# Mathematics Preservice Teachers Learning About English Language Learners Through Task-Based Interviews and Noticing

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This article describes the 3rd cycle of an intervention in a mathematics content course that was designed to foster awareness among middle school mathematics preservice teachers (PSTs) of the challenges that English language learner (ELL) students face and the resources they draw on as they learn mathematics and communicate their thinking in English-only classrooms. Pairs of PSTs engaged 2 different ELL students in a videotaped task-based interview using 4 measurement tasks. Following each interview, the PSTs wrote a structured report guided by Mason's (2002) framework of *noticing.* The results of the intervention indicated that the PSTs went beyond awareness of ELLs' needs and challenges and also adopted strategies outlined in the literature that were aligned with best practices for teaching ELLs. The article also discusses the potential of the intervention and how it can be used by other mathematics educators.

***Key words:*** Preservice teacher education, Task-based interviews, Noticing, English language learners

The U.S. population of English language learners (ELLs) is growing, and there is a great need to prepare *all* mathematics teachers to work with these students (Bunch, 2010; Lucas & Grinberg, 2008). Between 1980 and 2009, the ELL student population experienced a growth spurt, rising from 10% to 21% of students (National Center for Education Statistics, 2010). However, specific preparation of teachers to work with ELLs has not kept pace with this growth. The National Center for Education Statistics (NCES) reported that out of the 41% of teachers who had ELLs in their classrooms, only 13% of those teachers received ELL-specific training (NCES, 2002). In their study of 417 teacher preparation programs, Menken and Antunez (2001) found that less than 17% prepared preservice teachers (PSTs) to work with diverse students, a category that includes but is not limited to ELLs. This lack of teacher preparation persists despite the growth in ELL population (e.g., Christian, 2006; Gandára & Maxwell-Jolly, 2006; Márquez-López, 2005).

This article reports on the third cycle of an intervention that I, as the instructor of a mathematics content course, carried out to support PSTs' work with ELLs in their future classrooms. This intervention provided multiple experiences for the PSTs to participate in task-based interviews (Goldin, 2000) and develop their observation skills through a framework of *noticing* (Mason, 2002). PSTs became more aware of the challenges that ELL students face and the resources that they draw on as they learn mathematics in English-only classrooms. Further, through the interviews, the PSTs also developed concrete strategies for assisting ELL students, which will be useful in their future classrooms.

## Language Demands for ELLs

De Jong and Harper (2005) pointed out that the pervasiveness of language in human activity leads to a tendency for teachers to look "through" language rather than "at" it. In the case of mathematics, there is a tendency to assume that it is universal and, as a consequence, that it involves minimal linguistic challenges for ELLs (Barwell, 2005; Walker, Ranney, & Fortune, 2005). Further, teachers may assume that "good teaching," with little or no modification, is enough to reach all students, including ELLs (de Jong & Harper, 2005). However, extensive research has illustrated the connection between language and mathematics, and the impact that language has on the teaching, learning, and assessment of mathematics (e.g., Bailey, 2007; Barwell, 2005; Clarkson, 2007; O'Halloran, 2005; Schleppegrell, 2004, 2007; Veel, 1999). I highlight a few aspects of the language demands that ELLs encounter as they learn mathematics in English-only classrooms. Note that even though non-ELLs face similar demands, the cognitive load is magnified for ELL students as they learn new content in a language they are still learning (Campbell, Adams, & Davis, 2007).

Cummins (2000) provides a useful distinction between the everyday *conversational language* that students encounter on a regular basis and the *academic language* that they encounter in school subjects such as mathematics. One part of the academic language consists of the *register*—the unique lexical and grammatical features that students can draw on in a content area to make meaning (Halliday, 1978). The *mathematics register* includes lexical aspects such as vocabulary that is unique to mathematics (e.g., words such as *coefficient* and *denominator*) and other everyday terms that have specialized meaning in mathematics (e.g., *rational* and *difference*; Bailey, 2007; Pimm, 1987). The latter can prove confusing to ELLs, who are learning English and the content at the same time (Bailey, 2007; Garrison & Mora, 1999; Lager, 2006).

Besides the challenge of lexical aspects, the mathematics register also includes unique grammatical features such as the use of the nominal group to pack information into a sentence (Veel, 1999). For example, "the volume of a rectangular prism with sides 8, 10, and 12 cm" (Veel, 1999, p. 197) consists of the elaboration of the noun *prism*. The prenumerative qualifier—the volume of—endows the prism with the mathematical attribute of volume; the classifying adjective—rectangular—subclassifies the prism into the existing taxonomies; and the qualifier—with sides 8, 10, and 12 cm—restricts the range of meaning of the prism. The use of complex nominal groups, like the one described, allows more information to fit into a sentence, thus increasing its lexical density (Eggins, 2004; Schleppegrell, 2004, 2007; Veel, 1999).

