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Dialogic Discourse in Linguistically Diverse Elementary Mathematics Classes: Lessons Learned from Dual Language Classrooms

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Purpose

There are cognitive advantages to speaking more than one language (Hakuta, 1986); however, linguistic diversity can impact teaching and learning in complex ways (Moschkovich, 2007). For example, measures such as the National Assessment of Educational Progress (NAEP) demonstrate significantly lower mathematics performance for English learners (ELs) than for other students (National Center for Educational Statistics, 2012). This disparity suggests that the growing number of ELs (National Clearinghouse for English Language Acquisition, 2011) are not being adequately supported.

The Common Core State Standards for Mathematics (CCSSM) (Common Core State Standards Initiative [CCSSI], 2010) expects all students to develop understanding of rigorous mathematics *content* and also key mathematical practices – including ones related to problem solving, argumentation, and precision of language. However, research suggests that instruction for ELs may focus on procedures and vocabulary rather than linguistically and cognitively demanding activities and meaningful mathematical discourse (Moschkovich, 2007, 2012; Turner, Dominguez, Empson and Maldonado, 2013) – and thus ELs may not be held to “the same high expectations” (CCSSI, 2010) as other students. To meet rigorous standards, ELs need opportunities to participate in rich mathematical activities and discussions that recognize their competencies and provide necessary support.

This research investigates discourse in linguistically diverse mathematics classrooms, representing interdisciplinary approaches (conference theme) at the intersection of mathematics education and language.

Theoretical Framework

Sociocultural theory provides a framework for investigating discourse as a mediating tool in the teaching-learning process (Vygotsky, 1978). Verbal interactions can develop processes from thought to word and from word to thought that allow learners to move beyond what they can easily grasp unaided (Vygotsky, 1978). However, even when the instructional language is the learner’s language, the presence of talk does not ensure that understanding follows. The quality and type of discourse affect its potential for promoting mathematical understanding. In most

classrooms, verbal moves are used to transmit information – that is, *univocal* discourse (see Figure 1). In contrast, dialogue that involves give-and-take communication where students actively construct meaning is characterized as *dialogic* discourse (see Figure 2) (Knuth & Peressini, 2001; Lotman, 2000).

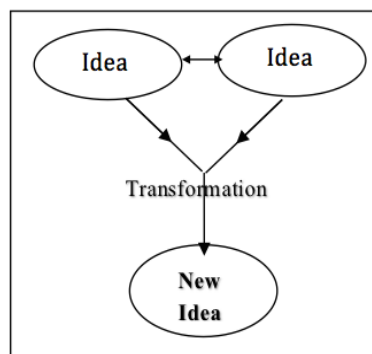
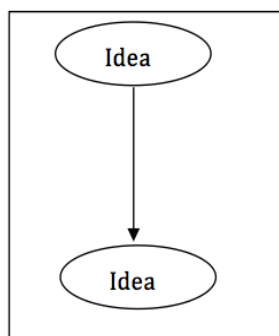


Figure 1. Univocal communication. Figure 2. Dialogic communication.

Issues of discourse become more complex when considering students whose first language is not English (the primary language of instruction in the U.S.). Acquiring mathematical vocabulary is important, but it is not sufficient; ELs need opportunities to construct multiple meanings for words within everyday and academic situations and to communicate meaningfully about mathematics (Moschkovich, 2007) – including dialogic discourse. A key idea is that it is necessary to keep cognitive demands high, but also to make those demands possible through contextual and linguistic support (Cummins, 2000; Turner et al., 2013).

Classroom Discourse Analysis

In order to better understand how these resources and competencies play out to support mathematical meaning making, this research analyzes discourse in linguistically diverse mathematics classrooms. Recognizing that there are many ways that classroom discourse could be analyzed, basic components, structures and tools used in this research that are adapted from previous research (e.g., Truxaw & DeFranco, 2008; Wells, 1999) are described next.

Components of Classroom Discourse

Many researchers have identified and discussed basic components of classroom discourse. For example, Wells (1999) parsed language according to the following categories: move, exchange, sequence, and episode. The move, exemplified by a question or an answer from one speaker, is identified as the “smallest building block” (Wells, 1999, p. 236). The exchange, made up of two or more moves, occurs between speakers. Exchanges are categorized as either nuclear

or bound depending upon whether they can stand alone or are dependent upon or embedded within previous exchanges. The sequence is the unit that contains a single nuclear exchange and any exchanges that are bound to it. Finally, the episode is the level above sequence and represents all the talk necessary to perform an activity (see Figure 2).

