I focus on data collected during the second year of the study. During the second and third years of the study, data was collected in Ms Moreno's kindergarten classroom, which was part of a Dual Language Immersion program based on an 80–20 model (80% of the school day in Spanish, 20% of the school day in English). Each Dual Language Immersion class was projected to have equal numbers of students who were native speakers of each language. However, more children came into the program whose dominant language was English and the children were often somewhat familiar with both languages. This particular kindergarten class had 22 children; most children in the class were proficient in English and able to understand basic instructions in Spanish. About half of the class had also attended pre-kindergarten in the Dual Language Immersion program, so they had previously received a year of school instruction in Spanish.

Mathematics instruction was intended to be in Spanish. In my work with the children, the use of English was encouraged. Complex ideas were intentionally stated in both languages not only by me, but also by the children in the class. The data I consider in this article was collected during the second semester of the school year. The focus of instruction was the development of students' abilities to represent numbers and solve problems with addition and subtraction. For this purpose, the children and I often worked together, using familiar children's books in English and Spanish as well as scenarios (such as the park, the grocery store, or the classroom) to imagine a different context with meaningful questions involving numbers, addition, and subtraction.

Multilingualism and multimodality in children's mathematics learning

To represent the understandings that were developed in this study, in this section I focus on the experiences and language practices of children participating in a mathematical discussion centered around grocery shopping and adding doubles. The activity started with a whole-group discussion, in which the children took the lead in considering what they would like to buy during a visit to the grocery store and what they would buy a lot of. When I prompted the children to think about items they would buy nine of, one of the children suggested pies. Other children found humor in the idea of being able to buy a lot of very large pies, prompting several children to continue to make jokes throughout the lesson about buying absurd quantities of sweets. I moved the discussion forward by asking the children to consider if it would be reasonable to buy several small pies to share with a group of friends and family. The discussion then shifted to other items that it would be good to buy nine of if you were buying lots of pies, which prompted a child to suggest apples as a healthy alternative. The children then worked independently to identify the total number of items bought and create models for their thinking. At the end of the activity, some of the children shared their models and thinking with the whole group.

One of the most common presentations of translanguaging that occurred during mathematics instruction was me prompting the children in Spanish and the children then responding mainly in English, and inserting keywords in Spanish. This way of communicating can be noticed in the pies and apple lesson when a student, London, was called to share her work (see Table 1).

In the interactions portrayed in Table 1, the use of linguistic features socially associated with Spanish and English is easily recognized. From the perspective of translanguaging, London and I were using features of Spanish and English as part of one integrated repertoire, instead of drawing on two abstract and discrete systems (García and Kleyn, 2016). This integrative view of

language counteracts biases and supports an interpretation of London as an agentic language user who is able to choose from a wide range of linguistic features to communicate and learn, instead of an imperfect monolingual speaker of English or Spanish who is forced to rely on her dominant language because she is not yet proficient in the language of instruction.

When London was called on to share her work, she immediately tried to count the objects in her work in Spanish. Domínguez (2019) has conceptualized that students and teachers engage in processes of reciprocal noticing, through which diverse learners are able to bring forward culturally and linguistically situated manifestations of mathematics. In this instance, London demonstrated her experience sharing mathematical ideas and her understanding of practices that were relevant to the context of the classroom. Since the children regularly shared their models and thinking, London had experienced that the use of Spanish was valued, and that counting was positioned as an important skill to explain models of mathematical thinking. Prompting children to count was one of the most common responses during sharing activities. London demonstrated her skill with language by choosing from semiotic features that were appropriate and relevant to the context and communicative practices of the bilingual mathematics instruction she was part of.

London's words while sharing indicate how bilingual children necessarily rely on having multiple ways to represent their thinking to be able to successfully solve mathematics questions and explain their mathematical ideas. Multimodality is necessary for meaning-making and, as such, is an inherent feature of any translanguaging practice (Blackledge and Creese, 2017; García, 2011). London's ability to communicate complex meanings resides at the intersection of multiple modalities of language. As can be seen in Figure 1, London represented nine pies and nine apples, concretely drawing each of them. In her model, London demonstrated her thinking about quantity while also exhibiting familiarity with the expectations of carrying out mathematics procedures in schooling contexts. She represented the total number of objects by writing the number 18 at the bottom of her piece of paper, as well as a checkmark to demonstrate that she had counted and checked her work. When London counted by ones to 18, she pointed at each object she drew, and when she reached the total number of objects, she pointed to the numeral for 18. London's

Table 1. Transcription and translation of interaction with London.

