# Assessment and Evaluation in Bilingual Education

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# Margarita Machado-Casas and Yolanda Medina

*General Editors*

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**Developing Bilingual/Dual Language Educators' Assessment Practices**

# 8. A Classroom Observation Tool for Assessing Mathematics in Two Languages

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Although there are few research studies on math instruction in dual language programs, there is ample evidence that Emergent Bilingual Learners (EBLs) are not performing to their potential in this discipline. Trends in the National Assessment of Educational Progress (NAEP) illustrate a continued disparity between students designated as English Language Learners and native English speakers in terms of math achievement (NAEP, 2017). For more than a decade, on average a statistically significant gap of 25 points has existed between these two student groups. Other research on the achievement gap suggests that forms of tracking students based on students' native languages may be a significant explanatory factor (Mosqueda & Maldonado, 2013). Still, others have found that the structure of assessments and their validity do not allow EBLs to fully demonstrate their understandings (Martiniello, 2008; Solano-Flores & Chía, 2017).

These results are further problematized with the implementation of the Common Core State Standards (CCSS, 2010) in several states (e.g., California, Arizona) and the pronounced attentiveness to the role of language in teaching and learning mathematics that are now a part of the instructional goals of teachers (Lee, Quinn & Valdés, 2013). With the renewed focus of language across content areas, teachers must develop new forms of instructing EBLs across content areas that account for not just conceptual development but bilingual development as well.

To assist teachers to further develop the knowledge, skills and dispositions that are necessary to work with EBLs, we developed the Mathematics and Language, Literacy Integration (MALLI) project.[1] The goals of MALLI are to bring to bear seasoned teachers, parents and math methods instructors' knowledge to prepare the next generation of bilingual teachers. The project draws from the literature that has shown promise to assist EBLs acquire language in and across content areas (Llosa, Lee, Jiang, Haas, O'Connor, Van Booven, & Kieffer, 2016; Musanti & Celedón-Pattichis, 2013; Zavala, 2017) and share these practices with pre-service teachers, cooperating teachers, and parents. Vocabulary, literacy and discourse practices that are germane to the mathematic discipline are integrated into the pre-service teacher education program. The research project developed an observation instrument to capture pre-service teacher's enactment of instructional practices that utilized language and literacy as tools for mathematics learning and bilingual development. In this chapter, we chronicle the development of this instrument that we refer to as the Mathematics Classroom Observation Protocol (M-COP). The M-COP was modeled after the Science-Classroom Observation Protocol (SCOP) (Cervetti, Kulikowich, and Bravo (2015). Before we describe the development and piloting of this instrument, we describe the MALLI project to offer a context for this instrument and what we intend for it to capture.

## *MALLI*

The MALLI project addresses the shortage of bilingual teachers in California and Texas (Arroyo-Romano, 2016; Carver-Thomas & Darling-Hammond, 2017; Kennedy, 2018). The main goals of the MALLI project involve supporting the learning of new bilingual teachers by providing models of effective pedagogy that support math learning and language development.

The research that we are conducting is guided by the following Theory of Change (Figure 8-1):

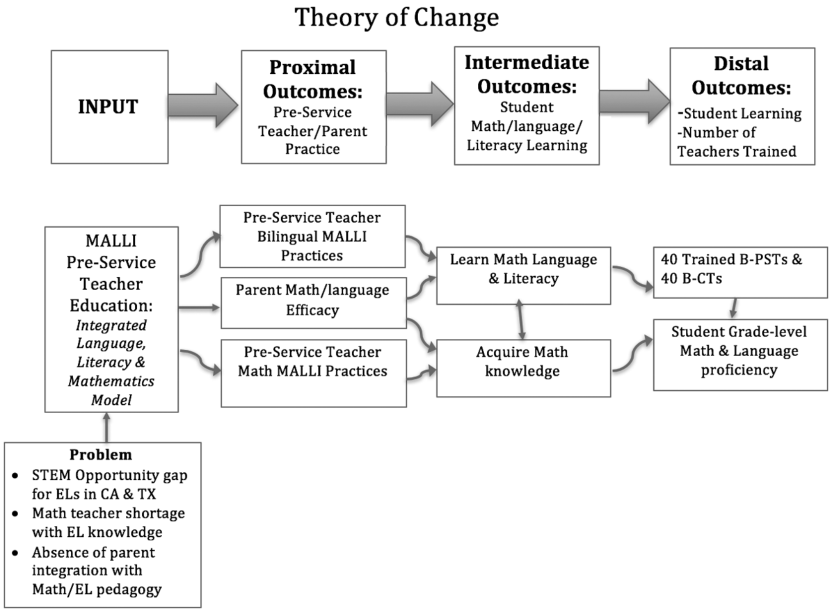


*Figure 8-1.* MALLI Theory of Change

To support the bilingual pre-service teachers, the MALLI project also involves bilingual master teachers (experienced teachers that host bilingual pre-service teachers in their classroom) and bilingual parents of the children that pre-service teachers work with at their student teaching placement. Both groups receive professional development opportunities in the MALLI practices in order to support the pre-service teacher in implementing instruction that develops content while students also sharpen their bilingual skills.

There are three MALLI teaching practices: (1) Mathematical Discourse, (2) Mathematics Vocabulary and; (3) Mathematics Bi/literacy. *Mathematical Discourse* refers to the structure of written or oral explanations and arguments that take place within the mathematics discipline (Rumsey & Langrall, 2016) as well as the evidence that is suggested to be leveraged to support explanations and arguments in mathematics (Knudsen, Stevens, Lara-Meloy, Kim & Shectman, 2018). Moschkovich (1999) states that this form of talking and writing is different than merely using particular math vocabulary. Rather, mathematics discourse means talking and acting "to prove or explain statements." Additionally, allowances for translanguaging practices are promoted, as EBLs pose a wide array of linguistic tools that they can bring to bear to solve problems (Garcia & Wei, 2014).