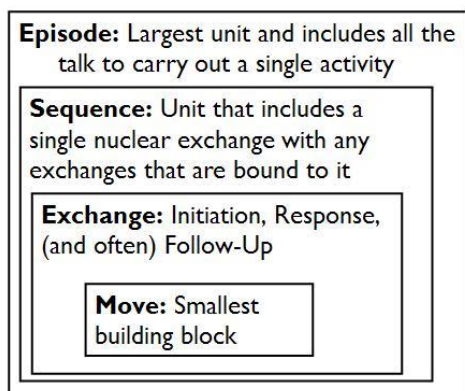


Figure 2. Components of classroom discourse (Wells, 1999).

Triadic Structure of Verbal Exchanges

The most common pattern of classroom discourse follows the three-part exchange of teacher initiation, student response, and teacher evaluation (IRE) or teacher follow-up (IRF) (Cazden, 2001; Coulthard & Brazil, 1981; Mehan, 1985). This triadic structure has been criticized as encouraging “illusory participation”—that is, participation that is “high on quantity, low on quality”—because “it gives the teacher almost total control of classroom dialogue and social interaction” (Lemke, 1990, p. 168). However, Nassaji and Wells (2000) found that triadic dialogue was the dominant structure within inquiry-style instruction as well. Further, it was noted that within triadic exchanges, the teacher’s verbal moves influence the function of the discourse. In the initiating move, the type of question asked has the potential to influence the flow of discourse toward univocal or dialogic. Additionally, the last move in the exchange has been found to be pivotal in whether the discourse will tend more toward univocal or dialogic. For example, when the teacher uses the follow-up move as an evaluation tool, the intended function of the discourse is typically to transmit information (i.e., univocal). On the other hand, if the follow-up move is related less to evaluation and more to an exploratory stance, the discourse is more likely to tend toward dialogic (Truxaw & DeFranco, 2008; Nassaji & Wells, 2000).

Verbal Moves: Talk and Verbal Assessment/Feedback

Various categories of classroom talk have been identified within the research literature. For this study, categories of talk used when analyzing discourse include: monologic, leading,

exploratory, and accountable (see Table 1 for definitions and examples). In any category of talk, the teacher's ongoing monitoring and verbal assessment/feedback affect the dynamics of discourse and the tendency toward univocal or dialogic (Truxaw & DeFranco, 2008; Wells, 1999). The flow of talk is guided by verbal assessment (for the purposes of this research, verbal assessment includes verbal moves [usually by the teacher] that help the teacher to guide instruction and/or enhance learning). Table 1 shows categories of verbal assessment/feedback used in this study: inert and generative.

Table 1

Verbal Moves

Verbal Move	Description	Example
Monologic Talk	One person speaking with no verbal response expected (Truxaw & DeFranco, 2008)	Teacher lectures or shares directions without asking for feedback.
Leading Talk	Students are led to the teacher's understanding (Truxaw & DeFranco, 2008)	Triadic discourse structure where the teacher initiates a question, student responds, and teacher provides feedback (Cazden, 2001) that leads toward the teacher's point-of-view.
Exploratory Talk	Speaking without answers fully intact, analogous to rough drafts in writing (Cazden, 2001)	Students participate in brainstorming or partner talk.
Accountable Talk	Interactions that require accountability to knowledge, to standards of reasoning, and to the learning community (Michaels, O'Connor, Hall & Resnick, 2002, 2008)	Student offers an explanation that incorporates others' ideas and evidence to support mathematical claims.
Inert Assessment (IA)	Verbal feedback that tends to maintain the current follow of discourse, supporting tendencies toward univocal discourse (Truxaw & DeFranco, 2008)	"Nice job" or "That is not correct."
Generative Assessment (GA)	Verbal feedback that mediates discourse to promote students' active monitoring and regulation of thinking (i.e., metacognition) about the mathematics being taught, supporting tendencies toward dialogic functions (Truxaw & DeFranco, 2008)	"What do you think?" or "Why do you think that?" or "Do you agree/disagree and why?"

Research Question

The primary research question for this investigation follows:

- How do various types of verbal moves (monologic talk, leading talk, exploratory talk, accountable talk, inert assessment, and generative assessment) mediate mathematical discourse on a continuum from univocal to dialogic in linguistically diverse elementary mathematics classrooms?