Original transcript	English translation (italics represent original in Spanish)
Cristina (Author): A ver London ¿cuál es tu respuesta?	Cristina: *Let's see London, what is your answer?*
London: Uno, dos tres …	London: *One, two, three …*
Cristina: No, no … muéstranos que dibujaste … What's in your picture?	Cristina: *No, no … show us what you drew …* What's in your picture?
London: ¿Nueve?	London: *Nine?*
Cristina: A ver … muéstranos.	Cristina: *Let's see … show us.*
London: These are pies and they are in a row of pies and is nueve, and these are apples in a row of apples.	London: These are pies and they are in a row of pies and is *nine*, and these are apples in a row of apples.
Cristina: Y muéstrales lo demás … espera - ahí para que puedan ver.	Cristina: *And show them what else … wait - right there so that they can see.*
London: Uno, dos, tres, cuatro, cinco, seis, siete, ocho, nueve, diez, once, doce, trece, catorce, quince, dieciséis, diecisiete, dieciocho.	London: *One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, sixteen, seventeen, eighteen.*
Cristina: Dieciocho! Gracias London, muy bien.	Cristina: *Eighteen! Thank you, London, good.*

drawings and actions showed a depth of understanding and communicative skills that her verbalized words alone did not.

London skillfully wove together her words, drawings, and body movements to effectively share her mathematical thinking. London's actions pointed to the complexity of what was being communicated at this moment, and the complexity of the mathematics being learned. Her model demonstrated a consideration of quantity that seemed to evoke the whole-group discussion about large pie quantities and previous discussions the class had had about strategies that could be used to represent groups of objects. Langer-Osuna et al. (2016) have explained that multilingual children are able to use multiple communicative resources to participate in and create opportunities for their own mathematics learning. In her drawing, London represented one big pie and then nine small pies, evoking the discussion about reasonable amounts of pies and the idea that the small individual pies formed a group of nine. London's communicative choices and language use transformed shared understandings of mathematics, translating them through her lived experience and perspectives—a key step that children can take in fostering their mathematics learning (see Turner et al., 2013).

This brief glimpse of London's learning indicates the importance of children having opportunities to represent their mathematical understanding through multiple modes while also being supported in making connections across them. These are important skills and key learning opportunities (Radford et al., 2017), particularly when considering the increase in the language demands of students in mathematics instruction; children are now expected to provide in-depth explanations for their mathematical understandings and procedures (see National Council of Teachers of Mathematics, 2013). The importance of children's ability to use different modes and languages to make sense of mathematics can also be identified in Jaxon's experiences. As can be seen in Figure 2, to find the total number of apples and pies, Jaxon drew abstract representations of quantities using circles that originally did not match the actual quantities he was considering.

In previous lessons, the class had discussed the use of circles as a strategy to represent quantities and objects. When I approached Jaxon, he had drawn more than twice the number of required circles to represent 18. He was able to verbally explain what he wanted to represent and seemed aware that