The MALLI project addresses *Mathematics Vocabulary* by drawing attention to the nature of vocabulary and strategies that can be applied to give access to these words in mathematics. Math vocabulary includes words that are rare and most likely to be encountered in the discipline. These words are commonly referred to as technical tier 3 words due to the infrequency with which they appear in everyday contexts (Beck, McKeown & Kucan, 2002). Math vocabulary often is present in collocation form (e.g., Distributive Property, surface area), that if not read collectively, can lead EBLs to the wrong meaning. These issues are addressed by providing pre-service teachers with instructional models to address these linguistic pitfalls which take place across languages. Strategies include attention to cognate relationships which can provide access to the meaning of unfamiliar math terms.

*Mathematics Literacy/Biliteracy* practices include the types of reading and writing that are part of the mathematics discipline. Pre-service teachers are provided with models for teaching writing during math time that can include such practices as written explanations that describe how they solved a math problem, writing math word problems for others, and constructing tables and diagrams to explain their mathematical thinking. Similar instructional models are offered regarding reading math texts that include reading strategies (e.g., changing rate of reading, utilizing their native language) and how to make sense of diagrams, tables and charts, which require explicit instructional attention (Mosqueda, Bravo, Solís, Maldonado & De La Rosa, 2016).

While this study is preparing pre-service teachers to teach integrated math, language and literacy in Spanish, pre-service teachers are regularly given examples to help elicit the full linguistic repertoire that is afforded to EBLs (García & Wei, 2014). This is especially the case when asking students to construct oral explanations and arguments or writing about their procedures to solve math problems. Saliency for particular words, phrases and experiences drive what pre-service teachers elicit from students when teaching mathematics. Moreover, the goal of MALLI is also to promote instructional strategies that are not didactic or follow the typical interaction in classrooms where a teacher *Initiates,* a student *Responds,* and the teacher again takes a turn to *Evaluate*. This IRE-model (Mehan, 1979), is not very conducive for bilingual and biliteracy development and hence we promote more interaction and opportunities for student-to-student talk where students take more turns in talking than does the teacher. The MCOP instrument is structured to capture these practices and how they are enacted. A description of this instrument is presented below with exemplars that we have captured thus far in our observations of pre-service teachers after participating in the MALLI project.

## *M-COP*

The MALLI classroom observation protocol is designed to document the array of practices employed by mathematics teachers at the elementary level with a special focus on literacy and language development activities in Spanish as math is taught. The tool was developed to capture instruction taking place in bilingual education programs. This includes the wide array of bilingual programs (e.g., Early-Exit Bilingual Programs, Two-way Bilingual Programs) where two languages are used for instruction.

This observation protocol includes three parts. The first involves capturing information about the classroom setting. This is followed by the observer taking ethnographic notes of the instruction taking place. Observers take ethnographic notes for seven-minute chunks of instruction and then identify which codes (MALLI Practices) were noticed during the seven-minutes of instruction. This pattern is repeated for the duration of the observation which usually takes between 30 and 45 minutes. The last part of the observation scheme is an Implementation Questionnaire—a series of questions and activities that ask the observer to reflect back on what was observed and document implementation of language learner adaptations.

### *Part 1: Pre-Observation Data Gathering*

This section of the observation scheme gathers information about the classroom setting, including grade level, teacher code, date, start time and number of learners in the class. Observers are asked to gather additional information from the pre-service teacher, including a lesson plan and the number of English Learners and Spanish Learners in the classroom. The observer checks in with the pre-service teacher before the observation to ask if the lesson will be in English-only, Spanish-only or flexible language use. The number of adults in the room is also gathered including documenting if the adult is a teacher, teaching aid, parent, other pre-service teacher or other adult.

The observer gathers physical environment data of the classroom. The observer notes what technology is available in the classroom, the environmental print on the walls and in what language that print is written in and classroom library. The observer draws a sketch of the arrangement of tables and desks as well. This portion of the M-COP is attempting to capture the general linguistic ethos of the classroom. Here we recognize the classroom as a dynamic, complex and socially constructed space (Candela, Rockwell, & Coll, 2004), yet a context that requires professional vision (i.e., relevance of seating arrangements, student roles, materials, use of technology, etc.) in order to contextualize the focal classroom events and activities (Sherin, 2014).

## *Part 2: Narrative Notes and Coding*

*Narrative Notes.* To capture the instructional practices of pre-service teachers, particularly the attention to language and literacy development as they taught mathematics, observers write narrative notes of the instruction taking place. The shorthand description of pre-service teacher activity and student response captures not only what students and pre-service teachers are doing, but the language of instruction, use of technology, grouping structures, the use of vocabulary, literacy involved in the task as well as any discourse activities. These narrative notes take place over a seven-minute span. Below we provide a short example of these narrative notes by drawing from an observation of a bilingual teacher candidate (Ms. Betty) placed in a 1st grade classroom teaching a full math lesson for the first time (Figure 8-2).

