Exploring the Mathematical Agency of a Multilingual Child With an Identified Learning Disability

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Abstract

In this article, I illustrate how one student, Carlos, who is an emergent bilingual with a learning disability, expresses his mathematical agency dynamically and fluidly in multiple languages throughout 12 teaching sessions centered on mathematical discussions. The findings of this study show how Carlos made sense of fraction word problems, felt empowered to engage in conversations with peers about his thinking, and took ownership of his strategies. Implications are offered for the math instruction of bilingual children identified with a learning disability.

Discussion And Reflection Enhancement (DARE) Pre-Reading Questions

1. In what ways would you adapt instruction to meet the needs of multilingual learners with identified learning disabilities?

2. How would you provide multilingual learners opportunities to take ownership of their mathematical ideas in your classroom?

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Carlos sat in the back of the room at a table in the corner six feet away from the rest of his peers during his fourth-grade math class. He faced his classmates and not the front of the room where the whiteboard was. Most of his peers were sitting in groups of two or three and were facing the board. At his table, he had a worksheet with mathematics problems. His worksheet had additional examples with solutions to some of the problems. As the teacher began to introduce the problems, Carlos began fidgeting with his pencil and then scribbling his answers without showing his work because he could solve these problems in his head.. The teacher then began showing the class how to solve for x, a missing supplementary angle. As the teacher demonstrated his [the teacher's] knowledge to his students, Carlos shouted the solution, "64." His peers and the teacher did not acknowledge his response. Soon Carlos stood up and went to sharpen his pencil even though his pencil seemed to have a sharp end.

Carlos was a Latinx student who had been identified with a learning disability (LD) and was classified as an English language learner (ELL) by the school district. In the vignette, I showcase an observation of Carlos's intentions to participate and demonstrate his abilities in a math lesson prior to this study. Carlos attempted to exert his agency by calling out a solution during the middle of instruction, his teacher and peers ignored him because he did not raise his hand to ask for permission to speak.

Research on mathematical agency with Latinx children has been a focus for many scholars (e.g., Gutstein, 2007; Martin, 2000, Sanchez-Suzuki Colegrove & Adair, 2014; Turner, Dominguez, Maldonado, & Empson, 2013). This literature explains the importance of children's agency and how it can greatly affect their mathematical learning (Boaler & Greeno, 2000; Cobb, Gresalfi, & Hodge, 2009). In contrast, much of the mathematics research on children with identified LD labels is usually related to student achievement (Lambert & Tan, 2017; Tan, Lambert, Padilla, & Wieman, 2018) and supports the use of direct instruction (Woodward, 2004). In intersecting the research of ELLs with identified LD labels, we find that there is an overrepresentation of Latinx children in LD in individual districts and states among the approximatly 9% of ELL students labeled with a disability in the United States (Artiles, 2013; Sullivan, 2011). Thus, it becomes critical to examine the experiences of Latinx dual-labeled children in special education. A few scholars like Lambert (2015) are beginning to focus on documenting the experiences of children with LD labels. In this work, she documented the mathematical experiences of two students with identified LD and found that when instruction focused on high stakes testing, children were "denied opportunities because of assumptions built on their labels" as needing "extra support" (Lambert, 2015, p. 15). Aligned with Lambert's work, this study offers an alternative to much of the LD mathematics research by focusing on the experiences of children with dual labels. I aim to address the gap in the literature by documenting the mathematical agency of Carlos when exposed to bilingual problem-solving discussions. I will unpack the following research question: In what ways does Carlos, a child with an identified learning disability, express mathematical agency when engaged in bilingual mathematical discussions?

Promoting Agency for a Marginalized Population

In general, the construct of *agency* is defined as the capacity to take action onto the world (Holland, Lachiotte, Skinner, & Cain, 1998). It is important to draw your attention to the idea that in every context, including mathematics education spaces, children are always exercising agency, taking or not taking action. In this study, I utilize Turner's (2012) construct of *critical mathematical agency*, where she defines as:

> student's capacity to (a) understand mathematics, (b) identify themselves as powerful mathematical thinkers, and (c) construct and use mathematics in personally and socially meaningful ways. (p. 55)

Specifically, I use this construct to identify the mathematical agency and agentic roles (Turner et al., 2013) exhibited by students with dual labels and to illustrate the ways in which they take actions during math discussions (Gresalfi, Martin, Hand, & Greeno, 2008). Particularly, I was interested in looking at instances where Carlos demonstrated agentive roles, such as seeing himself as a mathematician who had expertise, who could critique others' ideas, or could explain or justify his mathematical thinking.