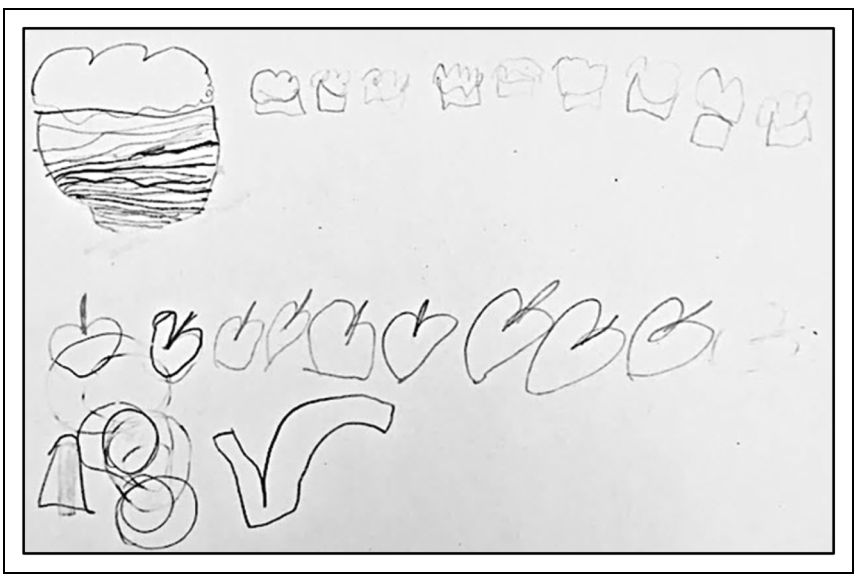

Figure 1. London's representation of nine pies and nine apples.

the model he had created did not match his thinking. When I offered counting tiles (little plastic squares in different colors), Jaxon was able to count, model, and explain his answer, communicating his thinking using Spanish and English interchangeably. Once he had represented the answer with the tiles, we used the tiles to revisit his drawing, matching each of the 18 tiles that he had counted to the circles he had drawn. In this final version of his work, it was possible to see the complexity of his understanding. Once I started working with a different child, Jaxon worked independently to accurately represent 18. He traced the shape of the counting tiles around some of the circles he had previously drawn and then erased most of the circles he had drawn before. In the final version of his model, Jaxon represented nine circles and nine squares for a total of 18 items.

Jaxon's work and his process to create an effective model of the mathematics question emphasize the importance of challenging preconceived notions of what mathematics learning and language practice should look like in schools. Students and teachers notice the way certain linguistic practices are valued over others in spaces of mathematics education based on an inevitable awareness of the inherent power dynamics that manifest in the way language is valued (Planas and Civil, 2013). Jaxon was not required to represent his work in a predetermined way or to use just one language to learn. Yet, he chose to model his mathematical thinking through an abstract model, which is often identified as a valuable mathematical skill (Lesh and English, 2005). When Jaxon was not immediately successful, he was given the opportunity to think about the situation independently and then to explain his thinking with support. Flores (2020) conceptualizes that multilingual children have the ability to draw on an array of linguistic features to communicate in ways that are effective and relevant to the context, and thus their ability to act as language architects should be recognized as an important skill to support academic learning. In this instance, Jaxon was supported in considering his mathematics ideas across different modes of communication while drawing on both Spanish and English to help him make sense of quantity in his own terms.

The ability to interpret and appropriate valued communicative practices for mathematics learning was common across the students. Although the students were encouraged to use numerals and drawings to represent their thinking, I did not introduce number sentences or symbols for addition or equality during the activity with the apples and pies. My goal for the activity with the apples and pies was to support the children's practice modeling quantities and their mathematical thinking of a complex situation we had imagined together in an open-ended manner. Yet the students had an experience of language as a multisensory and multimodal system that included non-linguistic resources (Wei, 2018) as useful modes to represent their mathematical thinking. Some of the students introduced the use of mathematical symbols as helpful resources to represent their mathematical thinking and models.

Figure 2. Jaxon's representation of nine pies and nine apples.

For instance, in Figure 3, it is possible to see the model Kira created for the apples and pies. Her model demonstrated a depth of familiarity with the use of multiple symbolic linguistic features to represent mathematical ideas, such as number sentences, numerals, and symbols for equality and addition, as well as drawing abstract equivalents of an object to represent quantity.

In a different drawing that she had created about a month earlier (see Figure 4), Kira developed a model portraying each element concretely, imitating the illustrations that she had seen in the book we used as a context to create questions that could be considered mathematically. In contrast, in the model in Figure 3, Kira created opportunities for understanding by adding the same quantity by creating two rows of circles that equaled nine and mirrored each other. In the model in Figure 4, Kira portrayed her understanding of addition by concretely representing two groups—one with five objects and one with three objects—and originally drawing the numeral for eight in the middle of the two groups. When I asked her to explain her model during individual work, Kira shared the ideas in her drawing, hovering her hands over each group of objects. When she described adding, she moved her hands, bringing them together to imitate the body movements we used to signal addition in whole-group settings. When I started working with another child, Kira continued to work on her model, erasing the numeral for eight she had originally placed in the middle and creating the equation to represent her mathematical thinking.

