Article

"Fake It Until You Make It": Participation and Positioning of a Bilingual Latina Student in Mathematics and Computing

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Abstract

Background/Context: After-school programs that focus on integrating computer programming and mathematics in authentic environments are seldomly accessible to students from culturally and linguistically diverse backgrounds, particularly bilingual Latina students in rural contexts. Providing a context that broadens Latina students' participation in mathematics and computer programming requires educators to carefully examine how verbal and nonverbal language is used to interact and to position students as they learn new concepts in middle school. This is also an important stage for adolescents because they are likely to make decisions about their future careers in STEM. Having access to discourse and teaching practices that invite students to participate in mathematics and computer programming affords them opportunities to engage with these fields.

Purpose/Focus of Study: This case study analyzes how small-group interactions mediated the positionings of Cindy, a bilingual Latina, as she learned binary numbers in an after-school program that integrated computer programming and mathematics (CPM).

Setting: The Advancing Out-of-School Learning in Mathematics and Engineering (AOLME) program was held in a rural bilingual (Spanish and English) middle school in the Southwest. The after-school program was designed to provide experiences for primarily Latinx students to learn how to integrate mathematics with computer programming using Raspberry Pi and Python as a platform. Our case study explores

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how Cindy was positioned as she interacted with two undergraduate engineering students who served as facilitators while learning binary numbers with a group of three middle school students.

Research Design: This single intrinsic case focused on exploring how small-group interactions among four students mediated Cindy's positionings as she learned binary numbers through her participation in AOLME. Data sources included twelve 90-minute video sessions and Cindy's journal and curriculum binder. Video logs were created, and transcripts were coded to describe verbal and nonverbal interactions among the facilitators and Cindy. Analysis of select episodes was conducted using systemic functional linguistics (SFL), specifically language modality, to identify how positioning took place. These episodes and positioning analysis describe how Cindy, with others, navigated the process of learning binary numbers under the stereotype that female students are not as good at mathematics as male students.

Findings: From our analysis, three themes that emerged from the data portray Cindy's experiences learning binary numbers. The major themes are: (1) Cindy's struggle to reveal her understanding of binary numbers in a competitive context, (2) Cindy's use of "fake it until you make it" to hide her cognitive dissonance, and (3) the use of Spanish and peers' support to resolve Cindy's understanding of binary numbers. The positioning patterns observed help us learn how, when Cindy's bilingualism was viewed and promoted as an asset, this social context worked as a generative axis that addressed the challenges of learning binary numbers. The contrasting episodes highlight the facilitators' productive teaching strategies and relations that nurtured Cindy's social and intellectual participation in CPM.

Conclusions/Recommendations: Cindy's case demonstrates how the facilitator's teaching, and participants' interactions and discourse practices contributed to her qualitatively different positionings while she learned binary numbers, and how she persevered in this process. Analysis of communication acts supported our understanding of how Cindy's positionings underpinned the discourse; how the facilitators' and students' discourse formed, shaped, or shifted Cindy's positioning; and how discourse was larger than gender storylines that went beyond classroom interactions. Cindy's case reveals the danger of placing students in "struggle" instead of a "productive struggle." The findings illustrated that when Cindy was placed in struggle when confronting responding moves by the facilitator, her "safe" reaction was hiding and avoiding. In contrast, we also learned about the importance of empathetic, nurturing supporting responses that encourage students' productive struggle to do better. We invite instructors to notice students' hiding or avoiding and consider Cindy's case. Furthermore, we recommend that teachers notice their choice of language because this is important in terms of positioning students. We also highlight Cindy's agency as she chose to take up her friend's suggestion to "fake it" rather than give up.

Keywords

bilingual Latina middle school student, positionings, computer programming and mathematics teaching practices, afterschool program, systemic functional linguistics

Research in the United States suggests that middle school students, especially students from underrepresented groups, often do not have access to experiences in and knowledge of engineering (McFarland et al., 2017; Wang et al., 2016). As documented in *2021 State of Computer Science Education* (Code.org et al., 2021), computer science is less likely to be taught in schools classified as Title I (which include higher percentages of students receiving free or reduced lunch), schools with underrepresented minority students, and schools in rural communities.

To encourage broader participation in science, technology, engineering, and mathematics (STEM), there is a strong need to expose students to STEM practices, such as computer programming, and provide them with accurate information about STEM careers. The exposure to STEM practices may help them make more knowledgeable choices about courses of study and career paths at the middle school level, when they are more likely to make a long-term decision about their future (Wyss et al., 2012). A major component of broadening participation for middle school students in STEM includes examining and understanding their personal experiences with learning in different contexts.