*Figure 8-2.* Sample Narrative Notes

| Time | Notes |
|---|---|
| 0 | T asks—"what's a strategy?". Calls on Ariel<br>Ariel. Alby, Haley, Junior all respond to the same question; science, math, using things in diff ways<br>T writes "strategy" on the board and then asks again for more ss definitions |
| 2:30 | T says "talk with partner". Question "what strategies are used for addition" while T writes the definition on the board |
| 3:13 | "Eyes on me". T stops partner talk and asks Ss to share with class<br>S1 offers "counting"<br>T asks for an example<br>S1 then writes the example on a paper poster under "strategy example"<br>T then asks Emilia do it with fingers too and others<br>T asks then for another strategy<br>Abby says "doubles"<br>T asks Abby to "show us"<br>Abby writes on the poster<br>T asks for another<br>Haley offer skip count<br>T says "ok show us"<br>Haley goes up and writes it on poster<br>T repeats strategy<br>T ok another one<br>S "number patterns". T number four writes number patterns |
| 7:10 | S explains |

In this case, Ms. Betty's lesson lasted more than 65 minutes which means that a narrative excerpt like the one in Figure 8-2 was repeated approximately nine times covering the entire observation using the MCOP instrument. Moreover, the narrative notes were used as an additional reference to identify and support the MCOP codes that were found present in the instruction.

*Codes.* After each seven-minutes of coding, the observer then turns to the codes for three minutes of coding. The coding scheme is made up of five levels: (1) Languages; (2) Major Instructional Focus; (3) Instructional Activities; (4) Teacher Interactions and; (5) Student Response.

*Language.* Each seven-minute segment of instruction is given a *Language* code that can be Spanish (S), English (E), or Translanguaging (T). As can be expected a code of (S) or (E) means the pre-service teacher provides the majority of instruction in either Spanish or English. Yet, if the pre-service teacher provides instruction across languages flexibly and/or allows/promotes this from students (e.g., allow for google translate, discussion allowed in either or both languages), then the *Translanguaging* code (T) is utilized.

*Major Instructional Focus* captures what the main goal was for students during the seven-minutes of instruction. This included whether students were involved in doing a math activity, including watching the teacher demonstrate an example math problem (D), reading (R) about mathematics, including making sense of data tables, writing (W) about math concepts, procedures or reasoning, listening (L) to the teacher or other students about a math activity, talking (T) about data or how to solve a math problem. There is a code in the instrument to capture non-relevant activities (e.g., interruption to the class, pre-service teacher taking attendance) (O).

The transcript above in Figure 8-2, received the code (T), given the major focus for students was talking and discussing the math task.

*Instructional Activities.* The Instructional Activities domain contains four major sets of codes, including (1) math instruction; (2) Vocabulary; (3) Literacy; (4) Discourse. Each of these domains contain sub-domains and each sub-domain is further detailed by what the teacher was doing (*Teacher Interaction*) and what the *Student Response* was, both of these level 4 and 5 codes will be explained below, as they pertain to the *Instructional Activities* code. The codes pertaining to the math instruction domain are presented below in Table 8-1.

*Table 8-1.* Math Instruction

| | | |
|---|---|---|
| **Math Concepts** | **MC** | Focus is on concepts. Teacher or students are introducing, composing, or reviewing math concepts. This may include:<br>• writing key concepts about math<br>• teacher expands a student's response in a conceptual way |
| **Math Procedural** | **MP** | Focus is on helping students complete procedural task or skill development (e.g., multiplication table). |
| **Math Procedural & Conceptual Connected** | **MCP** | Focus is on making connections between procedural knowledge and conceptual development (***MC supersedes MP***). |
| **Math Models** | **MM** | Focus is on using models to illustrate math concepts.<br>• Models include diagrams, physical replicas, mathematical representations, analogies, and computer simulations. |
| **Analyzing or sharing data** | **AD** | Focus is on making sense of or sharing data.<br>Students may be:<br>• Organizing data, e.g., transforming data into a data table.<br>• Making sense of their data<br>• Making claims about their data or drawing conclusions<br>Use this code when the teacher is discussing or modeling these activities, as well as when the students are engaged in them. |

These codes help capture what the instructional focus was for the math lesson. Whether the pre-service teacher focused on developing a math concept or build students' computational knowledge (Math Procedural), we code MCP if the teacher makes a connection between the MC and MP code. The instrument also captures whether the teacher is utilizing models to make math concepts clearer or the use of data and how to draw conclusions from a data set.

The vocabulary domain contains two subdomains. Table 8-2 below describes these two sub-scales.

*Table 8-2.* Vocabulary

| | | |
|---|---|---|
| **Vocabulary Concepts** | **VC** | Focus is on word meanings. Students/teachers are engaged in discussing/ working on word meanings; students are recording words and definitions or synonyms; the teacher is previewing, introducing, or reinforcing word meanings; or the teacher is defining words in context. |
| **Vocabulary Strategy** | **VS** | This may include discussions of cognates. A focus on word analysis, such as strategies for using morphology to discern the meanings of words. |

Codes VC and VS refer to whether the vocabulary instruction was focused on getting at the meaning of a particular math concept or helping students build a strategy to make sense of unfamiliar math vocabulary. Note that within these constructs, language of instruction is fluid and the instrument is set to capture nuances of language use, whether English, Spanish, or both.

For example, in the following exchange we see how the language in use can shift sometimes momentarily, other times more extensively, and usually strategically. The segment scored covering this stretch of the lesson would be coded as *translanguaging* given that the teacher manages both languages in the lesson (García & Kleyn, 2016). The example draws from an observation of a bilingual teacher candidate teaching a math lesson on addition in a dual language Kinder classroom. The bilingual teacher candidate (BTC) asks the class, while holding up a six-inch die, "¿Quién me puede decir qué es esto?" ((who can tell me what this is?)). Here several students make observations of the large die held by the BTC. Tony promptly responds first to the BTC's Spanish-constructed question with the response of "a die" in English (line 5). The BTC responds strategically by repeating his response in English and then asking for a response in Spanish (line 6).