Across the two samples of Kira's work, she demonstrated a continuous meaning-making process in the use of equations to represent her thinking while changing the strategies she used to model quantities. Kira's actions underscore the importance of instructional practices in mathematics that emphasize presenting multiple strategies based on children's readiness, instead of a standard strategy enforced by the teacher (Carpenter et al., 2017). The two work samples from Kira indicate the way different models afforded her an opportunity to demonstrate different understandings of addition and quantity. The practice of translanguaging, then, supported the necessary noticing of complex mathematics ideas that were being carried out through the diverse linguistic practices communicated (Barwell et al., 2017) in ways that created opportunities for learning (García and Wei, 2014).

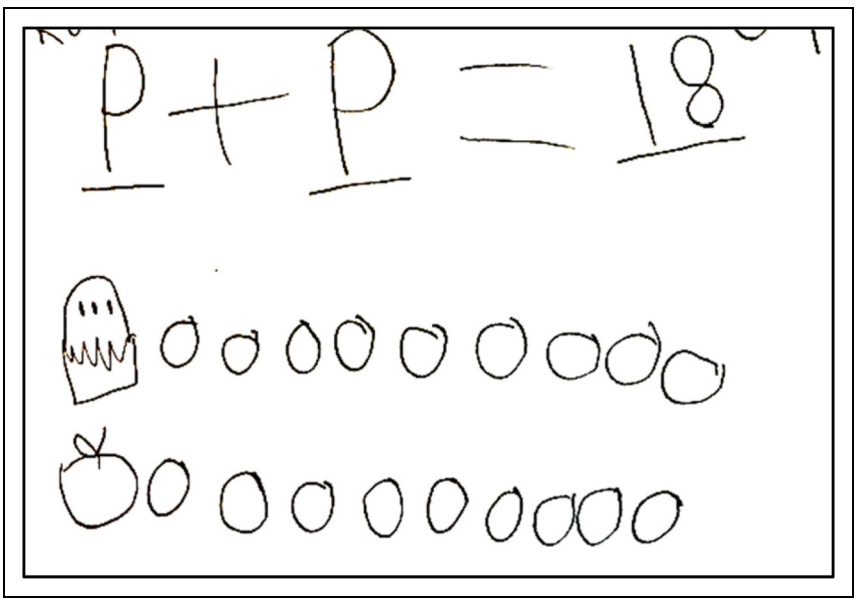

Figure 3. Kira's representation of nine pies and nine apples.

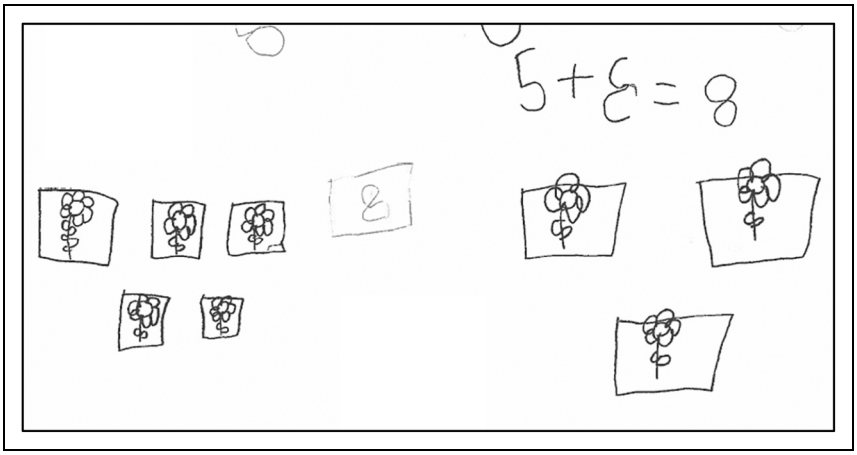

Figure 4. Kira's representation of eight flower drawings.

