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Computational thinking in a bilingual kindergarten classroom: Emergent ideas for teaching across content areas

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Abstract
Our study documents how a Spanish-English bilingual elementary teacher learned computational thinking while working to incorporate it into mathematics and language arts lessons in a bilingual classroom. We classified the elements of the teacher's process into two practices: intentional and unintentional use of computational thinking. Intentional use of computational thinking included the teacher's explicit incorporation of any of the four computational thinking elements (abstraction, algorithms, decomposition, and patterns) into her teaching practice. The unintentional use of computational thinking included those instances where the teacher used computational thinking as a means for teaching content not specifically oriented toward computational thinking. In addition, our work identifies how this bilingual teacher's instructional dynamics integrated computational thinking and Spanish in a nearly inseparable manner. With this work we intend to contribute to the emergent scholarship committed to understanding the promotion of learning computing in K-5 settings.

Keywords Computational thinking · Bilingual · Elementary · In-service teachers

The research community has shown a growing commitment to understanding how to adequately prepare K-12 students in computing (Israel et al., 2015). Respond-

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ing to research showing gender and racial inequity in computer science, efforts to broaden participation among females and students of color in K-12 settings continue to grow in the research community (Goode, 2008; Hsu, et al., 2019). For example, a study of the intersection between journalism and computational thinking used the shift in journalism, due to the internet, as a means to engage a broad range of middle school students in computing through writing, gathering and analysis of information, and use of images (Wolz et al., 2010). Studies have also agreed on the idea that bringing algorithmic problem solving and computational methods to K-12 settings is essential in successfully promoting computing broadly among students (Barr and Stephenson, 2011; Qiu et al., 2013; Scott and White, 2013). To prepare students for this, the Next Generation Science Standards included computational thinking (CT) as a science and engineering practice for K-12 (NGSS Lead States, 2013). Weintrop et al. (2015) subsequently subdivided the practice of CT in mathematics and science into a taxonomy of practices: data practices, computational problem-solving, modeling and simulation, and systems thinking. To affect these standards at the elementary level, researchers have engaged mathematics and science teachers in CT professional development (PD) through the use of technology and computer programming, such as robots (Ketelhut et al., 2019) and block-programming environments (Cateté et al., 2018), commonly referred to as *plugged* CT. Concurrently, researchers have also highlighted the potential to emphasize the cognitive practices of CT and engage students in logical and systematic mental strategies for learning and problem-solving without the use of computers or technology (Rich et al., 2020), conversely referred to as *unplugged* CT. An additional driver for this strand of research is to address inequity in computer science (Margolis, 2017): if students who lack access to the computational part of computational thinking are taught the thinking part of computational thinking, then they might be better equipped to learn and persist in computing when finally given the opportunity. However, these PD opportunities and resources remain scarce for supporting the learning and implementation of CT in the K-12 setting, especially when taking into account the location of the schools (Luo et al., 2022). Moreover, elementary school teachers who are motivated to start integrating CT into their classrooms often report a lack of necessary tools and knowledge to the CT learning opportunities to their students (Luo et al., 2022). For this reason, Luo et al. (2022) has called for research that provides these learning opportunities to teachers in the K-12 setting.

Our paper builds on this call and contributes to the effort of preparing K-12 students in computing. We also contribute to the effort of preparing teachers to incorporate instructional practices that support the teaching and learning of CT. We built our work around Wing's (2006) definition of computational thinking: a fundamental problem-solving tool set essential not only in computer science (CS) but for anyone in any domain. In particular, we focus our effort on working with linguistically diverse students. We document here how a Spanish-English bilingual teacher, Ms. J, with no prior preparation in computational thinking started to learn CT and incorporated it into two lessons (one mathematics and one language arts) in a bilingual classroom.