Context

This study is a subset of a larger study, which involved Carlos and two other upper grades Latinx bilingual children, from an elementary school located in an urban city in the southern United States. Carlos was selected based on his identification as a Latino, who had ELL with LD labels, and who also had prior exposure to an *I do, we do, you do* mathematics instruction model (Harry & Klingner, 2014). Carlos was a charismatic child who was not afraid to be honest. I selected Carlos among the three participating children in the study due to his mathematical identity transformation during the context of bilingual problem-solving discussions. He shifted his view of himself as someone who was not a math person to someone who was capable of understanding math.

Data collection occurred during 12 50-minute instructional sessions over seven consecutive weeks. Sessions occurred during additional math instruction in a conference room equipped with manipulatives such as Unifix® cubes. The sessions were planned by the author and a research assistant using a teaching experiment methodology (Cobb, 2000). Base-ten and fractional tasks (Carpenter, Fennema, Franke, Levi & Empson, 2015) were used to help children make sense of their thinking.

Children's roles, including Carlos's role, were to attempt to solve problems in whatever ways made sense to them, to communicate verbally in any language they were comfortable, and to ask questions. As the teacher-researcher, I presented children with story problems, encouraged the use of prior knowledge and children's cultural background to facilitate discussions that promoted agency. I wrote word problems in English and Spanish, and the children and I used language flexibly (Garcia & Kleifgen, 2010; Planas & Civil, 2013) to help in making sense of and communicating ideas. I designed teaching to ensure that children were making sense of the word problems (e.g., Martin, what does the 11 represent in this story problem?; Jacobs and Empson, 2016). When appropriate, I also assigned competence to children's ideas by allowing children to share complete and incomplete ideas in multiple ways (Gresalfi, Martin, Hand, & Greeno, 2009). For example, I encouraged children to share or critique the ideas of others and to communicate these ideas using gestures, drawings, objects, or words. In facilitating children's power to enact choice and take actions that encouraged ownership and competence, I made several attempts to position children as *experts* (e.g., Jorge, can you tell us why María's strategy is valid?) and as *evaluators* (e.g., Martin, so you are saying you disagree with Jorge's ideas? Could you explain why you disagree?) of mathematical ideas (Turner et al., 2013).

A research assistant and I conducted ongoing analysis before and after each session and uncovered ways in which Carlos exhibited agency and shared his math thinking (Simon et al., 2010). Using the MAXQDA software, we identified 64 video episodes as coherent interactions around a single math strategy. Video episodes were transcribed and then analyzed for patterns of Carlos's mathematical agency, drawing on the literature on children's agentic roles (Turner et al., 2013). Video episodes were categorized by agentic roles, which included children seeing themselves as mathematicians who had expertise, who could critique others' ideas, or who engaged in actions to explain or justify their mathematical thinking. I selected examples of mathematical agency that showed gradual changes in degrees of sense making and ownership that allowed Carlos to identify as a mathematical thinker who had contributing mathematical ideas.

Carlos's Mathematical Agency

In this section, I illustrate three examples that depict Carlos's mathematical agency. Each expresses his degrees of ownership of his ideas, his convincing others of his reasoning, and his risk-taking to share newly developed mathematical strategies.

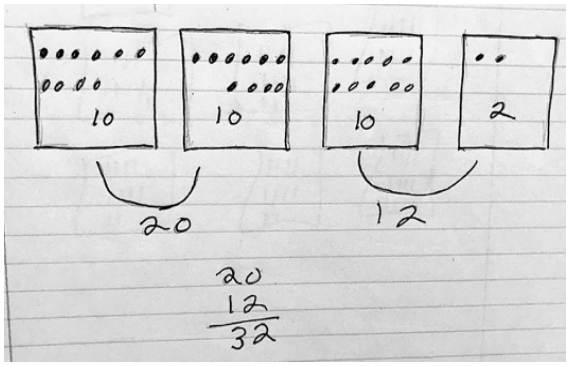
Carlos's Initial Math Agency

In initial sessions, Carlos would solve problems with standard algorithms, with no connections to the problem's story context. Carlos would say statements like, "I don't know," when asked to explain his thinking. At times, I would press for explanations (e.g., Why did you add 12 and 4 together?), and he would simply shrug his shoulders. Carlos resisted explaining his solutions and took little ownership of his ideas.