Methodology

Context and Data Sources

The research reported in this paper is part of a larger study where data are being collected in elementary mathematics classrooms where Spanish is the primary language (L1) of some or all of the students. Spanish was selected as the focus language because Spanish is the language, other than English, spoken most frequently in the U.S. (U.S. Census Bureau 2013) and is also the home language, other than English, reported most frequently for students in U.S. schools (NCELA 2011). This paper focuses on discourse in dual language programs (DLPs) (instruction in Spanish and English). Thus far, observations have taken place in six Spanish-language mathematics classrooms and three English-language mathematics classes in two different DLPs. Data sources include audio and video recordings, field notes, transcriptions, and translations.

The classroom. A first grade classroom in the DLP at Garden School (all names are pseudonyms) is used to illustrate results from the coding and mapping techniques and connections to how the verbal moves may mediate discourse on a continuum from univocal to dialogic. At the time of the observations, the teacher, Señora Castro (Sra. C.), had 14 years teaching experience, but it was her first year teaching first grade. She was fluent in Spanish and English and had specialized certification to teach in the DLP, along with elementary teaching certification. There were 17 students in the class – 8 boys and 9 girls. The students were predominantly from homes where Spanish was the L1. The classroom was observed three times.

The school. Garden School is a K-5 school located near an urban center in the western U.S. The 2011-12 school year profile reported 706 students enrolled at Garden School, with 92% Hispanic or Latino, 48% English learners, and 85% eligible for free/reduced meals (State Educational Demographics Office)¹. The school has a DLP that uses two languages for instruction and learning, Spanish and English. In kindergarten and grade 1 in the DLP, Spanish is used 90% of the time and English 10% of the time; the percentage of use of Spanish/English shifts toward 50% for each language by grade 5. The DLP at Garden School is voluntary – that

¹ Percentages have been rounded to closest whole numbers to support confidentiality.

is, families volunteer to have their children participate in the program. At each grade level there are one or two DLP classrooms; the remaining classrooms have instruction in English. The DLP classrooms serve predominantly students who are “native speakers” of Spanish

(<http://www.cal.org/jsp/TWI/SchoolView.jsp>). The school principal shared state assessment data demonstrating that the students in the DLP performed higher on state mathematics assessments than the students in the same school in structured English immersion classes. There was a strong sense that the school’s administration supported the DLP (principal, personal communication, July-October, 2012).

Data Analysis

Ongoing analysis involves constant comparative methods (Strauss & Corbin, 1990), line-by-line discourse analysis to identify verbal moves (i.e., forms of talk and verbal feedback); and development of graphic models called *sequence maps*. Sequence maps illustrate the flow of talk and verbal feedback within sequences and tendencies toward univocal or dialogic discourse. Sequence maps are developed by applying the coding to a template that includes the identified verbal moves (see Figure 3).