There is a further expansion of linguistic demands in current reform (NCTM, 2000; NGA Center & CCSSO, 2011) classrooms, as students are expected to master discourse features such as making conjectures, justifying their solutions, building on other students' ideas, and presenting solutions as part of the classroom community (Bailey, 2007; Moschkovich, 2002).

## The Use of Task-Based Interviews in Teacher Preparation

The discussion up to this point highlights the need for PSTs to be aware of the linguistic aspects that affect the teaching and learning of mathematics to ELLs (Fillmore & Snow, 2005). This awareness justifies adapting mathematics instruction to accommodate the needs of ELLs. For example, ELL students may benefit from explicit instruction and modeling of the discourse features in mathematics (Khisty & Chaval, 2002). Informal discussions with PSTs from the mathematics content courses that I taught revealed that they had minimal opportunities to interact with ELLs in prior educational experiences. Generally, the PSTs tended to view mathematics as being universal and minimally language intensive, and as involving symbols that could be transferred across languages (e.g., 1 + 1 = 2 was the same whether you spoke Spanish or English). However, they accepted that word problems could pose linguistic challenges for all students, not only ELLs. It is also important to note that mathematical notation and procedures may be different for recent immigrant students in their home country (Perkins & Flores, 2002). Research has shown that PSTs who are not aware of the role that language plays in the teaching and learning of mathematics are less likely to make linguistic modifications in their classrooms to accommodate ELLs (Lucas, Villegas, & Freedson-Gonzales, 2008). Based on my experiences with the PSTs from the content courses, and the needs engendered by the changing demographics in mathematics classrooms across the country, I wanted the PSTs to become aware of the resources ELL students draw on and understand the challenges that these students face as they learn to communicate mathematically in English-only classrooms.

There were two major factors that prompted the use of task-based interviews (Goldin, 2000). First, engaging in task-based interviews allowed the PSTs to go beyond the correct answers to problems to understand the students' thinking (Goldin, 2000). In the process of interviewing students, the PSTs were able to interact with students and observe the possible impact of language on students' mathematical performance and the resources students drew on to communicate their thinking. My own research with task-based interviews revealed the rich nature of ELL students' mathematical thinking when they were provided with the appropriate support and asked probing questions during the interview (Fernandes, Anhalt, & Civil, 2009). I conjectured that with appropriate support, the PSTs could replicate this experience, which in turn would ground their thinking about the influence language has on the teaching and learning of mathematics for ELLs.

Second, the research literature recommends that PSTs learn through direct experience. In multicultural education, direct experiences such as cross-cultural immersion and tutoring students from diverse backgrounds have had a positive influence on the beliefs that predominantly White PSTs hold about these students (Gay, 2002; Giroux, 1988; Grant & Secada, 1990; Nieto, 2000; Sleeter, 2001; Sowa, 2009; Waxman & Padrón, 2002; Zeichner & Hoeft, 1996). Griego-Jones (2002) found that PSTs who had tutored ELL students held beliefs that were in line with the research about second language learning. This idea has also been demonstrated in mathematics education. Opportunities to learn about children's mathematical thinking positively influenced PSTs' initial beliefs about mathematics teaching (Ambrose, 2004; D'Ambrosio & Campos, 1992; Vacc & Bright, 1999).

## Noticing

In addition to providing PSTs with direct experiences, research on teacher development also recommends the incorporation of reflection (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010; Mewborn, 1999). Without this component of reflection, the experiences could simply serve to reinforce deficit beliefs that PSTs have regarding diverse students (Grant, 1991; Grant, Hiebert, & Wearne, 1998). Based on two prior cycles of this intervention in previous semesters (this article reports on the third cycle), I observed that even though the PSTs reflected on their interactions with the ELL students, they focused on the strategies that the students used to solve the problem. Although this is consistent with the typical use of task-based interviews, in this intervention their focus was redirected toward the linguistic aspects of the interactions with the students. Mason's (2002) framework of *noticing* was used in the third cycle to focus PST attention on the complete mathematical communication within the interview. Mason pointed to *noticing* as being key to professional development and the first step toward action, stating that people learn through experience, and this causes people to react in habitual ways. These habitual ways of interacting with others influence people to classify others and react stereotypically to situations before they realize it. This appeared to be the case with the PSTs.

In previous cycles of the intervention, PSTs had a tendency to make a quick judgment and classify the student's strategy as correct or incorrect. This quick judgment of the student's attempt to solve the problem prevented PSTs from exploring the possible reasons why the student produced that solution. By slowing down their judgments about the ELL students' solutions, the PSTs could open up opportunities to notice possible linguistic challenges that the ELL students faced and the resources they used.