Moving forward

Children in multilingual classrooms are constantly deploying their linguistic repertoires to understand and communicate complex ideas. The previous section portrayed children making purposeful choices regarding their language use to learn and communicate mathematical ideas while drawing on a variety of linguistic features that included semiotic and multimodal resources. To learn mathematics, children use body movements, drawings, models, manipulatives, symbols, and contexts, as well as spoken and written linguistic features. These experiences reinforce the need to draw on practices and frameworks to provide a learning experience that comprehensively responds to and builds on children's agentic and contextual language use. In previous work, I have argued that translanguaging is a fruitful practice and perspective to support the mathematics learning of young multilingual students (Valencia Mazzanti and Allexsaht-Snider, 2018). In this article, I have outlined how drawing on translanguaging can support researchers and educators in noticing language as inherently multilingual and multimodal.

In the context of mathematics education research, Planas and Civil (2013) have highlighted the need to study issues of language not just as a resource for learning, but also as a social practice that manifests the power dynamics embedded in communities. Similarly, Setati (2008) writes eloquently about the need in mathematics research to think about the political nature of language, moving beyond its pedagogical use in contexts of schooling. Emphasizing these needs is urgent, to advance practices and perspectives that counteract the current biases that are ingrained in languages and dynamically transform learning spaces to reflect their inherent diversity. Currently, it is impossible to imagine any context in which the language practices of all the children in the class, the teacher, and the curriculum will be the same. Yet, questions about the ways language is used and perceived continue to pose challenges for researchers and educators.

A plethora of methodological practices has been developed within research that focuses on language to address the complexity of understanding and explaining increasingly diverse linguistic realities (King et al., 2017). Similarly, in the Compendium for Research in Mathematics Education, scholars identified the need for theories and methodologies that help us develop research to understand complex phenomena in mathematics education comprehensively and innovatively (see De Freitas et al., 2017; Stinson and Walsh, 2017). As researchers and educators aim to understand diverse language practices, they must also consider the multifaceted ways their own language

and experience necessarily mediate the ability to interpret children's learning. In my description of bilingual children's experiences with language and mathematics learning, I have identified a range of language practices that children deploy to carve various paths that support their learning. At the core of this array of language practices is an experience of language as a multifaceted and integrated system that brings together multiple modalities to communicate and understand complex ideas.

In its multiple dimensions, translanguaging is meant to challenge the hierarchy and separation of language. Intellectual and social endeavors that theorize language have resulted in distinctions amongst the modes that constitute communicative encounters and events of understanding. These distinctions continue to symbiotically forward the duality of helping make noticeable the diversity of language and name the experiences of minoritized communities, while becoming harmful when used to privilege certain modes of language over others. The prevalence of monolingual ideologies has been particularly ubiquitous and insidious in shaping the power relations embedded in language, which then translates into how the role of language is understood in learning. As we build educational spaces, the categories and distinctions used to understand language need to be intentionally challenged to create meaningful learning opportunities. The creative and agentic ways children use language are, then, an example of the paths that researchers and educators can follow to restore the inherent complexity and diversity that constitutes language, thus transforming the possibilities that language itself opens up.

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ORCID iD

Cristina Valencia Mazzanti https://orcid.org/0000-0002-5110-6628

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References

Adami E (2017) Multimodality. In: García O, Flores N and Spotti M (eds) *The Oxford Handbook of Language and Society*. Oxford: Oxford University Press, pp. 451–472.

Aroca Araújo A,. (2018) Etnografía del saber matemático de los pescadores de Buenaventura, Pacífico colombiano: Elementos para una educación matemática contextualizada. Universidad del Atlántico.

Bartell T. , Wager, A., Edwards, A., Battey, D., Foote, M., & Spencer, J. (2017) Toward a framework for research linking equitable teaching with the standards for mathematical practice. *Journal for Research in Mathematics Education* 48(1): 7–21.

Barwell B, Clarkson P, and Halai A, et al. (2016) Introduction: An ICMI study on language diversity in education. In: Barwell B, Clarkson P, Halai A, et al. (eds) *Mathematics Education and Language Diversity: The 21st ICMI Study*. Cham, Switzerland: Springer International, pp. 1–22.