Changes in Carlos's sense-making began to occur in the third session when he began to solve problems using robust strategies. During this session, I provided a measurement division problem, where the total consisted of 32 toys, and the groups consisted of 10-toy bins. I wanted to know how many bins he could fill. In this interaction, Carlos began to make sense of his strategies, but Carlos hesitated in sharing his thinking. I considered that Carlos maybe needed some form of encouragement to share his thinking. Figure 1 shows how Carlos began to share his strategy.

Figure 1

Carlos's Strategy for 32 Toys in 10-Toy Bins



In addition to Figure 1, the following exchange occurred in English and Spanish, with language transitions between Spanish and English occurring flexibly in the same phrase or sentence. Spanish sections are translated into English and appear in parentheses.

Teacher: Ooh this is interesting! ¿Este es un poco diferente a la estrategia de el? (*This is different than his strategy?*) [Teacher points to Martin's strategy.] ¿Me puedes decir como hiciste tu estrategia? (*Could you explain how you did your strategy?*)

Carlos: I did, ten, ten, ten, two. I added twenty and twelve and then I added them up and got thirty-two.

Teacher: You did ten, ten, ten, and two. And what does the twenty and the twelve represent?

Carlos: Juguetes. (*Toys*.)

Teacher: Juguetes, ¿y porque hiciste el veinte y el doce juntos? (*Toys, and why did you do twenty and twelve together?*)

Carlos: I added them up.

Carlos had clearly made sense of the story problem by making groups of 10 dots inside each of his bins, and he then added two groups of 10 and one group of 10 with two to check that he had a total of 32 toys. However, he struggled in explaining his thinking. It was not until I stated in Spanish "This is different than [Martin's] strategy. Could you explain how you did your strategy?" that Carlos began to share the details of his strategy. In this instance, and many others, I made the decision to use English and Spanish flexibly, sometimes repeating what children said in Spanish or posing new questions in English to provide Carlos and his peers with opportunities to express their ideas in any way.

This excerpt described how Carlos took an agentic role as an "explainer" of thinking, as he began to explain the mathematical reasoning in his solution. Carlos was beginning to take ownership of mathematical ideas. In this example, Carlos began to see his ideas as valid mathematical strategies.

Carlos's Final Math Agency: Justifying and Taking Risks

As the sessions progressed, Carlos not only became comfortable sharing his mathematical thinking with others, but he also began to justify his thinking with others. For example, in session eight, Carlos began to engage in conversations with Martin, his peer, about his strategy when solving an equal sharing problem about eight chocolate bars and three children. In this exchange of ideas between the boys, Carlos tried to convince Martin of his strategy to cut the leftovers into three parts:

Carlos: No es dos. (It is not going to be two.) [Carlos shakes his head and points to Martin's two leftovers on his page.]

Carlos: [Martin looks at Carlos.] They all have to be in half. [Carlos is referring to the leftovers needing to be partitioned.]

Martin: Two are going to be left over.
Carlos: Yeah two leftovers, the two left over you can do, three, one, [Carlos points in the air and makes imaginary partition lines] and the other one too… Mira (look). [Carlos shows Martin his notebook where he has drawn two leftovers partitioned into three parts.]
Martin: [Smiles and nods.] Oh. [Martin then begins to make three partitions in his two leftovers.]

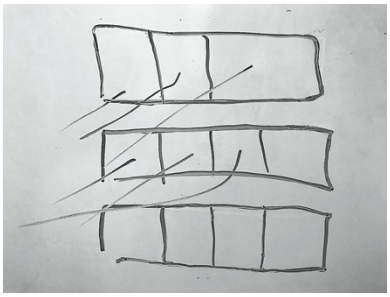
Carlos first initiated the conversation by questioning Martin's final answer of six chocolate bars and two leftovers. At first, Martin seemed confident about his answer of six chocolate bars with two leftovers. Carlos's questioning did not seem to discourage Martin from keeping his solution, so Carlos took it upon himself to justify the details of his solution to Martin, where he began to show the two leftovers cut into three pieces. After noticing the threes inside the leftover chocolate bars, Martin began to draw the leftovers and cut each into three parts as Carlos had done.