More specifically, in the process of documenting this effort we have strived to answer the question: *How does a bilingual kindergarten teacher start to integrate* *computational thinking across two content areas (mathematics and language arts), as she supports the development of bilingualism in her classroom?*

Ms. J was part of a larger study that began in 2019 funded by the National Science Foundation (NSF) (DRL #1,923,633). Through this grant we developed and piloted a CT professional development (PD) for elementary school teachers. Motivation for the analysis presented here was derived from learning how CT could support the development of a teaching practice that is responsive both to children's ideas and to their bilingualism. In documenting this process we intend to contribute to efforts to inform the field of education about instructional practices that can lead to more accessible CT experiences for linguistically diverse students.

1 A word on terminology

Research and policy documents across the country use different words to refer to students whose first language is not English. For this reason, we find it necessary to take note of the terminology used in this article. For the purpose of this article the term *bilingual* as applied to students, classrooms, and teachers specifically refers to those teachers and students who speak English and Spanish. We will use English Learner (EL) when we cite or quote the work of other authors who use this term or English Language Learners. We will use the term Latinx instead of Latino in order to be more inclusive of diverse genders and identities, unless a person has specifically identified as Latino or Latina. We use Latinx to refer to any person of Latin American descent residing in the United States. On some occasions we will use the term Hispanic, the word adopted by the U.S. government since the 1970s to give people from Latin America a common identity (MacDonald, 2004), when we cite the work of state or federal entities in the United States.

2 Conceptual Framework

To frame our study, we highlight three bodies of research. First, drawing on research on CT, we review the discussion surrounding the definition of CT and its importance. In this way we present the reader with a basis for understanding our lens for developing our PD. Second, drawing on research on translanguaging, a flexible use of linguistic resources (García & Li, 2014), in elementary grades, we provide an overview of teaching and learning in bilingual contexts. In particular, we identify specific practices of bilinguals which can help the reader make sense of the teacher's considerations when teaching in a bilingual classroom. Third, we describe our researcher-practitioner partnership (RPP) drawing on the idea that research and practice must inform one another. The development of our RPP is centered on the principle that practitioner knowledge is integrated with practice and it is organized around problems of practice (Hiebert et al., 2002).

2.1 Computational thinking

Given the lack of consensus in the research community on what CT is, it is important to explain how we understood and used CT in designing and conducting our PD. By doing this we also intend to provide clarity regarding what CT looks like in practice. Building on the work of (Wing, 2006) and Dong et al., (2019), we narrowed our definition by framing four elements necessary in CT: **P**attern **R**ecognition, **A**bstraction, **D**ecomposition, and **A**lgorithms. These four elements are commonly identified as the PRADA elements and provide both accessible yet rigorous use of CT by elementary teachers in the classroom (Dong et al., 2019). Pattern recognition involves identifying patterns and making observations about those patterns to answer questions or make predictions. Abstraction refers to the process of focusing on key details and filtering out unimportant information. Decomposition is the process of breaking down large complex tasks into small more manageable pieces. Algorithms refer to step-by-step procedures for solving problems or completing complex tasks. Our study aimed to teach teachers these four unplugged CT elements for use across four core elementary content areas: language arts, mathematics, social studies, and science. The impetus to focus on these unplugged elements for teaching CT stems from the idea that integrating CT in a manner that supports students' understanding requires curricula in which CT is not taught as a separate topic, but rather is interwoven with learning across different domains (Sengupta et al., 2013).

With this framing we consider CT to be the process by which these elements are applied in order to find solutions to problems or to facilitate the execution of a complex task. In our definition we also want to note that, because complex and new problems would continue to emerge, these four elements might also be applicable in other context, not only when we devise a solution to a problem. Therefore, for us CT is an evolving research activity that includes inventing appropriate new models of solving complex tasks.