Barwell B, Moschkovich J and Setati-Phakeng M (2017) Language diversity and mathematics: Second language, bilingual, and multilingual learners. In: Cai J (ed.) *Compendium for Research in Mathematics Education*. Reston, VA: National Council of Teachers of Mathematics, pp. 563–606.

Bengochea A, Sembiante SF and Gort M (2018) An emergent bilingual child's multimodal choices in sociodramatic play. *Journal of Early Childhood Literacy* 18(1): 38–70.

Blackledge A and Creese A (2017) Translanguaging and the body. *International Journal of Multilingualism* 14(3): 250–268.

Blommaert J and Rampton B (2011) Language and superdiversity. *Diversities* 13(2): 1–21.

Canagarajah S (2013) *Translingual Practice: Global Englishes and Cosmopolitan Relations*. : Routledge.

Canals L (2021) Multimodality and translanguaging in negotiation of meaning. *Foreign Language Annals* 54(3): 647–670.

Carpenter T, Franke M, Johnson N, et al. (2017) *Young Children's Mathematics: Cognitively Guided Instruction in Early Childhood Education*. Portsmouth, NH: Heinemann.

Celedón-Pattichis S, Borden L, Pape SJ, et al. (2018) Asset-based approaches to equitable mathematics education research and practice. *Journal for Research in Mathematics Education* 49(4): 373–389.

De Freitas E, Lerman S and Parks AN (2017) Qualitative methods. In: Cai J (ed.) *Compendium for Research in Mathematics Education*. Reston, VA: National Council of Teachers of Mathematics, pp. 159–182.

Denzin NK (2001) Thick description. In: *Interpretative Interactionism*. Thousand Oaks, CA: SAGE, pp. 99–118.

Domínguez H (2005) Bilingual students' articulation and gesticulation of mathematical knowledge during problem solving. *Bilingual Research Journal* 29(2): 269–293.

Domínguez H (2019) Theorizing reciprocal noticing with non-dominant students in mathematics. *Educational Studies in Mathematics* 102: 75–89.

Flores N (2020) From academic language to language architecture: Challenging raciolinguistic ideologies in research and practice. *Theory into Practice* 59(1): 22–31.

Flores N and Schissel J (2014) Dynamic bilingualism as the norm: Envisioning a heteroglossic approach to standards-based reform. *TESOL Quarterly* 48(3): 454–479.

Freeman M (2014) The hermeneutical aesthetics of thick description. *Qualitative Inquiry* 20(6): 827–833.

García O (2011) Educating New York's bilingual children: Constructing a future from the past. *International Journal of Bilingual Education and Bilingualism* 14(2): 133–153.

García O (2017) Translanguaging in schools: Subiendo y bajando, bajando y subiendo as afterword. *Journal of Language Identity and Education* 16(4): 256–263.

García O and Kleyn T (2016) Translanguaging theory in education. In: García O and Kleyn T (eds) *Translanguaging with Multilingual Students*. Routledge, pp. 9–33.

García O and Leiva C (2014) Theorizing and enacting translanguaging for social justice. In: Blackledge A and Creese A (eds) *Heteroglossia as Practice and Pedagogy*. Dordrecht: Springer, pp. 199–216.

García O and Wei L (2014) *Translanguaging: Language, Bilingualism and Education*. Basingstoke: Palgrave Macmillan.

Harrison AK (2013) Thick description. In: McGee RJ and Warms RL (eds) *Theory in Social and Cultural Anthropology: An Encyclopedia*. : SAGE, pp. 860–861.

Karsli-Calamak E and Allexsaht-Snider M (2020) Manifestations of mathematics within the power dynamics in a Pre-K classroom. *Teachers College Record* 122(9): 1–42.

King KA, Lai Y-J and May S (eds) (2017) *Research Methods in Language and Education*. Cham: Springer.

Langer-Osuna JM, Moschkovich J, Norén E, et al. (2016) Student agency and counter-narratives in diverse multilingual mathematics classrooms: Challenging deficit perspectives. In: *Mathematics Education and Language Diversity*. Cham, Switzerland: Springer, pp. 163–173.

