PARENTS AS FACILITATORS: UTILIZATION OF BILINGUAL LANGUAGING PRACTICES DURING MATHEMATICAL PROBLEM SOLVING

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This study highlights parents' linguistic capital and how they use specific languaging practices to facilitate their child's learning. One bilingual family used multiple languages to facilitate their son's learning through two mathematical tasks. Using Dominguez' conceptual framework of bilingualism, we analyzed these conversations to look for natural units of communication and its relation towards their problem solving goals. The data shows the family would switch from English to Spanish to help their child surpass several barriers during their mathematical activities. Leveraging bilingual languaging practices can counter the deficit lens with which minoritized students are typically viewed.

Introduction and Relevant Literature

Much has been explored regarding the relationship between school-based learning and out-of-school contexts; establishing a unidirectional path where content learned in school is expected to be applied outside of school contexts (Dominguez, 2011). This study contributes to the growing body of literature pushing against this relationship by recognizing and valuing bilingual languaging practices in families as they use their linguistic capital to solve mathematics problems. Previous research broadly focuses on bilingualism's relationship to mathematical learning from the student's perspective. For example, multilingual students achieve higher levels of meaning making when mathematical problems incorporate their home language (Erath et al., 2021), while others utilize language switching, recalling their specific language of instruction to help them solve mathematical problems. (Moschkovich, 2007).

Language switching involves utilizing two (or more) languages during mental arithmetic computation (Moschkovic, 2007). For bilingual learners, they each have a preferred language for conducting arithmetic computation, with the preferred language being the one utilized for their instruction (Moschkovic, 2007; Edmonds-Wathen et al., 2019). When confronted with a novel mathematics problem in their second language, bilingual learners will language switch in an

attempt to make sense of the task (Moschkovicz, 2007). While this phenomenon is well explored from the student's perspective, fewer studies have been conducted on how parents and guardians utilize these same strategies.

Through our work, we look at a family's languaging practices occurring as parents fulfill a facilitator role during their children's mathematical work. Previous research on parental involvement has highlighted the overall desire for parents and guardians to fulfill a facilitator role (Civil & Bernier, 2006; Harper et al., 2021). While acting as facilitators, bilingual parents and guardians use language switching to help scaffold their children's learning. For example, Willey and Morales (2020) demonstrated how parents participating in a dual language after school mathematics program with their children frequently re-shaped the linguistic landscape by pushing for the usage of their primary language (Spanish), despite the social pressures to use their second (English). This helped establish new norms allowing for more languaging practices to be used in mathematical problem solving (Willey & Morales, 2020).

The objective of this study is to explore how families make sense of mathematical problems using their linguistic capital via a case study of one family's experience working through activities as a unit at a family mathematics event. By recognizing and leveraging their linguistic capital as bilinguals, parents and guardians can be recognized and involved in their children's education as facilitators. In turn, positive attitudes towards school can be created, countering the typically deleterious consequences of traditional school curriculum that continually views students of color with a deficit lens (Pinedo et al., 2021).

Conceptual Framework

We follow Dominguez's (2011) conceptualization of bilingualism as "cognitive resources for solving school based mathematical problems" (p. 307). It is imperative that bilingualism be seen as an asset, and subsequently leveraged to its fullest extent. This includes the assets found at home, as parents fulfill their roles as facilitators and use their own linguistic capital to help out their children when prompted. In addition, we also draw from Yosso's (2005) model of community cultural wealth, which includes various forms of capital minoritized students bring with them into the classroom. Among them, we focus on linguistic capital which includes cultural knowledge among family members and their communication skills in more than one language (Yosso, 2005). As a result, bilingualism is further defined as a social action,

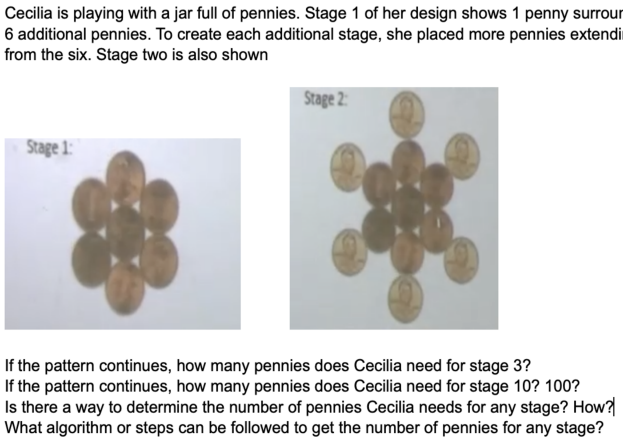
incorporating all forms of communicative practices with and to others that converge towards meaning making (Dominguez, 2011).