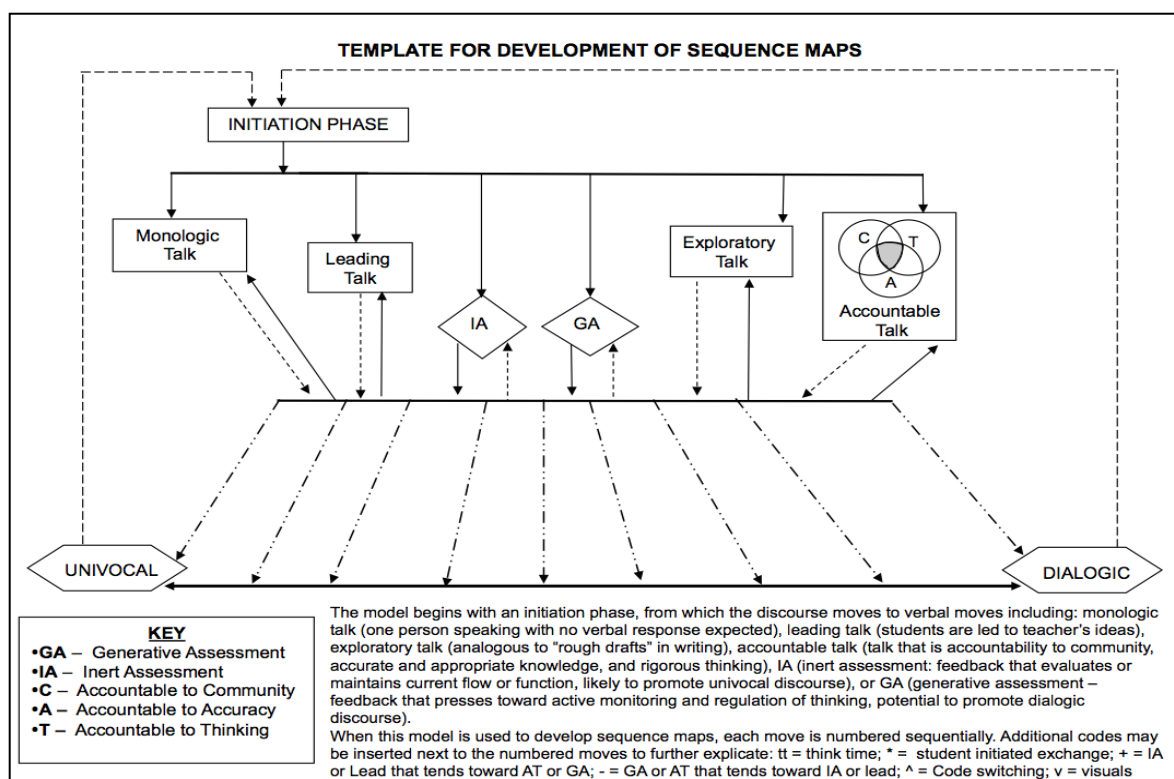


Figure 3. Template for developing sequence maps.

Figure 4 shows examples of a sequence map and associated dialogue. Note than only those moves that were actually used in the dialogue appear in the sequence map. Explanations of coding of verbal moves are shown in Table 2.

Sequence 1 was a simple sequence that involved a daily routine of singing a song together. The numbers on the map indicate the verbal moves that coincide with the transcript (far left column of transcript). Note “code switching” to English in move 2 (“Ready? Go.”).