Mason suggests that professional noticing is about being sensitive and becoming systematic without acting automatically. In his book *Researching Your Own Practice: Discipline of Noticing* (2002), he outlines processes through which one could become more sensitive. For the purposes of this intervention, I focused on one process, the creation of *accounts*. He describes two forms of recording what we notice: *accounts-of* and *accounts-for. Accounts-of* refers to recording an event as it would be seen and felt by another observer, by paying careful attention not to involve emotion or judgments. Making a judgment could mean that we have labeled something too fast, and this could blind us to new interpretations. To *account-for* something means offering "interpretation, explanation, value-judgment, justification, or criticism" (p. 40). By writing *accounts-of,* the observer leaves things open. He or she and others can revisit the incidents at a later stage and make interpretations.

The intervention included the use of this process of accounts as a starting point to develop PSTs' sensitivity to noticing linguistic aspects during interviews. Additionally, the intervention included my feedback on the process; I reviewed the PSTs' accounts and provided them with alternative interpretations. These points will be elaborated further in some of the sections below.

## The Intervention

The intervention consisted of a semester-long project in four phases (see Figure 1), which was integrated into content courses I taught for middle school mathematics PSTs. The intervention described in this article was the third cycle conducted in a geometry and measurement course. Topics in this course included perimeter and area of two-dimensional shapes, surface area and volume of three-dimensional objects, and proofs in Euclidean geometry, including parallel lines, triangle congruence, and properties of various quadrilaterals. There were 32 PSTs in total, 10 males and 22 females; however, 1 female student dropped the course after conducting the first interview. I did not consider her report as part of my analysis. There were 20 Caucasians, 7 African Americans, 3 Hispanics, and 1 Middle Eastern student. All the students were in the second or third year of the teacher preparation program, which contained a special mathematics strand for PSTs who expressed an interest in teaching the middle grades (Grades 6-8). Four out of the 31 students had also participated in the second iteration of the intervention in a previous course.

Phase one (Figure 1) consisted of one class period that was used to introduce the project, engage the PSTs in solving the four measurement tasks, watch two video clips of a researcher interviewing ELL students, and craft an interview script. The second phase involved pairs of PSTs interviewing individual ELL students from a group of fifth and sixth graders at a local intermediate school. A Flip video camera (Cisco) was given to each pair to record the interview. The recording was used to assist PSTs with the written report they submitted after each interview. The PSTs interviewed a second ELL student and submitted another report in the third phase. This interview was also recorded with a Flip video camera. Finally, the fourth phase involved the PSTs sharing what they learned from this interview in a class discussion. The sections below will outline the selection of tasks and the four phases of the intervention.

### Selecting Tasks

The four NAEP measurement tasks (Figure 2) were chosen based on prior research and the potential they had to foreground various linguistic challenges for ELL students. Since NAEP does not report performance data about ELLs, I used NAEP data on Hispanic students to guide the selection of tasks. Though the data are not entirely aligned, this strategy seemed reasonable, as 79% of the students in the Hispanic category are ELLs (McKeon, 2005).

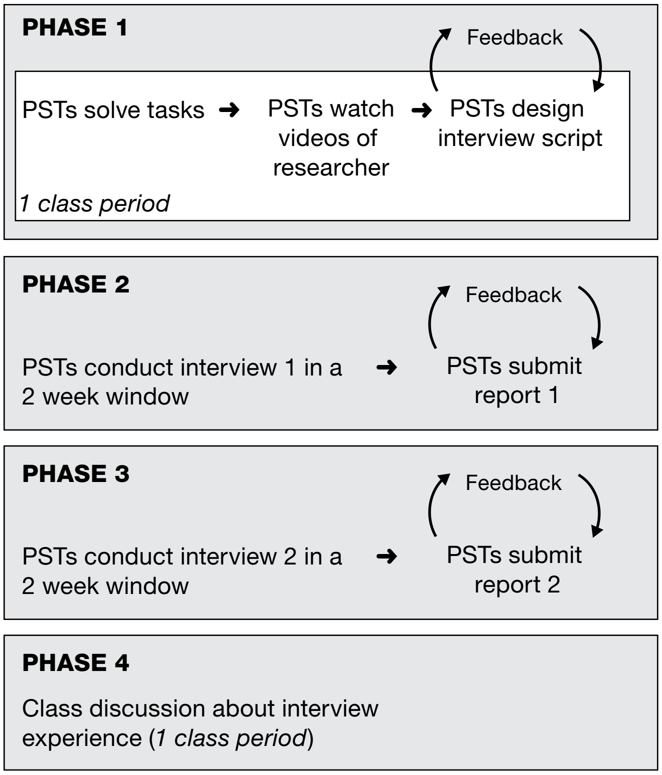
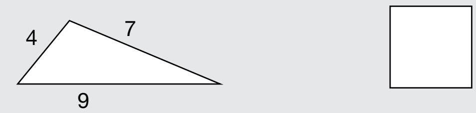