2.2 Teaching and learning in bilingual contexts

A growing body of research has focused on teacher recruitment and the practices and experiences of bilingual teachers (de Araujo et al., 2018). Within this research are studies suggesting that bilingual teachers are potentially more capable than monolingual teachers of supporting language learning, tapping into their own backgrounds and those of their students (Cavazos, 2009; Celedón-Pattichis et al., 2010; Gutiérrez, 2002; Musanti et al., 2009; Remillard & Cahnmann, 2005; Sleeter et al., 2015; Turner et al., 2012). Drawing upon this research, we analyzed the specific practice of a particular bilingual teacher, trying to capture how her teaching and learning of computational thinking intersected with her bilingual instructional practice. In doing so we focused our attention on two common practices identified in bilingual classrooms. One García and Sylvan (2011) defined as *dynamic bilingualism*. According to them, as bilinguals interact, so too do all the languages that contribute to their bilingualism. In the contexts of teacher-student interaction, dynamic bilingualism requires that both the teacher and the student participate in a negotiation of meaning (Savignon, 1991) between content and language to hit upon the necessary ideas. The other practice we highlight is translanguaging. More specifically we focus on the translanguaging classroom, where teachers and students learn in a *space built collaboratively* (García & Kleyn, 2016) by the teacher and the students, each with their own language practices.

These two ideas are fundamental to the work we present here. They provide the frame necessary for developing a bilingual teaching practice that centers on developing bilingualism across content areas.

2.3 Researcher-practitioner partnership

The case study presented in this paper is part of a larger research-practitioner partnership (RPP). We provide details of the RPP in this section to help readers understand the contexts in which Ms. J learned CT, the support structure in place to engage Ms. J and other teachers in learning and implementing CT, and how the collaboration with the teachers through the RPP played a role in the case study.

Our researcher-practitioner partnership (RPP) consisted of two computer science researchers, one teacher educator, and one sociology researcher from three universities. Our RPP also included 16 teachers and 3 administrators from two school districts. One district reported in 2019 having 2,375 students with 40% of them being Hispanic, 51% White, 7% multiracial, 1% Black, 1% American Indian, and 1% Native Hawaiian. This district also reported having 25% of the students as English Learners. The same year, the other district reported having 3,000 students of which 94.3% were White. Our RPP was organized around the idea of integrating CT into K-5 classrooms with the purpose of engaging teachers in using CT as a way of promoting and developing interests and skills in students to study computer science and other STEM disciplines later in their education.

The first year of the project was divided into three phases. Phase 1 started with the first cohort which consisted of four teachers, one teaching in kindergarten, two teaching fourth grade, and one teaching fifth grade. The kindergarten teacher and one of the fourth grade teachers were both Spanish-English bilinguals and taught in a dual language classroom. During Phase 1 we provided professional development centered on building CT content knowledge for these four teachers through readings, videos, and small group meetings in which teachers engaged in CT activities (e.g. teachers identified patterns in data about their favorite shows to develop an algorithm to predict which show a particular person was likely to enjoy) and reflected on their experience learning and using CT. In Phase 2, these teachers began designing lessons that integrated CT into their K-5 classrooms. Researchers provided support during lesson development (e.g. clarified CT elements, shared instructional resources, etc.), observed the implementation of each lesson, and reflected on the experience with the other practitioners. During Phase 3, researchers and practitioners used CT as a tool to design and develop a five-day online CT professional development summer institute (Skuratowicz et al., 2021). This summer institute welcomed our second cohort of 14 K-5 teachers. During the institute we prepared all teachers in our project to learn CT and integrate it into lessons the following year. We ended up with a total of 16 teachers in our RPP, because 2 teachers were unable to continue participating.

3 Methods

Using an instrumental case study approach (Stake, 1995), we examined the teaching practice of Ms. J as she engaged in learning CT within the professional development we designed. In addition, this methodology allowed us to identify the bilingual practices enacted in Ms. J's classroom as she implemented CT across two content areas. In this way we could also understand how the professional development we designed and implemented influenced the enactment of Ms. J's instructional practices.

3.1 Participants

This paper centers on the work of Ms. J, the kindergarten Spanish-English bilingual teacher from Cohort 1. At the start of this study Ms. J had nine years of teaching experience and was teaching kindergarten in a dual language program. Ms. J was part of the district with a larger percentage of Hispanic students in our study.