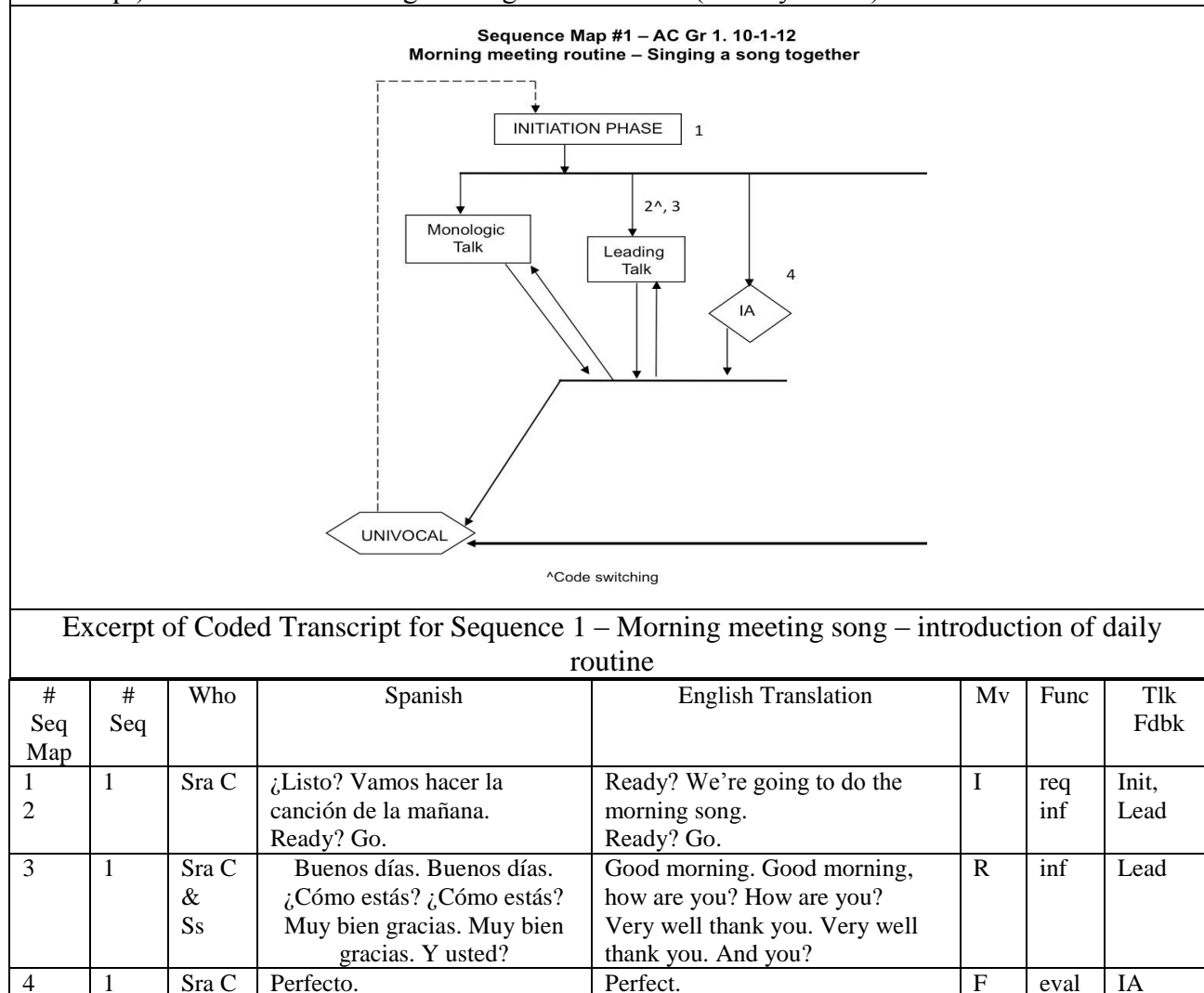


Figure 4. Description, sequence map and coded transcript representing univocal discourse.

Note: For additional details related to coding, mapping, and development of teaching models, please refer to Truxaw & DeFranco, 2008.

Table 2

Description of Column Headings in Coded Transcript

Column Heading	Explanation
# Seq Map	The move number within that particular sequence (i.e., numbering starts at 1 for the first move in a new sequence)
# Seq	The number of the sequence within that lesson (i.e., “1” represents the first sequence in the lesson, “2” represents the second sequence in a lesson, etc.)
Who	The speaker
Spanish	The words spoken in the class in Spanish (though some code switching to English may also be represented)
English	English translation of the dialogue;
Mv	Verbal move – I (initiation), R (response); F (follow-up);
Func	Function of the move – for example, req inf (request information), inf (inform), eval (evaluate) (see Author & Colleague, 2008 for details)
Tlk Fdbk	Talk/feedback – forms of talk or verbal assessment (e.g., init [initiate the sequence], lead [leading talk], IA [inert assessment])

Results

Similar to results from monolingual classrooms (Truxaw & DeFranco, 2008), analysis revealed discourse in DLP classrooms to be predominantly univocal (e.g., leading talk and IA). However, there were examples of shifts toward dialogic discourse that provide glimpses of promising practices. Verbal moves associated with dialogic shifts include: *exploratory talk*, *accountable talk*, and/or *generative feedback*. Additional supporting moves were identified, including: *think time*, *visuals*, *use of learners’ L1*, and *code switching* (see Table 3).

Table 3.

Supporting Moves

Supporting Move	Description
Think Time	Providing students with time to think about the mathematics (e.g., wait time, partner talk, etc.)
Visuals	Using visuals (e.g., pictures, writing, gestures, and manipulatives) to support verbal moves
L1 Use	Using students’ primary language (L1) for instruction
Code-switching	Switching between languages (e.g., English and Spanish)

Analysis of Lesson from Señora Castro’s Grade 1 Class

Sra. C's first-grade Spanish-language mathematics lesson is used to illustrate results. The line-by-line analysis of this lesson in Sra. C.'s first grade class revealed four episodes and 18 sequences within these episodes (see Table 4).