In this article, our purpose is to analyze how group interactions between students and facilitator(s) mediated Cindy's[1] (a bilingual middle school Latina student) positions as she learned binary numbers in the context of a mathematics and computer programming after-school program. The article describes Cindy's resilience and agency. Even though she was positioned by her facilitator as someone who did not understand the material, she endured the process by choosing "fake it until you make it" as a way to not let herself go, and instead take "responsibility for [her] own learning" (Furlong & Christenson, 2008, p. 365). Our goal is to answer the following research questions: (1) What were the positions that Cindy took up as a student in the program? (2) How was language used to position Cindy? (3) Which positionings best supported Cindy's learning of mathematics and computer programming?

Conceptual Framework

We drew from *positioning theory* (Davies & Harré, 1990) to examine the different positionings that Cindy took up as she interacted with her peers and facilitators in an after-school program. Furthermore, we used systemic functional linguistics (SFL) (Halliday, 1978), *a discourse analytic approach* (de Oliveira, 2021), as a tool to analyze how language was used to position Cindy as a student in this context, as discussed in the next section.

Positioning Theory

As expressed in Halliday and Matthiessen (2004), language influences positioning. Davies and Harré (1999) stated that the act of positioning is produced in discourse. Similarly, Hollway wrote that "discourses make available positions for subjects to take up" (as cited in Van Langenhove & Harré, 1999, p. 16). In the context of our study, positioning serves as a framework that informs how the discursive nature of identity is

closely connected to who holds knowledge and power, because these impact most interactions (Dennen, 2011). Regarding interactions, Chval et al. (2021) stated, "Teachers have a pivotal responsibility to productively position multilingual learners" (p. 13). Because of the *asymmetric distribution of knowledge and power* in the classroom (Gibbons, 2006), with teachers having more power, educators constantly position students. "It is a matter not of *if* a teacher positions, but of *how* the teacher positions" (Chval et al., 2021, p. 13). Thus, how teachers position students and how students position each other further affect how those students will be seen and categorized by their peers (Chval et al., 2021).

The important triad in positioning theory is storylines, positions, and speech acts. Storyline is a life scenario that forms episodes of human relationships. Within storylines, people are metaphorically positioned or have a position, which refers to one's "moral and personal attributes as a speaker" (Harré & Van Langenhove, 1991, p. 395). Speech acts are the speaker's intentions encoded in the utterances. Moreover, drawing from Herbel-Eisenmann et al. (2015), we appropriate their use of *communication acts*, which helps us to contextualize positionings by adding intonation, gestures, and physical location to speech itself. We used these meaningful positioning theory components to analyze interactions in mathematics and computer programming.

Systemic Functional Linguistics

To analyze participants' communication acts, we used systemic functional linguistics (SFL), a meaning-based theory of language "used throughout the world as a discourse analytic approach, and more recently, as a pedagogical framework" (de Oliveira, 2021, p. 181). SFL considers language as a meaning-making system (Halliday & Matthiessen, 2004) that can be used to analyze how language shapes positioning. Schleppegrell (2012) suggested SFL to analyze students' and teachers' positionings in the classroom based on the premise that "language is a powerful means of construing our social reality and of enacting social relationships" (p. 110). As Chval et al. (2021) stated, "What we don't say or don't do can be just as powerful as overt messages" (p. 21). SFL can be used as an important tool to analyze how positioning is enacted through speech acts in interactions. One of the basic speech function pairs to analyze oral interactions is initiation and response. For example, in classroom interactions, teacher responding moves are important from the viewpoint of how they influence student participation and positioning. According to Eggins (1994), "Responding can be broadly differentiated into two types: a supporting type of responding move, versus a confronting type" (p. 145). A supporting move expresses acceptance, compliance, and acknowledgment. On the other hand, a confronting move indicates rejection, refusal, contradiction, and disclaimer (Eggins, 1994). When using confronting moves, the teacher can *sequentially delete* the student's utterance by devaluing, ignoring, or constructing the student's response *as nonexistent* (Rymes, 2009).

Another important linguistic resource to analyze in interactions is modality, with which participants express their "attitudes and judgements of various kinds" (Eggins,

1994, p. 179). More specifically, to explore modality, it is important to trace how modalization takes place. Unlike yes and no responses, modalization expresses "a number of choices of degree of certainty, or usuality" (p. 179). When modality is used to argue about the obligation or inclination, it is referred to as modulation. In the context of power relations in the classroom interaction, mood adjuncts, especially expressions of intensification or minimization (such as "really," "absolutely," "just," and "somewhat"), can strongly affect the creation of meaning of intensity and counter-expectancy (Eggins, 1994) to augment, diminish, or take out a person's agency (Rymes, 2009).

Methods

Overview of the Project and Curriculum

In 2011, three faculty (Drs. Celedón-Pattichis, Pattichis, and LópezLeiva) from the Department of Language, Literacy, and Sociocultural Studies and the Department of Electrical and Computer Engineering developed an integrated curriculum in mathematics and computer programming (Celedón-Pattichis et al., 2013). The curriculum was implemented with primarily bilingual (Spanish/English) middle school students through an after-school program.