3.2 Data

The data we analyze come from Ms. J's first year of involvement in the project. The data consist of Ms. J delivering one mathematics lesson and one language arts lesson. The mathematics lesson focused on ways to make the number 10. For this lesson Ms. J used a ten-frame template and Skittles to distinguish different amounts by color. The language arts lesson centered on learning how to order a sequence of events and using key details to identify the events. This lesson was based on the children's book *La Lluvia* (Stojic, 2009). Ms. J wrote the lessons and revised them after receiving feedback from the two CT experts in the study. Ms. J then taught the lessons and all four authors conducted observations of the two lessons. We followed an observation protocol we developed based on our prior classroom and research experience. Because individual teachers might have a different way of structuring their classroom instruction, the protocol served as a guideline, rather than a checklist, for conducting the observation. Overall, we focused the observation on the teacher moves enacted during the delivery of the lesson. For example, we paid attention to how the teacher started the lesson (e.g. Did she emphasize sense making? Did she provide opportunities for students to provide and share their own thinking?) During the observations we took field notes and then met as a group to debrief on the notes from the observation. After teaching the lessons, Ms. J was asked to also write a reflection on the process of writing and teaching the lessons. These reflections are also part of the data we report in this piece.

3.3 Analysis

The first three authors created a list of preliminary codes, i.e. tags highlighting content in the data relevant to our research goals. This preliminary list was informed by our experience designing and conducting the research project. This list was extensive and detailed (Saldaña, 2015). Then, the first three authors individually read the lesson plans, observation notes, and reflections. After that, each of these three authors modified the initial individual codes. Then we met to discuss the list of initial codes and generated a common list of codes (Saldaña, 2015). Next, each of the first three authors separately coded one lesson plan using the common lists of codes. After this coding process, we met to compare the codes and perform a triangulation process (Vallejo and de Franco, 2009). During this process we refined the codes. We repeated the coding and triangulation process four times until all three first authors reached a consensus on the codes, their definition, and how they applied to the analyzed data. We then took a second look at the data using the coding scheme that emerged. Our coding scheme centered on three fundamental codes: (1) *Intentional use of CT*: we defined this code as the explicit incorporation of any of the four CT elements into the lesson. For instance, if a lesson was using *decomposition* and Ms. J explicitly used the word *decomposition* together with its definition in the written lesson or during instruction, we coded this portion of the lesson as an intentional use of CT. (2) *Intentional use of CT to support language development*: we defined this code as the explicit use of any of the four CT elements with the purpose of teaching or foregrounding the use of either English or Spanish. For instance, if Ms. J used the word *pattern* and defined it in order to help students identify a particular counting or color sequence in order to emphasize counting in Spanish or the learning of colors in Spanish, we coded this instance as intentional use of CT to support language development. (3) *Unintentional use of CT*: we used this code when Ms. J used CT as a tool for teaching without explicitly mentioning it or defining any of the four CT elements. We also used this code when we identified instances in the lesson plan or the instruction when CT was used but not with the purpose of teaching CT, but as a means to teach content or introduce a different idea, not related to CT. For example, we coded some instances where Ms. J's students created patterns with the different color Skittles when making a 10-frame. In these instances, Ms. J did not use the word *pattern*, nor use its definition, but used the clear distinction that the colors made in order to ask students to explain how the 10 was made. For the entire coding process we used the coding software MAXQDA (VERBI, 2020).

4 Results

In the data we derived from Ms. J's instruction, we identified two basic characterizations of how Ms. J integrated CT into her lesson plans: *intentional* and *unintentional use of CT*. We also identified that teaching CT and teaching language were intertwined in her practice, so that we could not separate instances where Ms. J *only* taught Spanish or *only* taught CT. We saw how Ms. J executed the lesson plan purposefully to emphasize the teaching of CT. At the same time, we saw how Ms. J seemed to intentionally support language use. In some cases, we noticed a shift in which she would foreground Spanish, however there never seemed to be a separation between the teaching of CT and the teaching of Spanish.