***Figure 1*. Phases of the intervention.**

Lubienski (2003) pointed out that the biggest difference between Whites and Hispanics on the eighth-grade NAEP mathematics exam was in the content area of measurement, and this was the motivation to choose that topic for the interview tasks. Based on the Lubienski article, I assumed that tasks (shown in Figure 2) for which there were "big" differences between the performance of Whites and Hispanics (as shown in Table 1) could possibly reveal interesting linguistic challenges for ELLs with proper probing. Interviews I had previously conducted with ELL students (Fernandes, Anhalt, & Civil, 2009) revealed linguistic

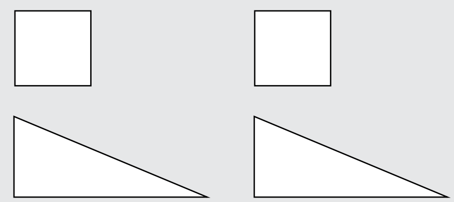
**Task 1: The Triangle and Square problem**




If both the square and the triangle above have the same perimeter, what is the length of the side of the square?

**Task 2: The Area Comparison problem**

[*The following cutouts of N (square) and P (triangle) are provided with the problem. Note that the height of P is the same as the side N and the base of P is twice the side.*]



Bob, Carmen, and Tyler were comparing the areas of *N* and *P*. They each conclude the following:

(a) Bob: *N* and *P* have the same area

(b) Carmen: The area of *N* is larger

(c) Tyler: The area of *P* is larger

**Task 3: The String problem**

Brett needs to cut a piece of string into 4 equal pieces without using a ruler or other measuring instrument. Write directions to tell Brett how to do this.

**Take 4: The Tile problem**

How many square tiles, 5 inches on a side, does it take to cover a rectangular area that is 50 inches wide and 100 inches long?

***Figure 2.* The interview tasks.**

**Table 1**

*NAEP Performance Data on the Four Interview Tasks*

| Task | Year | Grade level | Difficulty (easy, medium, hard) | Percentage correct: White vs. Hispanic |
|---|---|---|---|---|
| The Triangle and Square problem | 1996 | 4 | Hard | 29, 14 |
| The Area Comparison problem | 1996 | 8 | Hard | 34, 15 |
| The String problem | 1996 | 4 | Hard | 6, 2 |
| The Tile problem | 2009 | 8 | Hard | 19, 9 |

challenges. For example, for the Triangle and Square problem, when an interviewed student read the "if-then" conditional clause, she was not able to solve the problem because of her focus on the word "if"; she claimed that it was possible that the triangle and square did not have the same perimeter.

The second factor for choosing the tasks was to ensure that there was a blend of problems that used different modes of presentation, challenged ELL students on various linguistic facets, and also allowed them to use diverse resources to explain their mathematical thinking. For example, even though the Area Comparison task was considered a "hard" eighth grade problem in NAEP (task 2 in Table 1), it included cutouts that the students could manipulate to explain themselves orally. A written explanation could prove more challenging. The Area Comparison problem would provide opportunities for the PSTs to contrast students' verbal explanations with their written solution. The String problem and Tile problem (tasks 3 and 4 in Figure 2) could pose linguistic challenges because they contain a complex clause (e.g., "into four equal pieces without using a ruler or other measuring instrument") and an embedded clause, (e.g., "square tiles, 5 inches on a side"), which would have to be unpacked by the students to successfully solve the problems. In the case of the String problem, similar to the Area Comparison problem, the students could use concrete materials (i.e., an actual string) to display their thinking, which would again allow the PSTs to contrast the students' oral solution with their written work.

### Phase 1: Developing the Interview Script and Pre-interview Preparation

The PSTs were introduced to the project during the first week of the semester. I outlined the goal of the project, which was for PSTs to develop an awareness of the challenges that ELL students faced when learning mathematics in English-only classrooms and the resources that these students used to communicate mathematically. During the same class period, the PSTs solved the interview tasks on their own, and there was an in-class discussion about possible challenges that ELL students could encounter when they solved the same problems. In these initial discussions, the PSTs pointed to possible mathematical challenges that the students could face, such as not knowing how to find the area or perimeter of a shape. In terms of linguistic challenges, the PSTs pointed mostly to vocabulary (e.g., students not knowing the meaning of "measuring instrument"). Because the PSTs had never interviewed students, I presented examples of a researcher interviewing two ELL students about the Triangle and Square problem. One of the clips highlighted the challenge that an ELL student had with the "if-then" conditional clause and the probing questions that the researcher asked to clarify the student's thinking. I also discussed my own experience with interviewing students and additional challenges, such as confusion between area and perimeter.