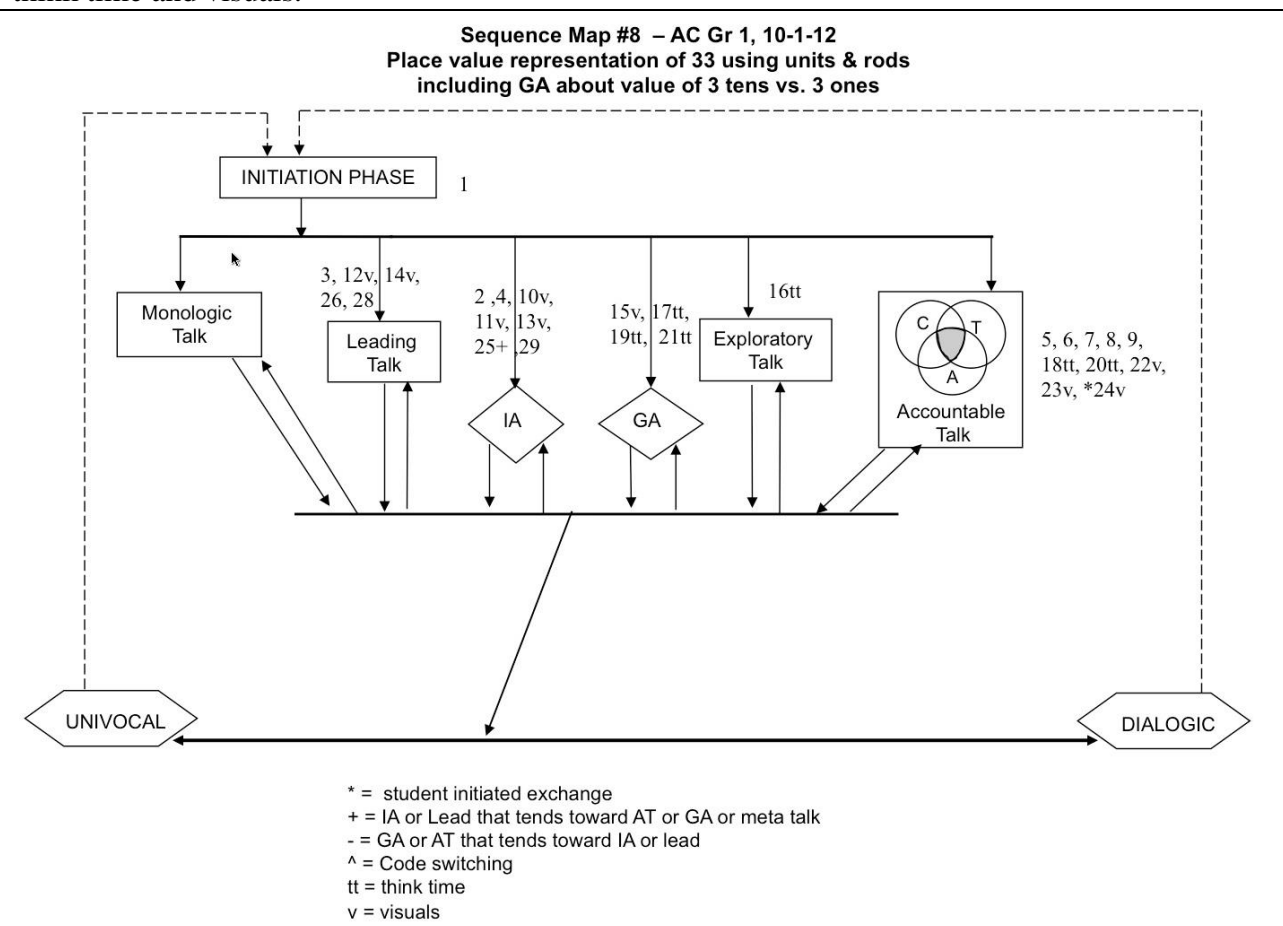
Table 4

Episodes in one First Grade Mathematics Class - Señora Castro Teacher

Episode #	Topic/Theme	Sequences
1	Morning meeting – Day 33 of school – various representations of 33 (calendar, pocket chart, place value sticks, numbers, words, tallies, etc.)	1-9
2	Addition or subtraction (“suma o resta”) word problems – whole class discussion and practice	10-14
3	Setting up and facilitating independent work	15
4	Closure – whole group discussion and journal writing	16-18

In the first episode of this lesson, routines with specific procedures and expectations were facilitated. Although the analysis shows that overall the discourse tended toward univocal, there was evidence that Señora Castro encouraged students to explore, to think, and to explain (shifting somewhat toward dialogic discourse). Señora Castro facilitated a classroom routine where students represented the “number of days in school” (e.g., 33 days) in multiple ways – words, tally marks, pictures, etc. Examples of shifts toward dialogic are shown in Figure 5 (displaying a sequence map and associated dialogue from sequence 8 within the first episode) and are explained below. Note that Sra. C. began the sequence using predominantly leading talk and IA and then infused GA, exploratory talk, and accountable talk. As suggested in earlier research, leading talk and IA may be appropriate for setting up common understanding of the task or problem at hand prior to infusing GA to press students' thinking. Sra. C. seemed to do just this – set up common understanding through predominantly univocal discourse and then press toward thinking and more dialogic discourse.

Sequence 8 description – After sharing various representations for 33 in earlier sequences, sequence 8 continues with representing 33 using place value materials. The numbers on the map indicate the sequence of verbal moves and support that coincide with the transcript (far left column). The discourse is predominantly univocal, but includes some tendencies toward dialogic. Note coding of exploratory talk, accountable talk, and generative assessment. Also note coding of think time and visuals.