4.1 Integrating CT into teaching

In both her lesson plans Ms. J included several CT elements. But in some instances this inclusion seemed intentional (e.g., teaching specific vocabulary), while in others the use of CT seemed incidental to the lesson.

4.1.1 Intentional use of CT

Decomposition and Abstraction. In her math lesson titled *Making 10*, Ms. J planned to teach decomposition. The lesson objectives were “to show number pairs for 10 using objects and drawings” and “to name number pairs for 10”. The excerpt below comes from the lesson plan:

> Remind students/review that we’ve been practicing counting and recognizing numbers to 10. Today we will learn about composing (making) groups of ten using number pairs (2 numbers or groups of objects).

Ms. J is not using the word *decomposition*, but she is using “composing (making)” and elaborating on it by providing an example of what she anticipates students will do. In the lesson she is encouraging students to use a 10 frame and to use the sentence frame 10 *son* ___ *y* ___.

[10 is ___ and ___] to answer, for example, 10 is 5 and 5 (Fig. 1). Here we see how ten is *decomposed* into two smaller parts.

In her language arts lesson titled *Story Sequencing, Key Details*, Ms. J explicitly states two objectives for teaching: “how the story can be broken apart (decomposed)”, and how “being able to identify (abstract) key details can help us understand the story better.” She was very intentional about the CT elements she chose to integrate into each lesson.

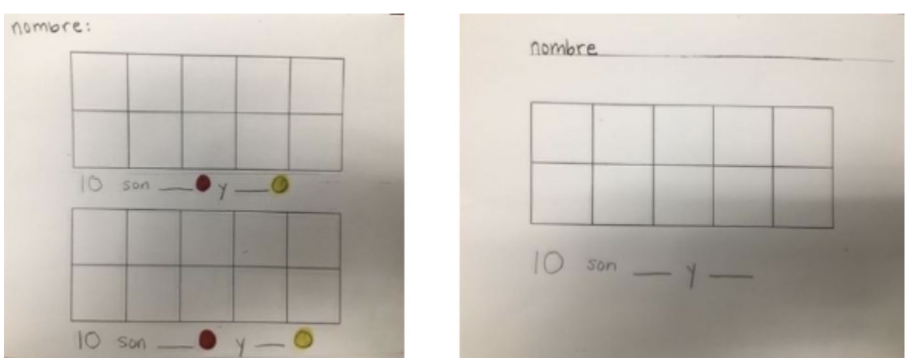

Fig. 1 10 frame used in the lesson

4.1.2 Unintentional use of CT

Pattern Recognition & Algorithms. Although her math lesson was focused on decomposition, the introduction involved asking students, "How many different ways could we make a group of 10 cubes with some number of green and some number of yellow cubes?" Starting with 10 green cubes and 0 yellow cubes, she asked one student to remove a green cube and one student to replace the cube with a yellow one, and continued to prompt students, "Now what does the group of 10 show?" As they continued to replace green cubes with yellow cubes, they recorded number combinations on chart paper. Even though it wasn't intentional, this activity gave students the opportunity to observe patterns relating to how the numbers were changing and make predictions about what would happen next, which she didn't explicitly plan.

Further, in her language arts lesson *Story Sequencing, Key Details*, although Ms. J's goal was to teach decomposition and abstraction, in the written lesson there were several instances where she used aspects of pattern recognition and algorithms without linking these approaches to CT. For instance, the two goals of the lesson (e.g. retelling of the story and using images following the order: beginning, middle, and end) align with pattern recognition, because students use patterns they already know (e.g., puddles come after rain) to determine where images belong, and the idea of ordering events in sequence is fundamental to writing an algorithm (which often involves steps that must be completed in a specific order). However, her lesson does not make reference to pattern recognition or algorithms. She also asked questions such as: *What do we notice at the beginning of the story? We just read that lightning flashed, what happened next? What happened after it stopped raining? What do the baboons do after the rain stops? What happened at the end of the story?* By asking these questions, Ms. J is asking students to draw on previous knowledge to order a series of events. We interpret this recollection of events as engaging in pattern recognition and the ordering of events by using algorithms.