Lesh R and English LD (2005) Trends in the evolution of models and modeling perspectives on mathematical learning and problem solving. *Zentralblatt für Didaktik der Mathematik* 37: 487–489.

Moschkovich J, Wagner D, Bose A, et al. (2017) Topic Study Group No. 31: Language and communication in mathematics. In: *Proceedings of the 13th International Congress on Mathematical Education*. Cham: Springer, pp. 521–524.

Moules NJ, McCaffrey G, Field JC, et al. (2015) *Conducting Hermeneutic Research: From Philosophy to Practice*. : Peter Lang.

National Council of Teachers of Mathematics (2013) Mathematics in early childhood learning: A position of the National Council of Teachers of Mathematics. Available at: https://www.nctm.org/Standards-and-Positions/Position-Statements/Mathematics-in-Early-Childhood-Learning

Otheguy R, García O and Reid W (2015) Clarifying translanguaging and deconstructing named languages: A perspective from linguistics. *Applied Linguistics Review* 6(3): 281–307.

Pacheco MB and Smith BE (2015) Across languages, modes, and identities: Bilingual adolescents' multimodal codemeshing in the literacy classroom. *Bilingual Research Journal* 38(3): 292–312.

Pahl K and Rowsell J (2006) *Travel Notes from the New Literacy Studies: Instances of Practice*, vol. 4. Bristol, Blue Ridge Summit: Multilingual Matters.

Planas N and Civil M (2013) Language-as-resource and language-as-political: Tensions in the bilingual mathematics classroom. *Mathematics Education Research Journal* 25: 361–378.

Ponterotto J (2006) Brief note on the origins, evolution, and meaning of the qualitative research concept "thick description." *Qualitative Report* 11(3): 538–549.

Radford L, Arzarello F, Edwards L, et al. (2017) The multimodal material mind: Embodiment in mathematics education. In: Cai J (ed.) *Compendium for Research in Mathematics Education*. Reston, VA: National Council of Teachers of Mathematics, pp. 700–721.

Rosa J (2019) *Looking Like a Language, Sounding Like a Race: Raciolinguistic Ideologies and the Learning of Latinidad*. Oxford: Oxford University Press.

Rowe LW (2018) Say it in your language: Supporting translanguaging in multilingual classes. *Reading Teacher* 72(1): 31–38.

Setati M (2008) Access to mathematics versus access to the language of power: The struggle in multilingual mathematics classrooms. *South African Journal of Education* 28(1): 103–116.

Skøvmose O (2011) Critique, generativity and imagination. *For the Learning of Mathematics* 31(3): 19–23.

Stinson D and Walsh M (2017) Exploring different theoretical frontiers for different (and uncertain) possibilities in mathematics education research. In: Cai J (ed.) *Compendium for Research in Mathematics Education*. Reston, VA: National Council of Teachers of Mathematics, pp. 128–155.

Takeuchi M (2015) The situated multiliteracies approach to classroom participation: English language learners' participation in classroom mathematics practices. *Journal of Language, Identity and Education* 14(3): 159–178.

Turner E, Dominguez H and Empson S, et al. (2013) Latino/a bilinguals and their teachers developing a shared communicative space. *Educational Studies in Mathematics* 84(3): 349–370.

Valencia Mazzanti C and Allexsaht-Snider M (2018) ¿Es lo mismo? Bilingual children counting and making sense of number. In: Goffney I and Gutierrez R (eds) *Annual Perspectives in Mathematics Education (APME) 2018: Rehumanizing Mathematics for Black, Indigenous, and Latinx*. National Council of Teachers of Mathematics (NCTM), pp. 135–146.

Wei L (2018) Translanguaging as a practical theory of language. *Applied Linguistics* 39(1): 9–30.

Author biography

Cristina Valencia Mazzanti is an assistant professor in the Department of Education and Child Study at Smith College. She studies the social construction of languages as a multifaceted phenomenon that shapes children's experiences of learning as well as the work of educators and researchers. Currently, she is researching young children's experiences with multilingualism, multimodality, and learning through a series of interdisciplinary longitudinal studies involving kindergarten students, elementary school teachers, and Latine families. She teaches classes in the areas of early childhood and elementary education as well as educational research.