#Seq Map	#Seq	Who	Spanish	English Translation	Mv	Func	Tlk Fdbk/ Support
1,2	8	Sra C	O, ya se me olvidado algo muy importante. Necesitamos agregar ¿qué? (Shows base-ten blocks.)	Oh, now I forgot something very important. We need to add what?	I	req inf	Init, IA
3	8	Ss	Un palito más.	One more stick.	R	inf	Lead
4	8	Sra C	Un palito más. ¿Se agregaron uno?	One more stick. Did you add one?	F/I	req inf	IA
5	8	S	Tres!	3!	R	inf	AT
6	8	Sra C	¿Tres más? ¿Qué paso aquí? ¿No agregaron con la substituta?	3 more? What happened here? You didn't add with the substitute [teacher]?	F/I	req inf	AT
7	8	S	No porque mañana era sábado y domingo y viernes.	No because it was Saturday and Sunday and Friday.	R	inf	AT
8	8	Sra C	O, pero jueves no agregaron?	Oh, but Thursday you didn't add?	F/I	req inf	AT
9	8	S	No.	No.	R	inf	AT

10 11	8	Sra C	No, <i>okay</i> bueno. Entonces tenemos tres unidades. ¿Cuántos unidades?	No, okay fine. So we have three units. How many units?	F I	inf req inf	IA IA V
12	8	Ss	Tres.	Three	R	inf	Lead, V
13	8	Sra C	Tres. Y se nos (*inaudible) nuestra vasito ... ¿Cuántas decenas?	Three. And our (*inaudible) little cup ... How many tens?	F I	ackn req inf	IA V
14	8	Ss	Tres.	Three.	R	inf	Lead, V
15	8	Sra C	Espera. Tengo tres decenas, y tres unidades, ¿esto es igual? Tres y tres es igual? Tres decenas es igual a tres unidades? (Holds up base ten blocks.)	Wait. I have 3 tens, and three ones, is this equal? Three and three is equal? Three tens is equal to three ones? (Holds up base ten blocks.)	F/I	req ag/ dis	GA V
16	8	Ss	[Mixed responses] No...	[Mixed responses] No...	R	inf	ET, TT
17	8	Sra C	¿Quien piensa que sí? [gestures thumbs up]	Who thinks it is? [gestures thumbs up]	I	req ag/dis	GA TT
18	8	Ss	[some ss indicate thumbs up]	[some ss indicate thumbs up]	R	ag/dis	AT, TT
19	8	Sra C	¿Quién piensa que no? ? [T gestures thumb down]	Who thinks it isn't? [T gestures thumb down]	I	Req ag/dis	GA, TT
20	8	Ss	[some ss indicate thumbs down]	[some ss indicate thumbs down]	R	ag/dis	AT, TT
21	8	Sra C	Hmm <i>okay</i> , ¿quién nos puede decir porque no? ¿Por qué no es igual? [S name], porque no es igual?	Hmmm okay, who wants to tell us why it isn't? Why isn't it equal? [S name], why isn't it equal?	I	req just	GA, TT
22	8	S	... la suma no puede hacer igual porque hay 30 allí, y si pones tres mas no es tres...	... the amount can't be equal because there are 30 there, and if you put 3 more it isn't 3...	R	expl	AT, V
23	8	Sra C	So, este son mas. Sí, <i>so</i> esta son tres unidades.	So, these are more. Yes, so this is 3 ones.	F	expl	AT, V
24	8	S	También hay de esos, de esos. [S stands up & points to place value blocks]	Also there are those, from those. [S stands up & points to place value bloxk]	I	expl	AT V
25	8	Sra C	Sí, o, <i>so</i> tú, [S name], quieres decir que cada uno vale...	Yes, oh, so you, [S name], want to say that each one is worth...	R I	rev req clar	IA+
26	8	S	10.	10.	R	inf	Lead
27	8	Sra C	10. En realidad esto es 10, 20, 30.... 30, y luego... cuento, listo? [S name] vamos así.	10. In reality this is 10, 20, 30... 30, and later... count, ready? [S name], like this.	F/I	inf restate	IA
28	8	Ss/S ra C	10, 20, 30, 31, 32, 33.	10, 20, 30, 31, 32, 33.	R	inf	Lead
29	8	Sra C	Perfecto, 33...	Perfect, 33...	F	Eval	IA

Key to Talk/Feedback/Support Coding:

Lead = Leading Talk; ET = Exploratory Talk; AT = Accountable Talk; IA=Inert Assessment; GA = Generative Assessment, V= Visuals; TT = Think Time; L1 = use of L1; CW = Code Switching
Note that L1 is not noted in coding because the lesson was taught in Spanish, the L1 for most students.