4.2 Language use and the teaching of CT

As we sought to identify the incorporation of CT, we also looked for instructional practices that supported the development of bilingualism in the classroom in the context of teaching CT. Below we describe excerpts from the language arts lesson Ms. J wrote with respect to her intentional use of Spanish, and observations about her delivery of the lesson that tightly intertwined CT and language as a single unit.

4.2.1 Intentional use of spanish

In her lesson plan, Ms. J identified the following goals:

> Introduction: Brief review of what we've learned so far in this unit about seasons and weather. Introduce vocabulary (*secuencia*, *principio*, *medio*, *fin*) on large chart paper. We may also use words such as *first*, *then*, *next* and *last* (*primero*, *luego*, *después*, *y por último*) to talk about the sequence of a story. Discuss

> how events in a story are told in a certain order and being able to identify (abstract) these key details can help us understand the story better.

In this excerpt above Ms. J intends to use vocabulary words in Spanish while simultaneously teaching about sequences in order to teach *abstraction* and demonstrate how it can be used to help improve student understanding. In the example below (also from the language arts lesson) she plans to teach about a different CT element, *decomposition*.

> Shared Reading: *La Lluvia*. As we read, emphasize the parts of the story (beginning, middle, and end) and how the story can be broken apart (decomposed) into these parts to help us understand the story better.

Here Ms. J is using decomposition to focus on reading comprehension. Her focus goes beyond the mere learning of vocabulary words. In the written lesson we start to see some evidence of Ms. J's translanguaging practices. In a few instances she incorporates some Spanish words in her description of the lesson. These appear as if she is narrating what she will emphasize in the lesson. We noticed it here as well as in her choice of the book. The book is originally written in English; however, Ms. J chose to do the read-aloud in Spanish. These facts hint at her classroom language practice which treats Spanish and English on equal footing, and which, when foregrounding content, permits expression of student ideas in the language students find most appropriate at the moment.

4.2.2 CT and language as a unit

As she delivered the lessons, Ms. J used a variety of expressions and vocabulary to describe the images and the events in the story. We noted her intentional questions that emphasized the concept of order. In addition, she used specific words to help make connections with the order of how things happened in the story. For example: *sol* (sun) was associated with *seco* (dry), *verde* (green), and *frutas* (fruits) and was included with the details of what happened after the rain. Ms. J also used questioning strategies to focus on the process, participation, and collaboration: *¿Es eso algo que pasó en el cuento? ¿Qué piensan ustedes?* [Is that something that happened in the story? What do you all think?] *Muéstrenme con los dedos*. *Creo que algunos no están seguros*. [Show me with your fingers. I think some of you are not sure.]

In another part of the lesson Ms. J asked a student, Pedro, to share his thinking. Pedro placed an image from the end of the story under *Principio* (Beginning). Ms. J let him do that and then followed up by asking, "Why is that image there?" The class shared some ideas and they moved the image to *Fin* (End). Ms. J asked Pedro, "First you put it at the beginning. Why?" They talked about the fact that it was dry, just like at the beginning. During this interaction they talk about how this connection made sense and Pedro's answer was validated.

This interaction between Pedro and Ms. J was in English. From the observation we noticed that Pedro seemed to favor English over Spanish, and Ms. J's decision to continue to discuss this idea in English appeared to be an instructional decision in which

Ms. J wanted to foreground the understanding of the sequence and the connection between "dry" and "lack of rain" at that particular moment; so, for that moment, language had to be in the background. If our observations are true, moments like this are rarely found in bilingual classrooms, because teachers tend to favor language over content or struggle with making a decision about what to foreground in the moment (Martínez et al., 2015; Krause et al., 2021).