**Excerpt 1**

| | | |
|---|---|---|
| 5 | Tony | A die |
| 6 | BTC | A die, *¿en español?* ((a die, in Spanish?)) |
| 7 | Stu2 | *Un cubo* ((a cube)) |

After several exchanges in Spanish and specially no one yet identifying the name of "die" or "dice" in Spanish, the BTC asks again in Spanish "*¿Quién sabe cómo se llama en español?*" ((who knows what it's called in Spanish?)) (line 18). But here again we see another student (Lupe) shifting to English to address the question with her response of "it's a die" like Tony previously. Lupe had previously revoiced a student observation with "*y tiene círculos*" ((and it has circles)) in Spanish (line 16) as well.

**Excerpt 2**

| | | |
|---|---|---|
| 16 | Lupe | *Y tiene círculos* ((and it has circles)) |
| 17 | BTC | *Tiene círculos* ((it has circles)) |
| 18 | | *¿Quién sabe cómo se llama en español?* ((who knows what its called in Spanish? |
| 19 | Stu4 | *Un cubo* ((a cube)) |
| 20 | BTC | *¿Un cubo? Sí, muy bien* ((a cube, yes very good)) |
| 21 | | *¿Quién los ha visto? Levanten la mano* ((who has seen it? Raise your hand)) |
| 22 | | *Sí*, Lupe ((Yes, Lupe)) |
| 23 | Lupe | It's a die |

By noting how these language shifts are managed, expanded on, or restricted throughout a lesson, we can learn more about the language goals of each lesson, schoolwide dual language policies, and more broadly, how these decisions reflect broader language ideologies.

The *Literacy* domain consists of five sub-scales, focused on reading, writing and language development. Table 8-3 below further defines the type of literacy that we coded for during the observations.

*Table 8-3.* Literacy

| | | |
|---|---|---|
| **Reading** | **R** | Activity involves reading various math texts (e.g., ruler, diagrams, book, chart, graph, worksheet, poster, traffic signs).<br>Students may also be searching for information to answer questions, to support their Math activity, or to write or present. |
| **Reading Instruction/ Discussion** | **RI** | Focus is on instruction or discussion about math texts (diagrams, graphs, ruler, table). This may include:<br>• Students are learning about text structures or features of math text or genres of math text. |
| **Writing** | **W** | Focus is on writing math texts (e.g., word problem, table, graph, diagram), including writing organization or instruction on important elements of math compositions. (showing work with numbers not W) |
| **Writing Instructions** | **WI** | Focus is on instruction or discussion about writing math texts (diagrams, graphs, ruler, table, converting units). This may include:<br>• Students are learning about how to construct text math texts in appropriate genre. |
| **Language Development** | **LD** | Focus is on language development (e.g., metaphors, idioms, subject/verb agreement). |

The *Literacy* domain specifically captures literacy that is germane to the mathematics discipline. That is, we code for reading and writing of math texts such as reading diagrams, word problems and reading a protractor for example. We noted that there were examples of teachers attending to accompanying literacy features such as those related to pronunciation of key terms and concepts (language development), classification of concepts (i.e., pictographs as a type of graph), and reading visual representations commonly found in the math texts. We see literacy supports provided by the teacher in Excerpt 3. In the example below, the BTC is teaching a 1st grade class focused on reading mathematical information represented in different types of graphs. She begins the lesson by announcing to the class that the lesson was going to be related to graphs and asks students, "¿Qué tipos de gráficas hemos aprendido?" ((What types of graphs have we learned about?)). The BTC guides the discussion by noting precisely her interest in "types of graphs" and not merely graphs (line 8). This led to students identifying both bar graphs and pictographs as related to the topic of graphs (lines 9–11). Moreover, the BTC provides language development support by helping students repeatedly hear and pronounce the word "*pictografía*" *((pictograph))*. Student clearly have difficulty articulating this word (Lines 11,13), and the teacher picks up on it.

**Excerpt 3: Language and Literacy Support**

| | | |
|---|---|---|
| 8 | BTC | *¿Sí, pero qué tipo de gráficas hemos visto?*<br>((Yes, but what type of graphs have we seen?)) |
| 9 | Stu2 | *Estamos viendo graficas de barra*<br>((We are seeing bar graphs)) |
| 10 | BTC | *Graficas de barra*<br>((bar graphs)) |
| 11 | Stu3 | *Picto, Pictografia, no sabia como pronunciarlo*<br>((Picto, pictograph, I didn't know how to say it)) |
| 12 | BTC | *Hemos aprendido sobre gráficas de barra y pictografía*<br>((We have learned about bar graphs and pictographs)) |
| 13 | Stu4 | *Y también picto—*<br>((and also picto)) |
| 14 | BTC | *¿Se acuerdan que es pictografía?*<br>((Do you remember what is a pictograph?)) |
| 15 | Stu5 | *Sí, cuando tiene fotos*<br>((Yes when it has pictures)) |
| 16 | BTC | *Cuando tiene símbolos de fotos*<br>((when it has symbols of pictures)) |

Of note as well is that the teacher reinforces academic terminology while augmenting students' contributions through reformulation of their definitions (Line 15–16). Our task as observers using the MCOP instrument was therefore to notice these overlapping literacy events and code the segments accordingly.

Moreover, in the case of literacy, we can observe and collect a range of mathematical representations created by students to demonstrate how a particular lesson evolved and support specific math practices. Figure 8-3 is an example of how a 1st grade bilingual lesson resulted in the production of different forms of writing following the model of 4 squares or "el modelo de 4 cuadros" to solve a word problem.