The program had two curriculum levels. Level 1, where Cindy, our focal student, was learning binary numbers, focused on foundations of computer programming using image and video representations and was typically taught in the spring through twelve 90-minute sessions. Binary numbers were a critical component of Level 1 as they relate to understanding how black and white (as well as color) images are generated using pixels. To facilitate understanding of binary numbers, facilitators drew from students' prior knowledge of base 10 by introducing base 2 using base 10 concepts. Facilitators also used base 10 blocks and Cuisenaire Rods, as well as base 10 and base 2 tables to support student learning of these concepts.

Students chose the group they worked with (ideally three other students) and the facilitator for their group. The facilitators were mostly engineering undergraduate or graduate students. The professional development for the facilitators focused on learning the curriculum and pedagogical strategies to teach middle school students and was offered to the facilitators before they worked with the participants in the spring and the summer.

Site, Participants, and Research Design

Cindy, a sixth grader, attended a rural bilingual middle school in the Southwest that enrolled 359 students, 92% of whom were predominantly Latinx. Being in a middle school and studying within a bilingual pathway (optional to students) meant that mathematics was taught in Spanish in sixth and eighth grades and in English in seventh grade. All students were on free or reduced lunch, indicating the low socioeconomic status of this student population. The English learner student population in the district was 16.4% (APS Dashboard, 2022).

This single intrinsic case with an embedded unit (Yin, 2017) focuses on a group of four middle school students working with Cindy and learning binary numbers. Two of Cindy's peers were monolingual, speaking either only English or only Spanish, and one was bilingual (Spanish and English). According to the results of a self-reported questionnaire, all self-identified as female. All of them worked at different times with three facilitators: two engineering undergraduate students, Katy and Wynter, the latter being bilingual, and one engineering faculty member. Katy started with the group and, when she left the program for another job, Wynter took her place. We chose this particular case because we noticed how Cindy, a bilingual Latina student who became a cofacilitator later in the program (see LópezLeiva et al., 2022, in this special issue to learn more about cofacilitators), struggled in this group when learning binary numbers. As part of her social background, Cindy brought many intersections of her identity: female, Latina, bilingual, immigrant, and student. She was experiencing the process of learning mathematics and computer programming from these perspectives. We noticed the relevance of the social context in her learning and her positioning. Thus, we decided to focus on the group interactions mediating Cindy's positioning and learning, tracing the challenges and resolutions of learning binary numbers.

Data Collection

During the implementation of the project in Years 1–3, student learning was assessed through the use of digital video recordings of small-group (students and facilitator) interactions, video recording of computer screen, student work (e.g., journals, source code, and final projects), facilitators' field notes, interviews, and attitude scales. For the purposes of this article, we drew from the spring 2017 video data and Cindy's journal and curriculum binder.

Data Analysis Methods

To analyze how positioning happened in the group interactions, we used positioning theory to identify positioning episodes. Later on, we used SFL in these episodes, focusing on the language used in positioning. Specifically, by focusing on language modality (i.e., modalization, intensification, minimization) and the facilitators' responding moves (i.e., supporting or confronting), the authors explored how linguistic tools mediated Cindy's positioning.

First, we observed twelve 90-minute videos and created video logs describing interactions; we partially transcribed the videos, highlighting keywords and developing codes. Second, we checked transcripts for accuracy with verbal and nonverbal interactions based on undergraduate bilingual students' verbatim transcriptions of the videos. Nonverbal interactions, such as pauses, emotions expressed by vocalizations, and gestures were included in the transcripts. Third, we selected particular events in which participants used supporting or confronting responding moves directly related to learning binary numbers. Next, selected episodes were analyzed through SFL, specifically

language modality, to identify how positioning took place. From our analysis, three major themes emerged: (1) Cindy's struggle to reveal her understanding of binary numbers in a competitive context, (2) Cindy's use of "fake it until you make it" to hide her cognitive dissonance, and (3) use of Spanish and peers' support to resolve Cindy's understanding of binary numbers.

Findings

Cindy's Struggle to Reveal Her Understanding of Binary Numbers in a Competitive Context

This episode introduces Cindy's cognitive dissonance and her unfamiliarity with binary numbers, accompanied by a competitive context of refuting the gender stereotype that boys perform better than girls in computer programming (Starr & Simpkins, 2021). Cindy and Carmen, her peer, wanted to outperform a group of boys, whose facilitator was a young college student, Arthur. The competitive context was set by having at play the competition between the boys and the girls. This social context played out in the after-school program as different groups were created with girls or boys, as seen in Excerpt 1.