After our discussion, the PSTs brainstormed in their groups and developed an interview script for the four problems that encompassed possible scenarios that could play out during the interview. In the feedback that I provided, I emphasized that the purpose of the interview was not only to determine if the students could get the correct answer but also to understand their thinking and, if necessary, to provide them with appropriate scaffolding so that they could eventually solve the problem. In keeping with Moschkovich's (2002) ideas of viewing the resources that students bring to the classroom as assets rather than liabilities, I encouraged the PSTs to also accept gestures and drawings as an integral part of the students' explanation of their thinking process.

### Phase 2: The First Interview and Report

The PSTs completed the first interview in a two-week window. They visited the intermediate school (fifth and sixth grade) and interviewed ELL students selected by the English as a Second Language (ESL) teachers. Each interview was conducted by a pair of PSTs, one acting as the interviewer and the other responsible for setting up the camera and taking notes. The latter PST could also ask questions if he or she felt the need to do so. For those PSTs that did not have a partner, I provided filming support. The PSTs began by introducing themselves and the project to the ELL student; they were encouraged to have an informal discussion with the ELL student to make him or her feel comfortable during the process. The PSTs provided the student with the first task and allowed some time for the student to solve the problem independently. Once the student indicated that he or she had finished, the PSTs engaged him or her in an interaction to understand the student's solution and probe him or her further. In some cases, the PSTs began this interaction earlier, if the student asked a question about the task that he or she was reading. Because the school placed time constraints on the activity, the PSTs engaged the students for 40-45 minutes and in some cases skipped the fourth task (the Tile problem).

After the interviews, the PSTs were required to submit a detailed report with guiding questions (see Figure 3) based on Mason's (2002) constructs of providing *accounts-of* and *accounts-for.* The guiding questions were designed to spur the PSTs to notice aspects of language that may have influenced the mathematical performance of the student. The *accounts-of* questions related to detailed descriptions of what the student did on his or

| **Accounts-of** |
|---|
| 1. What did the student do on his or her own? Provide details. |
| 2. What support did you provide, if any, after the student worked on the problem independently? Provide details about the scaffolding process that you may have used. |
| **Accounts-for** |
| 3. In your opinion, what did the student find challenging about these questions? Provide evidence from your descriptions for each task and consider both the mathematics and language. |
| 4. In your opinion, what strengths and resources did the student bring to the problems? Provide evidence from the descriptions and consider both the mathematics and language. |
| 5. Note any other comments about the student's thinking or language or your interaction with the student. |
| 6. Comment on the presence of concrete materials (cutouts, graph paper, string, etc.) and drawings in the problems. Did they help or hinder the student? What role do you see concrete materials and drawings playing in ELLs' learning of mathematics? Why? Provide details. |
| 7. Comment on the student's writing for questions that required written responses. Provide details. |
| **Other** |
| 8. In your opinion, what sort of support would this student need in the classroom to understand and do well in math? Explain with examples. |
| 9. Overall, what did you learn about ELL students' mathematical thinking and teaching mathematics to ELL students? Elaborate at least three points in detail. |
| 10. What was your biggest surprise in the interview? |

***Figure 3.*** **Guiding questions for the reports.**

her own and what he or she did with assistance (questions 1 and 2). Once the PSTs answered these for each of the four tasks, the *accounts-for* questions (questions 3–7) required them to take a more holistic view and go back over their descriptions of the four (or three) completed tasks and notice patterns in aspects that were challenging to the student, the resources that the student employed, and the student's use of concrete materials, communication, and writing. Further, the "other" questions required PSTs to make inferences about the support that ELL students would need in the classroom and what they learned about the teaching and learning of mathematics to ELL students.

For some questions (e.g., 3 and 4), where there was a chance that the PSTs could overlook the linguistic aspects of the student's responses, I explicitly asked them to consider the language in addition to the mathematics. I provided the guiding questions to the PSTs before the interview to help them prepare probing questions ahead of time. The goal of working within this structured framework was to maximize the PSTs' opportunities to focus on linguistic aspects that arose during their interactions with the students.

Note that the guiding questions themselves would not elicit *accounts-of* or *accounts-for*; it was through the process of instructor feedback and PSTs reworking their written reports that the descriptions and evaluations would come to resemble *accounts-of* and *accounts-for* as described by Mason (2002). The guiding questions are useful to the instructor to assist the PSTs in moving their writing in this direction by emphasizing descriptions for the first set of questions and emphasizing evaluations and judgment for the second set.

## Phase 2: Feedback on the First Report

The PSTs submitted their reports electronically for feedback and grading. The reports were graded based on four criteria: detailed descriptions, quality scaffolding, insightful reflections, and depth of language issues covered. These criteria were shared with the PSTs before they conducted their first interview. The PSTs were required to provide details of how the interview unfolded so that another person, if he or she was present, could confirm the details. Thus the PSTs were to avoid making judgments about the student's statements and were instead instructed to report on what happened and what was said in detail. The quality of scaffolding criterion examined whether the PSTs' questions were leading rather than getting the student to grapple with the problem. Insightful reflections referred to the quality of the responses for questions 3–10. More weight was given to claims that were backed up in the descriptions. Finally, I examined the linguistic issues that the PSTs discussed in their answers to questions 3–10.