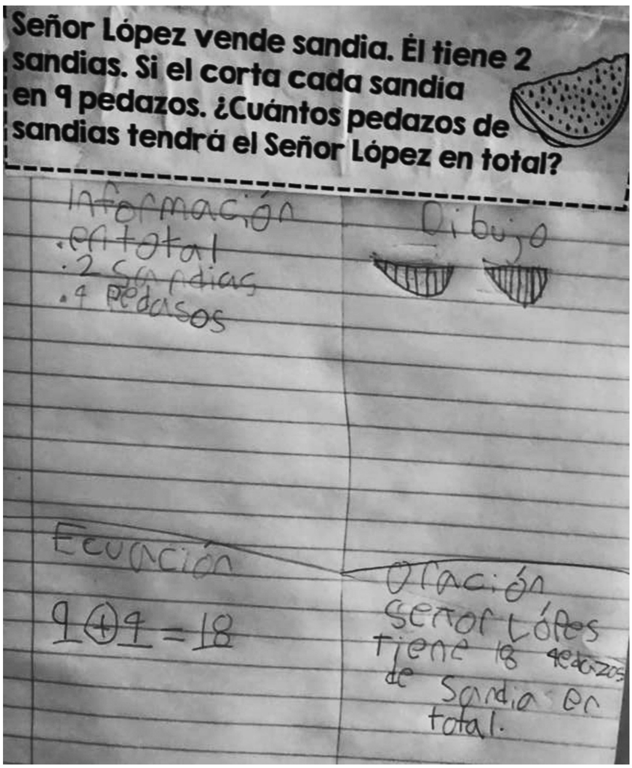


*Figure 8-3.* Writing Math

*Math Discourse* consists of five sub-scales that include whether the focus of instruction was making explanations about math activities, arguing for a position with respect to the math activity, the structure of the math talk activity, posing questions about math (e.g., Why do these numbers repeat?; Which words tell us to subtract?), and if prior knowledge is elicited. Table 8-4 below describe the codes.

*Table 8-4.* Math Discourse

| | | |
|---|---|---|
| Explanations/ Use of Evidence | **EE** | Focus is on the construction of math explanations supported by evidence (showing work of how to solve the problem in either orally, visual, or written form). |
| Math Argumentation | **MA** | Focus is on discovering new math ideas through convincing or being convinced that a math claim is valid (claim, evidence, reasoning-connecting evidence to claim--do you agree . . .). |
| Math Talk | **MT** | Focus is on structured talk about mathematics (concept; math careers; procedures; discourse of math). These structures can include Think-Pair-Share, Fish Bowl, Discourse Circle, elbow partner. |
| Questions About Math | **QM** | Focus is on posing questions about math. |
| Eliciting Prior Math Knowledge | **PK** | Different forms of mathematical contextualization that elicit students to share prior knowledge (outside of school) about math related ideas or topics. |

Below we provide a prototypical example of how math discourse is constrained. The example illustrates how a teacher structures an activity that allows students to share and explain their solutions. In the example below (Excerpt 4), a Kindergarten class is grappling with learning how to add two, three and four-digit numbers. A student (Beto) offers a solution to 1,000 plus 1,000 as equaling 1,002 (lines 24–26). The teacher (Ms.C) questions his solution (line 27) and then goes on to suggest they can solve it together (line 29).

**Excerpt 4: Missed Math Discourse Opportunity**

| | | |
|---|---|---|
| 22 | Beto | Miss Cortez |
| 23 | Ms.C | Beto |
| 24 | Beto | A thousand and a thousand |
| 25 | Ms.C | Uh-uh |
| 26 | Beto | It´s a thousand-two |
| 27 | Ms.C | A thousand plus a thousand is one-thousand-two? |
| 28 | Beto | Yeah |
| 29 | Ms.C | *Tal vez lo podemos resolver ahorita* ((perhaps we can solve it here now)) |
| 30 | Beto | Yeah |
| 31 | Ms.C | Okay |

This exchange exemplifies the rush to solve problems sometimes without engaging in reflective and explanatory math conversations with children. The missed opportunity occurs in Line 27 and Line 29 where instead of questioning Beto's solution or solving the problem, the teacher could have asked Beto to explain and/or describe how he solved the problem (MCOP codes EE, MA).

However, math lessons may contain activities that do promote a range of math discourse practices and with the MCOP, we can capture specific math discourse instances such as the lesson highlighted in Excerpt 5. The lesson begins with Ms. Lopez asking her 3rd grade bilingual students to pick-up their math notebooks. The lesson objectives are posted on the screen and read collectively. In addition to being able to multiply two-digit numbers, the lesson objectives include writing a mathematical solution in a complete sentence and being able to use previously identified math strategies and reasoning to solve a problem. The student read each objective in Spanish as most of the lesson was conducted in Spanish including this last part of the lesson objectives: *"[yo] puedo compartir mis estrategias con mis compañeros y describir mi razonamiento a la clase usando mi propia hoja de ancla* "/((I can share my strategies with my classmates and describe my reasoning to the class using my own anchor sheet)).

Ms. Lopez first checked with students if they knew what an "hoja de ancla" ((poster paper)) meant and then also checked with students if they knew the meaning of "auditorio" ((auditorium)) while showing them a picture of a lecture-style auditorium. Ms. Lopez then read a word problem together with the students projected on the screen asking students to find how many people can sit in a university auditorium with 14 rows and 38 seats in each row. She created eight groups of three students each assigned with one large, white blank piece of poster paper. Each student group then worked for approximately 25 minutes on solving the problem by including selecting a specific strategy for solving the word problem (MCOP codes MT, EE). Excerpt 5 describes part of the ensuing activity where each student group was asked to go to the front of the class, present their poster paper solution and express their reasoning for their solution.