Methods

For this paper, we focus on the Rodriguez (pseudonym) family and their languaging practices while facilitating their son's mathematics activities during two mathematical tasks. The Rodriguez family participated in a mathematics event held before a summer school program for parents and guardians to get a richer understanding of the mathematics activities students would do during the program. We focus our efforts on one of their assigned activities; a visual growth pattern task (see Figure 1). In this task, participants are asked to predict the number of pennies in several stages according to the visual growth pattern as shown in the first two stages. Based on these predictions, participants conclude this assignment by developing their own algorithm for determining the number of pennies at any stage.

Figure 1

Visual growth pattern task given to families to work on together.



Context and Data Collection

A summer mathematics institute was organized by our research team for rising fourth and fifth graders at an elementary school in central Texas. The overall goal of this institute was to enhance students' confidence in mathematics via a series of projects designed to encourage participation and increase the visibility of mathematics in their day to day lives. Alongside this institute, a family mathematics event was conducted to give parents and guardians an opportunity to become familiar with the kind of work their children would be doing at the institute. Consent

forms were given to these family members to opt-in to the video and audio recorded segments of the family event.

Among the families opting in to the study, the Rodriguez family stood out due to their bilingual languaging practices used while working on the assigned activities. As shown above, the visual growth pattern assignment was written exclusively in English, and the mathematics event facilitators conducted these sessions in English. In spite of this limitation, the Rodriguez family used the Spanish language during their problem solving process. Their decisions to language switch at key intervals during their session was entirely their own. As a result, this paper focuses on the Rodriguez' mathematical languaging practices as they became facilitators to their child's mathematical learning.

Data Analysis

Audio transcripts were separated into two episodes of mathematical activity; one for each mathematical task facilitated by the Rodriguez family. These transcripts were analyzed to underscore languaging practices during each episode. Following our bilingualism framework, the transcripts were coded for natural units of communication, or individual units of conversation oriented towards solving a problem (Dominguez, 2011). Similar to Dominguez, we focus solely on verbal units of communication. Verbal units of conversation were then coded as either reinvention actions or reproduction actions. Reinvention actions are meaning making actions housed within the unique languaging practices of the family as a unit. Reproduction actions include students' predispositions to follow a formulaic path to an answer, which could often be incomplete or incorrect (Dominguez, 2011; examples below in results). Each unit of communication was categorized into these codes individually by our research collective. In addition, themes were generated for parents which highlighted their specific contributions towards reproduction and/or reinvention actions. These themes serve as the focal point of our data, serving to illustrate parents' contributions towards sense making via their languaging practices. Following that, all researchers met to share codes and arrive at a consensus. Looking across the coded units established via the research collective, patterns emerged in the Rodriguez family's usage of their linguistic capital.

Results

We use the data excerpt below to highlight the languaging practices occurring throughout the Rodriguez' problem solving session. The excerpt is from the conversation between the

learner and his parents as they work through the visual growth pattern task. Initially, the learner (marked as student) goes through a series of reproduction actions, where he relies on his previous knowledge to follow a formulaic path to an answer. When this fails, the parents tap into their linguistic capital to help facilitate the problem solving process. With that, the learner then goes through a series of reinvention actions, clarifying the prompts and allowing the learner to continue through the assignment.

1. Parents: Leele ahi, que dice?
2. Student: Dice, it says Cecilia is playing a jar full of pennies. Stage one of her design shows one penny surrounded by six additional pennies. To create each additional stage, she placed more pennies… if the pattern continues… six more, I know that's seven. Six equals thirteen.
3. S: How many pennies does Cecilia have for stage three. Since this is stage two, add nine… Nineteen.
4. P: Ok. Why?
5. S: Cause, even plus six equals thirteen. I know that three plus six equals nine. The ten left, plus nine, nineteen.
6. S: So if the pattern continues, how many pennies does Cecilia need for stage ten. Wait, what does it mean right here?
7. P: Ok, so this is stage three right? Nineteen, so
8. S: ten? Stage ten…
9. P: How many you think? Okay so…
10. S: If I multiply, six, I can take the one in the middle, since it says six, six times ten equals sixty, plus one we took off, sixty one
11. S: But why does it say this? It's a mistake?
12. P: Don't worry about it
13. S: Is there… is there a way to determine the number of pennies Cecilia needs for any stage? (Repeats). How, what does it mean?
14. P: Think about it
15. S: I still don't know what does determine? Wait
16. P: Determinar
17. S: Wait, is there a way to determine the number of pennies Cecilia needs for any stage
18. S: I didn't get it
19. P: Que dice?
20. S: That it says, is there a way to determine the number of pennies Cecilia needs for any stage
21. P: Ahorita lo acabas de hacer aquí. Cuantos ocupamos?