I first provided the PSTs with feedback on their reports and asked most of them to add more detail or to justify a statement with an example. In some cases, I watched part of the videotape together with the PSTs, and we jointly discussed areas where they could provide more detail and talked about possible linguistic issues that they might consider for further analysis. I later graded the reports after they had a chance to reflect and incorporate my feedback.

The reports allowed me to focus on their descriptions, assist with their interpretations, and provide suggestions on improving their second interview. This was a key part of the intervention. For example, if a PST mentioned that a student did not understand the concept of area, I asked the PST to think about other ways that the student could express his or her understanding of area besides the use of a formula, such as pointing to the area of the table or floor, shading area in a figure, or using graph paper. By accepting a broad range of student approaches, some of which may not seem "mathematical" (according to the PSTs) at the outset, the PSTs could appreciate the students' thinking and understand linguistic challenges and how the students were using resources in conjunction with speech to make meaning and partake in mathematical practices (Moschkovich, 2002).

### Phases 3 and 4: Second Interview and Report and Experience Sharing

Because most of the PSTs were interviewing students for the first time, the second iteration allowed them to have richer interactions and improve their probing of the student based on what they learned from the experiences in the first interview. Based on the feedback from the first report, the PSTs refined their interview script and interviewed a different ELL student toward the end of the semester. Once again they submitted a report that I graded, and in some cases I asked them to revise their reports. As a conclusion to the project, the PSTs shared something new that they had learned about the teaching and learning of mathematics to ELL students during an in-class discussion. The next section discusses the impact of the intervention.

## Impact of the Intervention

The major goal of the intervention was to build awareness among the PSTs of the challenges that ELL students face and the resources that ELL students draw on to communicate their mathematical thinking. To document the impact of the intervention with respect to this goal, I initially focused on the PSTs' responses to questions 3, 4 and 9 (see Figure 3). I created a separate document that compiled each of the 31 PSTs' responses from both reports for these three questions and used this as the starting point for examining the impact of the intervention. I specifically looked at the linguistic challenges that the PSTs described and the resources the PSTs mentioned that the ELL students used in connection to these challenges. I triangulated these points with their responses to other questions, particularly the descriptions they provided in response to questions 1 and 2. I also examined portions of the videotape where they were interacting with the ELL students to ensure that their interpretation was grounded in their interactions. Further, I had close interactions with all the PSTs during the project, and during the feedback process I clarified my interpretation of their statements.

The following sections will describe the challenges (understanding the questions and writing) and the resources (using concrete materials to assist with communication) reported by the PSTs. Further sections will discuss what the PSTs reported on learning through the task-based interviews and the few cases where prior deficit beliefs about ELLs were reinforced.

## Linguistic Challenges

All 31 PSTs brought up the linguistic challenges that the ELL students faced during the interviews. In particular, these challenges arose in students' understanding of the questions and explaining their thinking in writing.

### Understanding the Question

By allowing the ELL students to initially work independently on the task, the PSTs noticed challenges students faced in understanding the question. Some ELL students read the problem multiple times, others asked for the meaning of words that were unclear, and some guessed at what the question was asking by using portions of the problem that they understood. In some cases, the PSTs helped the students understand the question by getting them to read and explain the different parts back to them. By doing so, the PSTs were able to isolate parts of the question that were challenging to the students and assist them with the language. In some cases, especially for the Triangle and Square problem, the ELL students were able to solve the task with assistance, and this convinced the PSTs that the ELLs were challenged with the language in the question. One PST wrote,

> **I learned that ELL students' difficulty with language does affect their math [performance], but it does not affect their mathematical thinking. The student I worked with had difficulty understanding the language of the question. . . . But, once the student understood the question she was able to mathematically think correctly and figure out the answer to the question.**

The PST observed that assistance with the language in a question could make a difference in whether the student used an appropriate procedure to solve the problem. In the String problem, a number of PSTs observed that the ELLs were not using the whole string to form four equal pieces. On further probing, they linked the linguistic challenge to the phrase "a piece of string," which the ELLs assumed to mean a part of the string that was provided. In these cases, the students were able to rectify their solution method based on the assistance they got from the PSTs. One PST asked the ELL student to think of the string as Twizzlers© (a type of candy) that had to be divided among four friends. This scaffolding from the PST helped the ELL student understand the problem and then solve it.