**Excerpt 5: Promoting Student Math Talk and Reasoning**

| | | |
|---|---|---|
| 85 | Ms.L | *Bueno para empezar, ¿ qué estrategia usaron?* ((well to begin, what strategy did you (group) use?)) |
| 86 | Chuy | …*area* ((area)) |
| 87 | Ms.L | *¿Y como resolvieron eso?* ((And how do you solve that?)) |
| 88 | Chuy | *Hicimos 14 por 10 que es 140 y lugo los hicimos dos mas veces* ((we did 14 by 10 which is 140 and then we did that two more times)) |
| 89 | | *Y despues hicimos 8 por 14 que es 112* ((And then we did 8 by 14 which is 112)) |
| 90 | | *Entonces despues hicimos 140 mas 140* ((Then after we did 140 plus 140)) |
| 91 | | *140 mas 112 que es igual a 532* ((140 plus 112 which is the same as 532)) |
| 92 | Ms.L | *Muy bien* ((Very good)) |
| 93 | | *¿Y quien me puede leer la oración completa?* ((And who can read for me the complete sentence?)) |
| 94 | Maria | *532 estudiantes pueden sentar en el adentro del auditorio* ((532 student can sit inside the auditorium)) |
| 95 | Ms.L | *Muy bien* ((Very good)) |
| 96 | | ¿Y algo se les hizo difícil al principio o cambiaron su estrategia? ((And at the start was anything difficult or did you change your strategy?)) |
| 97 | Marta | ((looks at the poster)) |

This example highlights both repeated attempts by the teacher to augment, deepen and extend student math discourse through the use of explanatory prompts (Lines 87) as well as how a lesson can be structured, as in small groupwork, to enable greater student-to-student math talk and interaction (MCOP codes MT).

*Level 4. Teacher Interaction.* Each code referenced above correlates with a level 4 code that looks to capture the manner in which the preservice teacher is enacting the MALLI practices. We code if the teacher is telling or giving information (T), modeling (M) an activity, coaching or scaffolding (C) a task, listening (L) to students engage in an activity, reading aloud (RA) to students, engaging in a question and answer (QA) with students in an IRE sequence, having a discussion (D) with students that allows for more student to student interaction, eliciting prior knowledge (PK) or other (O) non-instructional activity.

*Level 5. Student Interaction.* For each level 4 code that the preservice teacher utilizes to engage students in the MALLI practices, we code the student response. We code if the student is reading (R), orally responding (OR), involved in discussion with the teacher (D), engaged with a student to student conversation (CV), observing a model (OB), listening to another student or to the teacher, manipulating objects (M), visually representing (VR) such as drawings, diagram or tables, writing (W) responses to math tasks, and other (O) non-instructional task.

## *Validation and Reliability*

The observation protocol was developed through a thorough review of the research literature regarding mathematics instruction (Hiebert & Carpenter, 1992; Rittle-Johnson, Siegler, & Alibali, 2001), bilingual education (Gándara, 2015; Jong, 2009), and content and language integration (Cervetti, Barber, Dorph, Pearson, & Goldschmidt, 2012; Lee, Quinn, & Valdés, 2013). This review helped us build our constructs of integration and the pedagogy necessary in working in dual language classroom settings. The instrument was then shared with five experts in the fields of mathematics, language, and teacher learning. This helped us further refine the constructs.

Six observers took part in a two-day training of the instrument. The training included an overview of the M-COP and four rounds of scoring using the coding scheme and a video of math instruction. These initial scoring sessions were followed by detailed discussions of observer scores and evidence to support those codes from their narrative notes. We conducted Interrater Reliability (IRR) checks and calculated IRR as percentage of absolute agreement to the main author of the instrument and differences in codes were discussed. By the eighth round of scoring we achieved an IRR score of 74%. These IRR checks are taking place after 1/3 of observations are collected to revisit the instrument and ensure the codes are being applied appropriately.

## *Discussion*

The MALLI Project goals discussed in this chapter attempt to support novice teachers and their EBL students in acquiring a powerful voice for explaining their mathematical thinking using sophisticated academic language, discuss and solve critical problems in mathematics, construct and extract meaning from mathematical texts, and accomplish these goals cross-linguistically, with the expectation that students' foundational knowledge in Spanish will transfer to English (and vice versa) (Cummins, 1991). Further, one of the deliverables of the MALLI project is an observational tool that can help capture, evaluate and provide guidance for teachers in the models of instruction that can best support EBLs' dual role of acquiring content while sharpening their biliteracy/bilingual skills.

The various dimensions of the M-COP offer a model for capturing classroom instruction, particularly instruction that is taking place across languages and within a content that is often thought of as being 'language-free'. If EBLs are to develop academic biliteracies, attention to language development across content areas will be necessary, as it is in content areas texts where the disciplinary language is made available. The M-COP is a valid and reliable instrument to capture these practices, which in turn can be utilized to evaluate bilingual programs, as well as provide guidance as to the focus of professional learning opportunities that can be made available to bilingual teachers. In our current work, we utilize these observation data to augment the bilingual teacher education program courses. We feed these data to the math methods instructors that work with our bilingual teachers so that they may emphasize (or de-emphasize) particular foci of the course that deals with the integration of mathematics and language. We have found that in order to get a consistent pattern of interaction, at least 30 minutes of instruction need to be observed. This would provide three segments of coding, a sufficient amount to decipher the instructional supports provided to emergent bilinguals. The evaluation of practice with the M-COP should be administered at least three times in order to see progression, but can also be administered as a pre/post observation in order to gauge growth in pedagogy.