Excerpt 1

1 Arthur: You guys are moving too fast, slow down.

2 Cindy (shaking her body as if imitating or mocking Arthur): "I thought girls were so slow?"

3 Arthur: I never said that. Usually girls are faster, smarter, quicker at thinking things, quicker at reading, math, science.

4 Carmen: Better at life.

After the implicit gender competition was set, Cindy and Carmen were concerned about their group's performance. Simultaneously, Cindy voiced her challenge repeatedly in understanding binary numbers as Katy quickly presented the conversion to binary, without going through the steps, as illustrated in Excerpt 2.

Excerpt 2

1 Katy (Katy speaks quickly and writes on the whiteboard. She places the whiteboard on the

2 table in front of her although Cindy cannot see her writing.): So we have the numbers

2^5 (2x2x2x2x2=32)	2^4 (2x2x2x2=16)	2^3 (2x2x2=8)	2^2 (2x2=4)	2^1 (2x1=2)	2^0 (2÷2=1)	Binary Number	Equivalent Decimal

Figure 1a. Table to Facilitate Understanding of Binary Numbers.

1 0

2^1 2^0

2 + 1 [None because there is 0 above, although this is not explicitly stated and students do not add the 1.]

Figure 1b. Recreating Katy's Quick Conversion on Whiteboard.

3 one and zero. (Writes on the board) This is two to the zero and this is two to the one. So

4 remember what we did before? It's two to the one is two, plus two to the

5 zero is one and there's none there so it's zero so equals two.

6 Cindy (confused): What?

7 Katy (reproachfully): It's what we just did!

8 Cindy (surprisingly): Where did you get the two from?

9 (Carmen laughs).

10 Katy (without pointing to the whiteboard): From right here.

11 Cindy (lamentably): And where did you get the two from there?

In Lines 2–5, Katy presents the elements of binary numbers without reviewing the conversion process. Figure 1a shows a table the students used to support their understanding of converting from decimal to binary numbers, and Figure 1b shows a recreation of Katy's quick conversion from a binary number (base 2) to a decimal number (base 10) for 1 0.

The challenge Cindy was facing was that she could not understand how to convert binary numbers into decimals, as evidenced by her questions (Lines 6, 8 and 11).

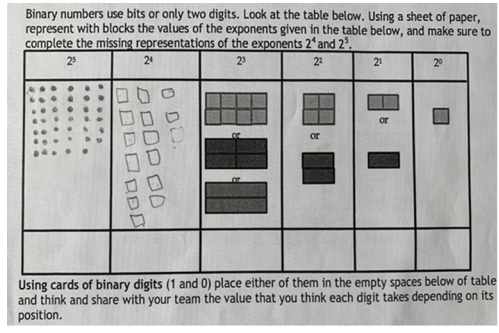

Figure 2a. Cindy's Representation of 2^4 and 2^5.

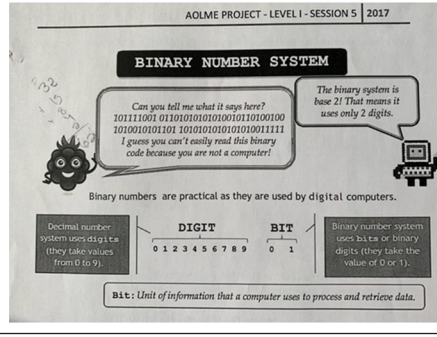

Figure 2b. Calculation for 1 1 1 1 1 0.

Cindy could not understand Katy's reasoning, as shown by Cindy's *question for explanation* (Line 6) (Dalton-Puffer, 2007).

Instead of creating a space for elaboration and discussion, Katy sequentially deleted Cindy's question by saying "*It's what we just did!*" (Line 7). Thus, Katy's communication act confronted Cindy and positioned her in a way that essentially dismissed her question. Moreover, it positioned Cindy as a student who was not paying attention and was not following the discussion of binary numbers. Katy did not provide a full explanation to Cindy's question, "*Where did you get the two from?*" (Line 8) either. Instead of providing a detailed explanation, Katy responded briefly, in the form of an elliptical clause: "*From right here*" (Line 10). This explanation was not enough for Cindy to understand the material, which was indexed by Cindy's third question for explanation in this interaction: "*And where did you get the two from there?*" (Line 11). Cindy positioned herself as a learner who *wants to understand*, constructing her own personal agency in this interaction. However, Cindy's consistent attempts to raise questions to negotiate meaning were not welcomed by the facilitator.

In addition to Cindy's cognitive dissonance described in Excerpt 2, we provide a sample of Cindy's work from the curriculum binder (see Figure 2a) to illustrate how Cindy's understanding related to the task of completing the missing representations for 2^4 and 2^5.