4.3 Reflections on learning

We also analyzed the reflection Ms. J wrote after teaching each lesson. In reflecting on her practice of learning CT and incorporating it into her instructional practice, Ms. J shared two aspects of what she learned that she used in her instruction: (1) using questions to direct students' attention to CT elements, and (2) adjusting visuals and activities. However, in her reflection on her math lesson she had an extensive list of questions. She mentioned that it was challenging for her to plan for instruction as these questions arose during her planning process:

> How explicit to teach the elements of CT to the students? How explicit to use vocabulary? What type of activity will allow students to explore and practice the elements while being engaging and manageable for Kinder students? What kinds of questions will extend their thinking? How to incorporate CT into existing curriculum and lessons? How to get responses/explanations of thinking from students that lack in language and communication skills and have very little background knowledge.

Her reflection also showed that after teaching the *Making 10* lesson she was able to identify some of her unintentional use of CT based on the students' behavior during the lesson. Specifically, she noted:

> In the introduction activity students were able to begin predicting what would happen next after a few examples, but not necessarily able to name it as pattern recognition that they knew what would change (A student will remove a green cube, and another student will add a yellow cube.)

Her reflection on the language arts lesson suggested a similar realization:

> Some students looked back at the whole group activity and tried to replicate the order. Others thought of the story in different categories of beginning, middle and end, but in the correct sequence. Others wanted to group/sort similar pictures (pattern recognition?)

Note her question in parentheses. She recognized the emergence of CT ideas as students engaged in the lesson.

Ms. J's reflection on her math lesson did not pose questions or comments regarding bilingualism explicitly, but her last question relating to planning challenges about students who "lack" language and communication skills touches indirectly on this theme. This note on the “lack” of language and communication skills falls into a common pattern of positioning bilingual students, which is documented in the literature (Aguirre et al., 2013; Colegrove & Krause, 2017; Krause & Maldonado, 2019; Krause et al., 2021). This perspective on students’ speaking ability tends to be common in programs that use and promote language separation (through dual language education programs, for example) for teaching a specific content in one language at a time, operating under the perspective that acquiring language depends on using only one language at a time (Palmer et al., 2014). Ms. J is in a dual language program and Spanish was the target language used to teach the lessons. However, we identified instances where she decided to switch to English in order to foreground the content she aimed to teach. In addition, in the particular contexts of Ms. J’s lessons she used Spanish to teach content (mathematics and language arts), to teach CT, and to teach the language (Spanish) rather than using Spanish as a resource or means for supporting the learning of the content and CT. In her context she is balancing more than teaching one language.

5 Limitations of the study

Naturally there are limitations to this study. We highlight those that we consider noteworthy for future studies. One is that we focused our analysis only on the lesson plans written, the observations conducted, and the written reflection. For this study we did not interview Ms. J to unpack some of the notes and comments she made in her reflection. We also did not ask questions about the decisions she made during the lesson writing nor during instruction. The other limitation of our study is that we only analyzed two lessons. Although we saw CT embedded in the lessons and the lesson instruction, it is necessary to study further how CT might be embedded across other content areas (e.g. social studies, science, arts, etc.).