This tool does not come without limitations. Learning the various codes to the point of reaching IRR was a challenge for the group of bilingual faculty and bilingual graduate students that are involved in the MALLI project.

The training that was needed was substantial and continues during data collection. With so many codes to keep in mind, conducting live scoring every seven minutes is an intense process. Also, the instrument attempts to capture multiple types of interaction and possible instructional activities that can take place during math instruction in bilingual settings, for which we may have not accounted for all. For example, it is clear that bilingual classrooms also house students with special needs (Baca & Cervantes, 2004) and the instructional supports a teacher might provide a special needs bilingual student may look different than the codes we present.

## Conclusion

The MCOP was developed to evaluate the efficacy of the MALLI project. The M-COP is a valid and reliable instrument. It has been tested and provided critical information about the academic biliteracy instruction that bilingual preservice teachers employ when teaching mathematics. For our research purposes, it captured fidelity of implementation of the MALLI practices. Pedagogically, it has helped identify preservice teachers' areas for growth and provided guidance to help focus future professional learning opportunities.

The MCOP results presented in this paper have important implications for policymakers, researchers and practitioners interested in improving teaching practices that maximize the linguistic knowledge and skills of bilingual students. The MALLI project recognizes that schools face persistent accountability pressures to demonstrate impact in dual language programs, we therefore draw from scholarship that advances a closer alignment between teaching and assessment practices and a holistic bilingual orientation to instruct and assess EBLs (García & DeNicolo, 2016; Soltero-González, Escamilla, & Hopewell, 2012). In terms of gauging EBLs mathematical learning, the MALLI project acknowledges that any assessment of content knowledge also is also an assessment of language. Moreover, to understand the mutual influence and development of two languages requires that both languages be examined together. Our project aims to demonstrate how the M-COP observation tool can support the development of mathematical biliteracy in dual language programs. While math instruction in Spanish is common in dual language programs, our aim is to contribute to pedagogical improvements that promote equity for EBLs by having a positive impact on students' mathematical achievement in dual language contexts. The next steps for this work are to continue to add new codes to the instrument in order to capture the wide range of practices utilized to maximize biliteracy and mathematical knowledge and skills.

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## References

Arroyo-Romano, J. E. (2016). Bilingual education candidates' challenges meeting the Spanish language/bilingual certification exam and the impact on teacher shortages in the state of Texas, USA. *Journal of Latinos and Education*, *15*(4), 275–286.

Baca, L. M., & Cervantes, S. (2004). *Bilingual special education interface*. Upper Saddle River, NJ: Pearson Education.

Beck, I., McKeown, M., & Kucan, L. (2002).Bringing words to life.NewYork: Guilford Press.

Bravo, M., Mosqueda, E., Solís, J. L., & Stoddart, T. (2014). Possibilities and limits of integrating science and diversity education in preservice elementary teacher preparation. *Journal of Science Teacher Education*, *25*(5), 601–619.

Candela, A., Rockwell, E., & Coll, C. (2004). What in the world happens in classrooms? Qualitative classroom research. *European Educational Research Journal*, *3*(3), 692–713.

Carver-Thomas, D., & Darling-Hammond, L. (2017). *Addressing California's growing teacher shortage*. Palo Alto, CA: Learning Policy Institute.

Cervetti, G., Barber, J. Dorph, R. Pearson, P. D., & Goldschmidt, P. (2012). The impact of an integrated approach to science and literacy in elementary school classrooms. *Journal of Research in Science Teaching, 49*(5), 631–658.

Cervetti, G. N., Kulikowich, J. M., & Bravo, M. A. (2015). The effects of educative curriculum materials on teachers' use of instructional strategies for english language learners in science and on student learning. *Contemporary Educational Psychology, 40*, 86–98.

Cummins, J. (1991). Interdependence of first- and second-language proficiency in bilingual children. In E. Bialystok (Ed.), *Language processing in bilingual children* (pp. 70–89). Cambridge, England: Cambridge University Press.

Gándara, P. (2015). Rethinking bilingual instruction. *Educational Leadership, 72,* 60–64.

García, G. E., & DeNicolo, C. P. (2016). Improving the language and literacy assessment of emergent bilinguals. In L. Helman (Ed.), *Literacy Development with English Learners: Research-Based Instruction in Grades K-6* (2 ed., pp. 78-108). Guilford Press.

García, O., & Kleyn, T. (2016). Translanguaging theory in education. In *Translanguaging with multilingual students* (pp. 23–47). Routledge.

García, O., & Wei, L. (2014). Translanguaging and education. In *Translanguaging: Language, bilingualism and education* (pp. 63–77). London: Palgrave Macmillan.

Hiebert, J., & Carpenter, T. P. (1992). Learning and teaching with understanding. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 65–97). New York, NY: Macmillan.

Jong, E. D., & Howard, E. (2009). Integration in two-way immersion education: Equalising linguistic benefits for all students. *International Journal of Bilingual Education and Bilingualism*, *12*(1), 81–99.

Kennedy, B. (2018). The bilingual teacher shortage in one Texas school district: Practitioner perspectives. *Journal of Latinos and Education*, *19*(4), 338–354, DOI: 10.1080/15348431.2018.1526688

Knudsen, J., Stevens, H. S., Lara-Meloy, T., Kim H. J., & Shechtman, N. (2018). *Mathematical Argumentation in Middle School: The what, why, and how.* Thousand Oakes, CA: Corwin Mathematics.