We noticed that Cindy included the correct representation of 16 squares for 2^4. However, Cindy may have erased one square, after she heard Katy mention 15, to reflect the facilitator's thinking. Cindy drew 41 dots instead of 32 to represent 2^5. The facilitator then posed for the group the task of converting 1 1 1 1 1 0 from a binary to a decimal number represented as a whole number. In the left upper corner of her binder (see Figure 2b), Cindy wrote the following: 32 (33 erased and corrected to 32) +15 (instead of 16) + 8 + 4 + 2 = 62 (64 corrected into 62) for the decimal conversion of 1 1 1 1 1 0. This evidence from her binder is used to illustrate Cindy's cognitive dissonance in her journey of learning binary numbers.

Excerpt 3 demonstrates how Cindy persists in voicing her need to clarify her thinking and understanding of binary numbers based on Katy's explanation.

Excerpt 3

1 Katy: Yeah. So that's where the two came from. Get it?

2 (Everyone laughs. Cindy denies with her head.)

3 Katy (disappointingly): Really?

4 Cindy: I don't get it. . .

Nevertheless, Katy decided to address Cindy's challenge by working on the session until Cindy understood how to convert decimals into binary numbers. Our assumption was based on Katy's choice of language: declaratives with modal verbs "will" and "can't" (e.g., "*Okay, we'**ll** do more of the ones that we were just doing*," "*We'**ll** do this all day until you get it*," "We **can't** move on until all of you know it"). Katy's utterances expressed certain degrees of obligation and inclination. The median obligation encoded in the modal expression "*we'll do*" in the first utterance was attenuated by the use of "*okay*," creating a communication act of invitation to collaborate and a promise to succeed. The message, "*We'll do this all day until you get it*," sounded categorical, performing a communication act of warning, and positioning Cindy as a student who needed more input. The use of a strong modal verb "*can*" in the negative form ("*we can't move on until all of you know it*") projected Katy's conviction and determination to address Cindy's challenge in understanding binary numbers. Katy's brief reaction, *"Really?,"* to Cindy's nonverbal response (denial with her head) sounded disappointed, adding to Katy's sense of frustration with Cindy's performance. This particular example also signaled an increasing tension between the two participants: "*You say you don't understand, when I explain it, you don't pay attention!*" In the absence of the

desired results, Katy acted as if "the students, not the techniques, are found to be lacking" (Ladson-Billings, 1998, p. 19).

In summary, in Excerpts 2 and 3, Cindy's acts illustrate how she tried to position herself as a student seeking to understand binary numbers when she encountered cognitive dissonance. These excerpts also illustrate how the facilitator's confronting acts positioned Cindy as a student who did not know how to problem solve in mathematics.

Cindy's Use of Fake it Until You Make it to Hide Her Cognitive Dissonance

Seeing that the group's pace was slowed by Cindy's challenges and her perseverance to understand binary numbers on the one hand, and Katy's determination to address Cindy's challenge, on the other, Carmen suggested to Cindy, "*Just say you understand it and fake it until you make it*." This tactic required Cindy to simulate the mathematical operation of converting decimals into binary by guessing the numbers instead of performing mathematical operations. Katy may have viewed guessing numbers as a bad mathematical practice; therefore, Katy criticized Cindy's *faking* practice as unacceptable, as illustrated in Excerpt 4.

Excerpt 4

1 Katy: What if you have one, zero, one?

2 Cindy: Eight. Six.

3 Katy: You can't, you can't just guess!

4 Cindy: Uhm. . . Nine.

Gradually, Cindy's individual agency of a student who persevered and voiced her challenge, (e.g., "*I don't get it though*") shifted to the level where she avoided openly expressing her misunderstanding of binary numbers. She either did not respond to questions about her performance, made random guesses as answers to the mathematical tasks, or asserted to Katy that she knew the content. At this stage, Cindy started avoiding responding to any questions about her performance (e.g., *Marina: (to Cindy) You still don't understand it? [Cindy looks at Marina, smiles but does not respond]*).

Excerpt 5 illustrates how Cindy, with a different facilitator, publicly announced that she had *to fake it.* After Katy left the program to begin a new job, Wynter began working with Cindy's group. By attending to students' understanding and using both languages, Wynter's questioning established a relationship with students, facilitating

Cindy's willingness to share the fact that she was hiding her lack of understanding of binary numbers.

Excerpt 5

1 Wynter: What did you guys learn today?

2 Carmen: We learned about binary numbers.

3 Cindy (chuckling and making an abrupt clap with her hand): I just had to fake it. (Putting her head on the table and covering it with her hands.)

4 Carmen: Fake it until you make it.

Through the communication act of confession (Line 3), Cindy positioned herself as the one who *just had to fake it*. The verb "have to" with modal meaning was important in Cindy's self-positioning. Modulated through high obligation, "have to" conveys a sense of external obligation and creates the meaning that Cindy *was obliged* to act in this way, perhaps against her will. Her gestures (Lines 3 and 4), accompanying her words, added a sense of frustration and disappointment with herself. We understand from the context that in reaction to confronting responses and powerless positioning, Cindy felt compelled to act in a faking manner toward Katy.