Rodriguez' use of linguistic capital

The Rodriguez parents' expansive languaging practices came at key moments during the assignment. For example, at lines 15 and 16, the parents' use of language switching to Spanish to translate a word allowed the learner to proceed to the next part of the task. Although simple at first glance, we would like to emphasize that translating the word "determine" into Spanish was a deliberate choice on behalf of the parents. By providing the word in Spanish, the child was given opportunities to use their linguistic capital to overcome language barriers and have an

understanding of what the mathematical task was asking. Using Spanish as a resource allowed the confusion to be clarified and the learner was able to proceed. This indicates that the parents knew about the value of language switching, and opted to use this tactic when needed.

Parents' role during moments of reproduction and reinvention

At lines 3-5, we see the learners' predispositions towards reproducing procedures, in this case addition and subtraction. The learner recognizes, according to the images, six more pennies are added per stage. Following that, he deduces adding the number six to each stage should give the answer to the number of pennies per stage. Even though the learner was able to reproduce addition procedures, he failed to recognize a consistent pattern or algorithm across the stages. This obstacle eventually halts progress on the task altogether, as the learner reads and rereads the prompts to try to find his way back toward making progress. This is an example of the limitations of reproductive actions in which students follow algorithms without having a conceptual understanding for why they work. In this instance, the student used the algorithm but was not able to recognize why it failed.

To move past these obstacles created by reproduction actions, the learner needs to deviate from established norms and reconsider the questions through a different perspective. This opens up space for reinvention actions, involving different languaging practices leading to sense-making. As seen in lines 20 and 21, the learner was unable to proceed through the part of the task asking the learner to generalize the pattern. His reproduction actions enabled him to predict the number of pennies per stage, yet insufficient to confirm a pattern or algorithm. Noticeably, the parents initiated a reinvention action by language switching and explaining how he could approach solving the problem. The need for language switching was indicative of a language barrier enhancing the difficulty for the learner to proceed through each question. The parents recognized this, and subsequently would language switch to Spanish to explain each prompt in a way they knew their child understood. Sometimes translating a word would suffice (lines 15-16), while other questions required a deeper explanation to yield the same result (lines 20-21).

Discussion and Conclusion

Through the excerpt shown above, we give a brief glimpse of language switching and how it was utilized by the Rodriguez parents in their facilitator roles, and how they tapped into their linguistic capital to facilitate their son's mathematical thinking. In doing so, the parents improved their ability to facilitate mathematical learning which led to an improved performance

on behalf of the student. These findings align with Yosso's (2005) community cultural wealth model, which disrupts the typical deficit lens through which multilingual Students of Color are viewed. When confronted with a particularly challenging problem, parents tap into their knowledge across languages in an effort to help their child succeed. Collaborative activities, as seen in family mathematics events, provide an excellent example of work that validates and leverages the entirety of students' linguistic capital. Although our findings are limited to an out of school context, the end goal of creating a more inclusive learning environment that allows for language switching is equally applicable in classrooms as well.

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References

Adler, J. B. (2006). *Teaching mathematics in multilingual classrooms* (Vol. 26). Springer Science & Business Media.

Civil, M., & Bernier, E. (2006). Exploring images of parental participation in mathematics education: Challenges and possibilities. *Mathematical Thinking and Learning*, *8*(3), 309–330.

Domínguez, H. (2011). Using what matters to students in bilingual mathematics problems. *Educational Studies in Mathematics*, *76*(3), 305–328.

Edmonds-Wathen, C., Owens, K., & Bino, V. (2019). Identifying vernacular language to use in mathematics teaching. *Language and Education*, *33*(1), 1-17.

Erath, K., Ingram, J., Moschkovich, J., & Prediger, S. (2021). Designing and enacting instruction that enhances language for mathematics learning: A review of the state of development and research. *ZDM–Mathematics Education*, 1-18.

Harper, F. K., Rosenberg, J. M., Comperry, S., Howell, K., & Womble, S. (2021). # Mathathome during the COVID-19 pandemic: Exploring and eimagining resources and social supports for parents. *Education Sciences*, *11*(2), 60.

Moschkovich, J. (2007). Using two languages when learning mathematics. *Educational studies in Mathematics*, *64*(2), 121–144.

Pinedo, A., Vossoughi, N., & Lewis Jr, N. A. (2021). Critical pedagogy and children's beneficial development. *Policy Insights from the Behavioral and Brain Sciences*, *8*(2), 183–191.

Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race ethnicity and education*, *8*(1), 69–91.

Willey, C., & Morales, H. (2020). Translanguaging to ensure Latinx mathematics learners thrive. In A. I. Sacristán, J. C. Cortés-Zavala, & P. M. Ruiz-Arias (Eds.), *Mathematics education across cultures: Proceedings of the 42nd meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, Mexico. Cinvestav / AMIUTEM / PME-NA.