Figure 5. Description, sequence map, and coded transcript for sequence 8 of grade 1 class.

In sequence 8 (see Figure 5), there are interesting verbal moves and exchanges to note. Sra. C. initiates the sequence with IA and leading talk. Moves 5-9 show exchanges between Sra. C.

and the students where they verbally work to clear up what had been done when there had been a substitute teacher and how to move forward appropriately. These moves show accountability to the classroom community and to working to accurately represent knowledge (two components of accountable talk). Although these moves would not be considered fully accountable talk, they demonstrate a commitment to communication and development of common understanding within the learning community. Another interesting point begins around move 15. As a class, they had shown 33 using place value materials to represent 3 tens (decenas) and 3 ones (unidades). Sra. C. paused, held up the base-ten blocks, and asked questions to help students think about place value.

Spanish:

“Espera. Tengo tres decenas, y tres unidades, ¿esto es igual? Tres y tres es igual? Tres decenas es igual a tres unidades?”

English translation:

“Wait. I have three tens, and three ones, is this equal? Three and three are equal? Are three tens equal to three ones?”

Señora Castro infused GA, visuals, and think time. Then, Señora Castro asked her students to put thumbs up or down to indicate if they thought three tens were equal to three ones (provoking students to think about place value, not just the value “3”). She then asked several students to explain their thinking. Students “explained” with a combination of words (in Spanish) and pointing to materials and numbers. The students seemed interested and willing to try to use language, gestures, visuals, and hands-on materials to explain and build meaning about the concepts. Señora Castro’s strategic use of verbal moves and support encouraged her students to think about and explain the difference between 3 tens and 3 ones, thus building and reinforcing concepts related to the value of the numbers and place value.

Within this sequence, dialogic shifts are associated with exploratory talk, accountable talk, and GA. Also relevant are support strategies such as think time, visuals, and use of students’ L1 (i.e., Spanish); these strategies are consistent with ones suggested in the literature for supporting emerging bilingual students (e.g., Truxaw & Rojas, 2014; Echevarría, Vogt, & Short, 2010; Moschkovich, 2007). Additionally, it is worth noting that *prior to* pressing toward more dialogic discourse, it may be beneficial to set up some common understanding as a base from which to press student thinking.

Conclusions and Implications

As noted in the introduction to this paper, it is critical that we hold the same high expectations for ELs that we do for other students. These expectations include developing understanding of rigorous mathematics content and also key mathematical practices (CCSSI, 2010). Also, we must identify and provide opportunities and support for ELs so that they can meet these expectations.

The results of this study suggest that ELs are capable of participating in meaningful mathematical discourse when provided with opportunities to think, explore, discuss and explain. The teacher's role is important in orchestrating such discourse. Researchers (e.g., Moschovich, 2007) remind us of the importance of moving beyond simple vocabulary with ELs in order to support meaningful mathematical discourse and learning. This research suggests promising moves and practices for supporting ELs.

First, because the practices documented took place in dual language program classrooms, there are implications about providing opportunities for ELs to use their primary language (L1) in mathematical discussions. Cummins' (2005) *Common Underlying Proficiency Model* supports the idea that academic proficiencies develop regardless of the language used for such development. Allowing ELs to use their L1 to participate in dialogic discourse may help them to build mathematical meaning.

However, recognizing that dual language programs are not universally available, there is still much to learn from this research. Even if teachers are not fluent in students' L1, it may be possible to provide support for emerging bilingual students as they construct meaning about mathematics. For both dual language and English-language classrooms, identifying the verbal moves and practices associated with dialogic discourse could help mathematics educators to support mathematical meaning making. Suggestions include: encouraging *exploratory* and *accountable talk*, infusing *generative assessment* moves, providing opportunities for *think time* in the students' L1 (through wait time, self talk, partner talk, writing, etc.), providing visual cues, allowing *code switching* (Moschovic, 2007) between the L1 and L2, and determinedly not watering down the mathematics for emergent bilinguals.

Speaking more than one language is a strength, not a deficit. It is important to figure ways to support students who have the capacity to learn more than one language to also learn mathematics meaningfully. This research provides beginning steps toward this goal.

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