While the students interacted with Wynter, it became clear that Cindy was not only compelled *to fake* but was also *the only one who did not understand the material*. Everyone in the group except Cindy answered positively to Wynter's question "¿*Ustedes lo entienden? (Do you guys understand it?*)." Cindy responded by denying with her head. When Wynter asked the next question, "*Are you the only one* [who didn't understand],*?*" Cindy nodded affirmatively, remaining again nonverbal.

By asking a question, "Are you the only one?," Wynter enacted Cindy's positioning as *the one who did not master the material*. Grammatically, *only* functions as an epithet that construes the meaning of intensity and expresses limitation (Halliday & Matthiessen, 2004). The use of the adjective *only* reinforces and accentuates the idea of Cindy's "oneness," thus positioning Cindy as a student who needs more explanation. Cindy said nothing to refute such positionings, thus tacitly conceding and accepting them. In the next section, we present an episode that brings resolution to Cindy's challenge of understanding binary numbers.

Use of Spanish and Peers' Support to Resolve Cindy's Understanding of Binary Numbers

The next episode describes how nurturing peers' and facilitators' interactions, empathetic to Cindy's current learning of binary numbers and use of Spanish, promoted a context that supported Cindy's understanding of binary numbers. Marina, Cindy's

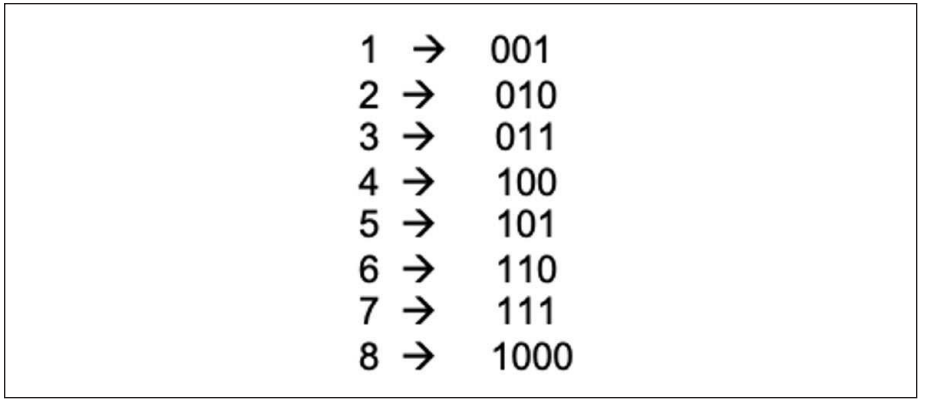

Figure 3. Conversion From Decimal to Binary.

Spanish-speaking peer, and Marios, a professor and a facilitator, interacted with Cindy to address her challenge of understanding binary numbers.

Perhaps encouraged by Katy's directive, "*So, I'm not a middle schooler, so why don't you guys try to teach Cindy how to do it?*," Marina initiated her own role as Cindy's "tutor." To explain the mathematical operation of converting decimals to binaries, Marina used Spanish, coupled with gestures to point at the whiteboard with her finger and placed it so that Cindy could see the board (italics represent a translation from Spanish): *And then, you put one below this one, it counts as 16, and then when you put it here below this one, it counts as 16, and then when you put it here in the one where you have 2 to the power of 2, it counts as 4. Do you understand?*

Marina's use of language is remarkable. She uses simple, repetitive sentence structures: *And then, you put one below this one, it counts as 16; and then when you put it here . . . it counts as 4*, which are understandable to her peer Cindy. In addition, Marina accompanied her explanations with visual representations on a whiteboard (the binary number conversion table), showing them to Cindy. Marina's use of Spanish, her unhurried manner of explaining with logical pauses, accompanied by the proper use of visual representations, supported Cindy's understanding of how to convert decimals into binaries.

Shortly after Cindy learned how to do decimal-binary operations, one of the authors, Marios, visited the group, "examining" students' performance. This episode is especially important in Cindy's repositioning as the dynamics of the interactions in the group and the storyline, where Cindy had *to fake*, changed. In an evolving storyline, Marios, who was unaware that Cindy had struggled understanding the binary system, came up to Cindy's group and checked students' understanding of converting decimal numbers from 1 to 8 into binaries. In doing so, Marios supported understanding of binary numbers by asking for a sequence of numbers, one by one, and highlighting the patterns of how 1s and 0s work (see Figure 3).

In Excerpt 6a, Marios began the interaction by inviting group members to count using binary numbers (e.g., "*Can you guys count in binary?"*). Contrary to Katy's directive communication act (*"What if you have one, zero, one?"*), Marios started his directive to the group as a request to help him count (e.g., *"Are you going to help me count?"*). This invitation opened opportunities for Cindy to make meaning of binary numbers as Marios used a whiteboard to pose the task of converting from decimal numbers to binary numbers and to write their responses.