The PSTs noticed the challenge for the students in the Tile problem lay in the phrase "five inches on a side," which they tended to ignore or misinterpret in their solution. For example, one ELL student ignored this phrase and counted all the squares on the graph paper that was offered. The PSTs also pointed to the numerous pieces of information that the students had to coordinate to solve the problem. For example, one PST wrote, "He had to work with inches, tiles, a small square, a big rectangle. He also had to figure out how all of them were connected in order to find the final answer." In the Tile problem, where the students were required to integrate the information and determine the mathematical approach they would take for a solution, most of the PSTs reported the challenges facing the student as both linguistic and mathematical. After observing how ELL students grappled with understanding the questions, some PSTs suggested that the questions could be modified with simpler language to ensure that the ELL students understood them.

### Writing

The PSTs noticed that the ELLs were challenged by explaining their thinking in writing, and some preferred just an oral explanation for their solution strategy. In most cases, the PSTs mentioned that students' written work was difficult to understand. Besides commenting on the incorrect spelling and grammar, the PSTs noted that the ELL students tended to write the way they spoke: "…and cut like two of the pieces…." This is common because students are familiar with spoken communication and draw on this resource for their writing if they have not been introduced to various genres of writing and ways of presenting their ideas (Gibbons, 2002).

Some PSTs commented on the structure of the sentences that the students used and reported that these were "run-on sentences". This referred to sentences which made use of conjunctions to chain their ideas: "Well, first take each end of the string and connect them, then take the other end that the string made and connect it to the two ends of the string, you then would cut the pieces of each end." Again, the use of chained clauses are characteristic of early writers who need explicit instruction to develop academic writing using more condensed clause structures (Schleppegrell, 2004).

In the case of the String problem, many PSTs were successful in getting the student to rethink their written explanation to achieve clarity by using the string to work through the steps and illustrate to the ELL students that their oral solution did not match their written instructions. This prompted the students to correctly modify their writing to match the sequence of steps that they used to cut the string. Further discussion of the use of concrete materials is described in the next section.

## Resources

In their discussion about the resources that ELLs used during the interview, concrete materials featured prominently in solving the problem and communicating their solution. The use of concrete materials, such as the string and the cutouts, were especially useful for the students for whom providing a coherent written solution was challenging. These students could use the materials, along with informal language, to demonstrate their solution. One PST says,

> **I can't stress enough how helpful the string and the cutouts were for [student name]. She used the cutouts to solve the area problem. Not only did they help her solve it, but they were a big factor in her communicating how she did it. . . . Where her writing was a little confusing, she was able to demonstrate using the string very clearly. . . . I think the availability of concrete materials to aid in understanding and communicating are vital for these [ELL] students and should be used extensively in the classroom.**

Note that, even though the PSTs thought that the use of concrete materials would be beneficial in work with ELL students, there were some who noticed that just providing the concrete materials was not enough and some support also was required. For example, in the Tile problem, a PST noticed that the ELL student assumed the square on the graph paper represented a tile with unit dimensions instead of 5 x 5, the dimensions specified in the problem. The PST had to help the student use the graph paper to appropriately represent and solve the problem. Overall, most of the PSTs reported that the concrete materials were a resource that ELL students employed to understand and communicate their thinking. The concrete materials also opened opportunities for the PSTs to understand the ELLs students' thinking and in some cases, such as the String problem, got them to modify or revise their solution.

## What PSTs Learned From the Interviews

Based on their interview experience, most PSTs concluded that language could prove to be a challenge for ELL students. In the words of one PST,

**[The ELL] is learning a new language and learning a new concept (math) and that is a lot for a child to do together. It's like double the work.**

Here the PST seems to understand that ELL students who are learning the content and the language at the same time face an added cognitive load (Campbell, Adams, & Davis, 2007). Most PSTs discussed adjustments that they would make to their mathematics class to account for the extra cognitive load that the language posed for the ELL students. For example, the PSTs reported that they would allow ELL students more time to process information, slow down their speech, and integrate strategies that would help the students with reading and writing the content. For example, one PST recommends that "reading, writing, and math are all covered in [the math] class," and goes further in stating that teachers should provide opportunities for students to integrate aspects of the language as they learn the mathematics content. Such opportunities could take the form of having students read the mathematics problem, interact with peers as they solve the problem, and provide a written explanation of their thinking. Thus the PSTs went beyond being aware of ELLs' needs and challenges to learning specific strategies that aligned with the research on best practices for working with ELLs.

The PSTs also reported that there was a lot of diversity among the ELL students that they interviewed and thus mentioned that they would avoid making "sweeping generalizations" in their future encounters with this group of students. For example, some PSTs mentioned that they would be careful not to automatically conclude that ELL students struggled with mathematics. After conducting the interviews and interacting with the ELL students, many PSTs were surprised that the students could speak English, as they assumed that the students would have difficulty speaking. However, in some cases, the PSTs assumed that students' conversational proficiency meant that these ELL students were no different from non-ELL students: "I don't know if you could really call these kids ELL students because it seems like they already know the language fluently." These PSTs seemed to assume that fluency in *conversational language* automatically meant proficiency in *academic language*.