In this episode, Carlos believed that he had a valid strategy. Carlos justified his solution to Martin by gesturing the partitions in each of the leftovers and used language flexibly, such as using "Mira," meaning "look," to illustrate his thinking. Carlos's agentive role as a "convincer" was evident here, as he took complete ownership of his ideas in that he believed he was right. He then succeeded in helping convince Martin that his ideas were correct. Carlos exhibited mathematical agency as he actively persisted in convincing his peer, despite his peer's initial disagreement with his solution. He viewed his mathematical ideas as competent.

Towards the end of the sessions, Carlos had many opportunities to defend his reasoning and critically analyze his peers' reasoning. But in session 11, Carlos made a significant change in the way he expressed agency. In this example, Carlos, decided for the first time to solve a new problem in front of his peers without first solving it on his own (see Figure 2). The following excerpt describes a moment in which I decided to introduce this new problem (three candy bars shared among 4 people) to all three children and, to my surprise, Carlos took the lead.

Teacher: Si tengo tres barras de dulce [Teacher draws three rectangles on the board] y tengo cuatro personas. (If I have three candy bars and I have four people.) [Teacher draws four smiley faces.]
Carlos: Naah eso es fácil! (That is easy!)
Teacher: ¿Como los vas a compartir? (How would you share those candy bars?)
Carlos: [Carlos gets up from his seat, approaches the board, and grabs the marker from teacher.] Like this, look… [Carlos begins partitioning each of the three bars in half. Then he tries to make four pieces in each bar but forgets to partition one of the bars into four pieces, does three instead.]
Teacher: What did Carlos do? [Teacher directs question to the group.]
Carlos: I split them up into four.

Figure 2
Carlos's Strategy of Three Candy Bars Shared with Four People



Carlos began to take risks sharing his ideas about his peers' strategies and posing mathematical arguments as the sessions progressed.

Overall, Carlos gained a sense of pride in his ideas and his methods for solving problems. He no longer relied on the teacher to explain his strategies, so much that he took a risk in explaining his unfinished strategies to the group. In this instance, he showed his peers he was not afraid to tackle a new problem and solve it in front of them despite making small mistakes in the process. Carlos gained ownership of his mathematical thinking and showed how his mathematical agency transformed from resistance to participation in moving from explaining his thinking to justifying and convincing his peers of his ideas, to taking risks in exposing his initial unfinished mathematical strategies.

Implications and Final Thoughts

I sought to investigate the mathematical agency Carlos exhibited when instruction focused on the use of teaching moves that allowed choice and placed competence onto a

child's thinking (Turner et al., 2013; Gresalfi, Martin, Hand, & Greeno, 2009). The findings of this study revealed that Carlos made sense of word problems, took ownership, engaged in conversations about his mathematical thinking, and, ultimately, felt empowered to co-construct mathematical ideas with peers. Carlos shifted from non-explanations of solutions to taking risks in sharing unfinished mathematical ideas. The flexibility to use language dynamically in the environment provided opportunities for Carlos to voice his thinking and engage in conversations with his peers that allowed him to engage in mathematical sense making and move towards higher degrees of mathematical agency.

This study offers an alternative to most of the research in special education that supports direct instruction (Woodward, 2004). This study focuses on instruction that gives a marginalized group of children opportunities to share, explain, and solve problems in English or Spanish. I believe some of the examples provided here give monolingual teachers a few ideas about how to promote the agency of a child with identified labels. For example, teachers could position children as experts or evaluators despite not knowing the native language of the child. Monolingual teachers could encourage multilingual children to discuss, critique, and justify their mathematical ideas with others in the classroom.

If the aim of research and practice is to provide equity for all, future studies in special education and mathematics should begin to integrate mathematical practices that promote choices for dual labeled multilingual children to use their native language flexibly whether teaching is by monolingual or bilingual teachers who do not know the language of the child, to work in small groups or individually, and to have opportunities to share their thinking with peers during instruction. Teachers could begin exploring different resources like Google Translate or someone who does know the languge to support the multilingual child during mathematics instruction. Also, future studies should explore how different forms of teacher moves could encourage children to participate and share their thinking with peers who do not speak the same language.

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Discussion And Reflection Enhancement (DARE) Post-Reading Questions

1. How would you use Carlos' story to reflect upon and analyze your teaching practice for multilingual learners with learning disability labels? Is it any different from your current teaching practice for all learners? If so why?

2. In what additional ways can you reflect on your teaching practice to leverage multilingual learners' with identified learning disability labels ways of expressing mathematical agency?

3. How else could learners express mathematical agency?