Excerpt 6a

1 Marios: 0, 1, 0, right? How about 3?

2 Cindy: 0, 1, 1.

3 Marios: How about 4?

4 Cindy: 1, 0, 0.

5 Marios: Do you guys see it? I know she's saying the answer, but can you see it?

In this interaction, Cindy demonstrated successful performance providing three consecutive correct answers to Marios's tasks in presenting decimal numbers 2, 3, and 4 in binary. Adversative conjunction "but" connects the two clauses and expresses contrast between the two statements: *She's saying the answer* and *can you see it*? "But" divides the group into two entities: one entity, to which Cindy belongs, is the part that *is saying the answer*, and the second part is those whose performance is still under examination (*Can you see it?*). Marios positioned Cindy as a competent learner, since *she's saying the answer*, while the status of the others was not yet clear. To check others' performance, Marios asked Marina to convert 5 into binary, which Marina again successfully did. Marios gave the next task to Carmen, but she self-positioned as the one who *doesn't know*. Cindy initiated her participation and gave the correct solution to Carmen's task, reinforcing her previously established status of a competent student in the group. Carmen positioned herself as aligned with Cindy's answer of *1, 1, 0* by saying *"Yes. What she said."* This alignment positioned Cindy positively, since Carmen's statement demonstrated her acceptance of Cindy's answer, which was seen by Carmen as correct. Cindy and Carmen successfully solved Marios's final task, pronouncing the solution simultaneously.

The interactions in Excerpts 6a and 6b illustrate how Cindy and other group members successfully solved all the tasks that Marios posed, and their performance was enthusiastically acknowledged by Marios and Katy.

Excerpt 6b

1 Marios (enthusiastically): Yes. Okay, you can count.

2 Katy (to students, enthusiastically): Awesome! . . . .

3 Katy: So, do you guys think you get it?

4 Cindy (determined): Yeah. That's what I think.

Cindy's response to Katy's question in Line 4 is an important moment in her own repositioning. In this statement, modalization is explicitly realized through the use of the median modal phrase "I think," and, pronounced with determination, adds confidence to Cindy's statement. Cindy was aware that she was performing not just correctly, but at the same level as her peers and at one point even better than Carmen. Thus, Cindy positioned herself and was positioned by Marios, facilitator Katy, and her peer Carmen as a competent problem solver.

Discussion and Implications

We explored how the facilitator's teaching, participants' interactions, and discourse practices contributed to Cindy's qualitatively different positionings. We also investigated Cindy's learning trajectory of binary numbers and how she persevered in this process. This single case study with an embedded unit (Cindy's learning) reveals the danger of placing students in "struggle" instead of a "productive struggle" (Hiebert & Grouws, 2007). When Cindy was placed in struggle when confronting responding moves by the facilitator, her "safe" reaction was hiding and avoiding. In opposition, we have also learned about the importance of empathetic, nurturing supporting responses that encourage students' productive struggle to do better. We invite instructors to notice students' hiding or avoiding and consider Cindy's case. Furthermore, we state that teachers' choice of language is important in terms of positioning students. We also highlight Cindy's agency as she chose to take up Carmen's suggestion to "fake it" rather than give up.

How Students' Performance is Related to their Positioning

As Van Langenhove and Harré (1999) stated, "Conversations have storylines and the positions people take in a conversation will be linked to these storylines" (p. 17). The social stereotype about gender-related performance in STEM (Starr & Simpkins, 2021) generated the competition between the two groups and created the main storyline. Within this storyline, Carmen and Cindy used "fake it until you make it" as a tactic to cope with the facilitator and keep up with the competition. Early in the program, Cindy's group engaged in a competition with a group of boys, as illustrated in Excerpt 1, and this brief interaction made it clear that there was a gender storyline at play as Herbel-Eisenmann et al. (2015) described. These gender storylines were evident as follows: Carmen: *They're behind*. Cindy: *Way behind*. Other examples that illustrate this competitive discourse included: Carmen: *"We're usually the first ones*

who finish," "We gotta hurry"; Cindy: *"We're gonna win," "Are we, like, further than anyone?," "Oh no, they're catching up!"*

Dynamic analysis of participants' interactions and discourse based on video data allowed us to observe how Cindy's performance was related to her positioning. Cindy's positionings ranged from a student who negotiated her understanding of binary numbers, to one who persevered and voiced her challenges, to a competent problem solver of mathematics and computer programming. The dynamics of Cindy's positionings changed while she was mastering conversions from decimal to binary numbers, thus gaining "control over knowledge" (Dennen, 2011). Cindy's self-positioning as a student who did not understand and who needed more explanation was an important step that leveraged the shift in her positioning.