Lee, O., Quinn, H., & Valdés, G. (2013). Science and language for English language learners in relation to next generation science standards and with implications for common core state standards for English language arts and mathematics. *Educational Researcher, 43*, 223–233.

Llosa, L., Lee, O., Jiang, F., Haas, A., O'Connor, C., Van Booven, C. D., & Kieffer, M. J. (2016). Impact of a large-scale science intervention focused on English language learners. *American Educational Research Journal, 53*, 395–424.

Martiniello, M. (2008). Language and the performance of English language learners in math word problems. *Harvard Educational Review, 78*, 333–368.

Mehan, H. (1979). *Learning lessons: Social organization in the classroom.* Cambridge, MA: Harvard University Press.

Moschkovich, J. (1999). Supporting the participation of English language learners in mathematical discussions. *For the learning of mathematics*, *19*(1), 11–19.

Mosqueda, E., Bravo, M. A., Solis, J. L., Maldonado, S. I., & De La Rosa, J. (2016). Preparing middle school students for the transition to high school mathematics: Assessing Latinas/os' mathematical understanding, academic language and English language proficiency. *The Bilingual Review/La Revista Bilingüe,1*(1), 1–20.

Mosqueda, E. & Maldonado, S. I. (2013). The effects of English language proficiency and curricular pathways: Latina/os' mathematics achievement in secondary schools. *Equity & Excellence in Education 46*(2), 202–219.

Musanti, S. I., & Celedón-Pattichis, S. (2013). Promising pedagogical practices for emergent bilinguals in kindergarten: Towards a mathematics discourse community. Journal of Multilingual Education Research, 4, Article 4. https://fordham.bepress.com/jmer/vol4/iss1/4/

National Assessment of Educational Progress (2017). *2017 Mathematics and reading assessment reports.* Retrieved January 15, 2018 from http://www.nationsreportcard.gov/reading_math_g12_2013/#/

National Governors Association Center for Best Practices & Council of Chief State School Officers (2010). *Common core state standards for mathematics*. Washington, DC.

Rittle-Johnson, B., Siegler, R. S., & Alibali, M. W. (2001). Developing conceptual understanding and procedural skill in mathematics: An iterative process. *Journal of Educational Psychology, 93*(2), 346.

Rumsey, C., & Langrall, C.W. (2016). Promoting mathematical argumentation: These evidence-based instructional strategies can lead to deeper mathematical conversations in upper elementary school classrooms. *Teaching Children Mathematics*, *22*(7), 413–419.

Sherin, M. G. (2014). Developing a professional vision of classroom events. In *Beyond classical pedagogy* (pp. 89–108). Routledge.

Solano-Flores, G., & Chía, M. (2017). Validation of score meaning in multiple language versions of tests. In K. Ercikan & J. Pellegrino (Eds.), Validation of score meaning in the next generation of assessments: The use of response processes (pp. 127-137). New York: Routledge.

Soltero-González, L., Escamilla, K., & Hopewell, S. (2012): Changing teachers' perceptions about the writing abilities of emerging bilingual students: Towards a holistic bilingual perspective on writing assessment. *International Journal of Bilingual Education and Bilingualism, 15*(1), 71–94

Zavala, M. R. (2017). Bilingual pre-service teachers grapples with academic and social roles of language in mathematics discussions. *Issues in Teacher Education, 26*(2), 49–66.

# Appendix: MALLI Classroom Observation Protocol

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## General Information about the Classroom Observations

The MALLI classroom observation protocol is designed to document the array of practices employed by teachers of math at the elementary level with a special focus on literacy development and language development activities in Spanish. This observation protocol includes two parts. The first is a Classroom Observation Scheme designed to describe instruction using narrative and codes during the observation. The second part is an Implementation Questionnaire—a series of questions and activities that ask the observer to reflect back on what was observed and document implementation of language learner adaptations.

**Part I: Classroom Observation Scheme**

## Schedule

An observation should be at least 20 minutes in length. Before beginning the observation, observers record general information about the observation and the classroom. During the observation, observers alternate between recording narrative notes about what they observe and categorizing the observations into a set of codes outlined in the Math Instruction Coding Scheme.

Observers record narrative notes for seven minutes at a time. At the end of each seven-minute segment, they take three minutes to (a) count how many students are on task, and (b) begin coding the five-minute segment. Each 60-minute observation allows for the coding of 6 7-minute segments, each followed by 3 minutes of coding.

## *Sample Schedule*

9:00–9:06 Narrative recording
*The observer records a narrative of what is happening in the classroom.*
9:07–9:09 Coding
*The observer takes an on-task count, and records the materials in use by the student.*
9:10–9:16 Narrative recording
9:17–9:19 Students-on-task count and coding
9:20–9:26 Narrative recording
9:27–9:29 Students-on-task count and coding
9:30–9:36 Narrative recording
9:37–9:39 Students-on-task count and coding
9:40–9:46 Narrative recording
9:47–9:49 Students-on-task count and coding
9:50–9:56 Narrative recording
9:57–9:59 Students-on-task count and coding

## *Accurate Time Keeping is Essential*

### *Coding Scheme Overview*

Each seven-minute segment of instruction will be coded at five levels:

**Level 1: Groupings** (What instructional groupings do you see?)
**Level 2: Major Focus** (What is the class mainly doing?)
**Level 3: Instructional Activities** (What were the specific activities?)
**Level 4: Teacher Interactions** (What is the interaction style being used by the classroom teacher during this level 5 event?)
**Level 5: Student Response** (What were the students [expected to be] doing?)

# See the Observation Coding Scheme for a list of codes. Observation Interface

**Observation Interface**