6 Discussion and conclusions

We set out on this study to document how a bilingual kindergarten teacher started to integrate computational thinking (CT) across her designing and teaching of a mathematics lesson and a language arts lesson, as she supported the development of bilingualism in her classroom. Our intention in documenting this practice is to outline what we learned about the incorporation of CT into instructional practices across content areas. In this way we could start to make generalizations about what works and what is productive for teachers and students as they engage in teaching and learning CT. In so doing, we identified two practices: intentional and unintentional use of CT. We defined the intentional use of CT as the teacher’s explicit incorporation of any of the four CT elements (abstraction, algorithms, decomposition, and patterns) into her instructional practice. On the other hand, we defined the unintentional use of CT as those instances in which the teacher used CT with no specific intention to teach CT but rather as a means for instruction. The intentional use of CT in some regard was expected as teachers were part of a project that focused on learning to incorporate CT across content areas. However, this intentional use of CT across the two content areas described here opens a window for discussing and further studying the many uses of CT. For instance, in the *Making 10* lesson, we saw how students composed and decomposed the number 10. At the practical level, the idea of composing a number (e.g., five cubes plus five cubes make 10 cubes) supports, for instance, the development of addition and subtraction understanding. This idea of composing a number is widely used and promoted in instructional practices that support children's mathematical thinking (for some examples see Parrish 2010). The nuance we identified here is how the idea of making and composing numbers link to CT. In this same way, in the language arts lesson *Story Sequencing, Key Details*, we identified practices that are used in reading comprehension. The extraction of key details to retell a story, and the ability to retell the story, are commonly used practices in teaching language arts (for some examples see Bui and Fagan, 2013). Here, as well, the nuance is the linking to CT. These two examples lead us to conjecture that CT is already embedded in common instructional practices. Moreover, we conjecture that CT is embedded in daily practices that we, teachers, researchers, and students engage in daily. If CT is embedded in our daily activities, perhaps we really do not need to engage in teaching CT. What we need in order to make CT more prominent in the classroom is to recognize how we use it. For instance, in Ms. J's reflection she wrote questions about "how explicit" to teach CT. Despite teaching the meaning of the CT elements, she still questions how explicitly to teach it, and it seemed that she did not notice how she used these elements to accomplish her instructional goals. Testing this conjecture would have theoretical implications for the study of CT. Moreover, these implications would extend to the study and teaching of languages across content areas in the elementary classrooms. For instance, in her lessons, we also noticed Ms. J's *intentional* use of CT to support language development. In this practice we also see how language use and CT are intertwined. In Ms. J's classroom both the teacher and students are using their own language practices. Ms. J seems to be making decisions in the moment to foreground language in some instances, or to foreground sequences or patterns in some cases. On one hand we see that she is enacting aspects of translanguaging pedagogy in the classroom, but on the other hand some of her comments suggest that she is still coming to grips with the underlying theory. For example, her comment that students "lack" language and communication skills contradicts aspects of translanguaging that consider a multilingual speaker's linguistic repertoire as a unified whole and therefore not subject to lack.

There is still much more for us to learn about the incorporation of CT across content into the elementary school classroom. However, what the analysis that we present here tells us is that perhaps the efforts for including CT early on in schools might need to center on the promotion of teaching practices that go beyond mere recognition of the occurrence of abstraction, patterns, ordering, and algorithms in other content fields. The method of abstraction has been with us at least since Plato's allegory of the cave, algorithms since Euclid's treatise, ordering since Homer composed Greek epics and since the Maya inscribed their calendar dates, and pattern recognition in the Roman imitation of Greek literary genres and in the classical art decorating countless holy structures of Muslim cultures the world over. We must convey the essence of CT beyond this: elements of CT have always existed in other domains, but with the rise of computers in the mid-20th century, computer science distilled these repeated elements into CT. CT is less a collection of elements and more a recognition of how combinations of these elements repeatedly occur in specific ways to develop solutions, and these combinations (and even the solutions) share common characteristics across domains. Conveying this process of distillation, combination, and repetition perhaps forms the foundation for the next phase of helping teachers, not to find out if elements of CT occur in their fields (of course they do), but to see how their patterns of occurrence generalize and share features across disciplines.

Moreover, this can be true of language and linguistic understanding. In the bilingual environment, the same elements of CT are at play in the guise of linguistics. When children guess *singed* instead of *sang*, they apply abstraction to pattern recognition: they recognize the existence of an abstract past tense and at the same time assume its marker must be *-ed*. We may view aspects of linguistics as another content-specific instantiation of CT. And in the context of a classroom dedicated to a translanguaging pedagogy, the very way in which students express their ideas can become the raw material for lessons, planned or impromptu, in CT itself. This must form a pillar of the next phase of teaching CT in the bilingual context.

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