Another marker of the shift in Cindy's positioning was Katy's inviting Cindy's peers to explain binary numbers to her: *"So, I'm not a middle schooler, so why don't you guys try to teach Cindy how to do it?"* This invitation empowered Cindy's peers to act as more skillful *knowledge holders* than Katy herself. Encouraged by that invitation, Marina acted as Cindy's tutor, and her use of Spanish and teaching practices marked a critical shift in Cindy's meaning making of binary numbers and her repositioning. Marios's collaborative and inviting teaching practices reinforced the shift in Cindy's repositioning. These interactions were friendly and tactful in nature and nurtured a social learning environment that invited students to participate in answering questions about binary numbers. The results reveal that a shift in Cindy's positionings from a learner who was still negotiating her learning binary numbers to a competent problem solver was advantageous in promoting Cindy's learning of binary numbers.

How Language Use in the Classroom Affects Students' Positioning and Participation

Analysis of interactions in the context of our research is important in understanding how linguistic tools can be used in positioning. By analyzing communication acts, we understand how Cindy's positionings underpin the discourse; how the facilitators' and students' discourse forms, sustains, or shifts Cindy's positioning; and how the discourse connects to storylines larger than the classroom interactions. The analysis of communication acts also illustrates "classroom interactions and how those interactions are shaped by participants in them" (Herbel-Eisenmann et al., 2015, p. 199).

The identified positionings were linked to how language was perceived and negotiated during the interactions, thus addressing the gap in the literature regarding communication acts (Herbel-Eisenmann et al., 2015) using SFL as a tool. Use of modality and adjuncts can express different attitudes toward students and should be chosen carefully. Modality can express a wide range of attitudes; it can be used as an invitation to participate in a discourse community (i.e., *Can you help me count?*), or it can be viewed as a sign of authoritative language of a more powerful agent (i.e., *We can't move on until all of you know it.*), thus restricting students' agency. Depending on the discourse context, some adjuncts can belittle students or diminish their efforts as they

engage in different tasks (i.e., *But you were **just** guessing numbers! That doesn't count, Are you the **only** one* [*who doesn't understand*]?) while others may empower students (i.e., *absolutely*) (Eggins, 1994; Rymes, 2009). It is important that educators take into consideration context and intonation in the use of modality and mood adjuncts as powerful linguistic tools in positioning and meaning making.

Another important linguistic tool in positioning is supporting and confronting responding moves. Teachers should be aware that responding moves that invite or encourage students, especially those experiencing challenges in their studies, increase participation (Turner et al., 2013). When teachers use supporting moves, they critically analyze classroom discourse and are ready to change the direction of the interaction with the student as an initiator of the talk. Moreover, teachers patiently listen and accept students' responses that may be considered unexpected or wrong from the view of the traditionally prescribed classroom interactions. Instead of criticizing or labeling a student for the use of unexpected statements, and thus positioning a student in a particular way, the teacher sees it as *potential for interaction* and creates a space for "correct and incorrect thinking" (Rymes, 2009, p. 66). When there is space to express correct or incorrect thinking, teachers and students can reshape the meaning of what is being said within these interactions.

Confronting responding moves, on the other hand, may shut down the student's further participation, *sequentially deleting* the student's statements, devaluing or constructing the student's response *as nonexistent* (Rymes, 2009). A confronting responding move can be clearly marked lexically (i.e., *Cindy: Like this? Katy: No.*), or interpreted as confronting from the context (i.e., *Cindy* (*hastily*): *Yes, I know, I know it. Yes. Katy (negating with her head): She knows it, she knows it*). Katy's response looks like a supporting responding move in its structure, but Katy's body language and sarcastic intonation, seen and heard from this context, show that the facilitator was refuting Cindy's self-repositioning statement. These findings are consistent with Yamakawa's (2014) work on how a teacher's positionings of students impact their participation in learning. These different positionings can vary, from affording students opportunities to engage in productive interactions to limiting their participation.

It is important to see Cindy's challenges not as a problem or obstacle, but as an asset to the development of her agency and potential for her one-year-later status as a cofacilitator, given that "some of the most valuable learning experiences come from the challenges we confront" (Stoecker & Brydon-Miller, 2013, p. 29). This case study illustrated how social positioning prompted Cindy's participation to either dare to think out loud and engage in productive struggle, or simply avoid being outed as incapable by not responding as expected. Marios's and Marina's interactions with Cindy, as well as Cindy's own perseverance and self-repositioning through "fake it until you make it," were key to supporting this shift. That said, "fake it until you make it" is a story of academic and social success. It is a story of a young Latina girl who, through her perseverance, agency, and use of available resources, promoted her opportunities to learn, found her own links with mathematics and computer programming, and, after one year, became a cofacilitator in the same program.

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Note

1. The names used in this manuscript are pseudonyms.

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