## Reinforcing Beliefs

The interviews, in a few cases, seemed to reinforce prior beliefs that PSTs had about mathematics being universal. This was usually the case when ELL students successfully solved the problems with minimal assistance with the mathematical concepts. One PST expressed this idea as "two plus two is four no matter what language or dialect you speak." This particular PST had experience teaching algebra in eighth grade and did not consider the linguistic assistance he provided the ELL student to be *linguistic* assistance. Rather, he considered it to be mathematical assistance that he would provide to ELL and non-ELL students alike. For example, in the Tile problem, when the student struggled to understand the phrase "five inches on a side," he used the cutout from the Area Comparison problem to demonstrate the dimensions of the tile. Later he used the cutout to illustrate how the tile would cover the rectangular area, which prompted the student to successfully work out the number of tiles that covered the space. In our interactions, he explained that he provided such assistance to non-ELL students as well; thus, according to him, this illustrated a mathematical challenge rather than a linguistic challenge. As such, he reiterated that mathematics was universal and that the same issues that challenged ELL students also challenged non-ELL students. Having such a belief ignores the fact that ELL students face an additional cognitive load because of the language (Campbell, Adams, & Davis, 2007).

Deficit beliefs about ELLs, such as "ELL students typically haven't had proper schooling before arriving here and generally do not receive proper help at home," were expressed by a few PSTs who interviewed students who needed a lot of prompting to solve the problem. However, in these cases, I also observed that the PSTs expected the students to express their mathematical knowledge in very narrow ways that fit with how they themselves would solve the problem. For example, for the Tile problem, one PST expected the student to use division to find the number of tiles. Initially the PST provided graph paper that the student used to work out the total number of tiles by simply multiplying the number of actual squares along the length and width of the sheet and ignoring the dimensions of the tiles in the problem. Instead of attempting to build on the student's approach, the PST tried to funnel the student toward the use of division. When the student struggled to do so, it seemed to reinforce the PST's deficit beliefs about ELL students.

Deficit beliefs about the use of native language were reported by two PSTs, who assumed that the students were taking a long time to work out the problems due to having to translate between English and Spanish. However, there was no overt evidence of this in the videotapes of the interviews. One of these PSTs concluded that translating back and forth would be "extremely taxing" on the student. In essence, these two PSTs' comments in the report seemed to view the native language as a hindrance for the student's mathematical performance rather than an asset that could be used in the classroom. The PSTs statements imply that "taking longer" indicates a lack of understanding—again expressing a narrow view of what it means to know and do mathematics. Research has established that ELLs may take a little longer in calculations; however, this does not reflect their level of mathematical understanding (Moschkovich, 2010).

## Others Using the Intervention

Although the intervention took place in a content course for middle school PSTs, it is flexible enough to be integrated into various mathematics content and methods courses and can be used to help PSTs notice the linguistic issues that arise in the mathematics curriculum and how ELL students negotiate them. The interview tasks can consist of NAEP questions that relate to the topics being discussed and share some of the characteristics with the tasks that were used in this study. The instructor can pilot some of the tasks in interviews with ELL students to determine which ones have the potential to benefit the PSTs in their interviews.

Further, the instructor will need some assistance from the schools. In this intervention, the ESL teachers at the school obtained parental permission on my behalf (for videotaping), identified the ELL students to be interviewed, and coordinated the PSTs' visits during the two-week window for each interview. The ESL teachers went even further and outlined their program and how ELLs were classified and answered specific questions that the PST may have had.

Because most PSTs are new to conducting task-based interviews, a significant amount of time is invested at the beginning of the project helping the PSTs write detailed descriptions and notice linguistic aspects in the videotape. In my case, I spent time reading the reports, viewing the videotapes, providing the PSTs with appropriate feedback on their reports, and in some cases also viewing sections of the videotape together with the pairs. I found that the PSTs also learned from informal interactions among themselves as they shared experiences of what worked and what did not work with each other. For example, one PST shared how he pretended not to understand the questions and thus encouraged the ELL student to elaborate and explain the questions and the mathematical thinking to him in great detail. In the future, I plan to incorporate these interactions into the structure of the intervention by building in more discussion time during class. Knowledge of the basics of systemic functional linguistics (e.g., Eggins, 2004) is also essential in understanding the linguistic complexity in the formulation of problems and how this may impact ELL students' communication of their mathematical thinking.

PSTs tend to need more assistance in probing students during the interview and providing detailed descriptions in their reflections at the beginning of the course; as they gain experience over time, they get better. The four PSTs who participated in the second and third cycles of the intervention showed improvement in their probing. For example, one of these PSTs was able to reframe the String problem using a scarf that the student was wearing. The PST first complemented the student on the attractive scarf and then asked her to imagine how she would divide it equally with three other friends who wanted to have the same scarf but could not purchase the same one at the mall. By reframing the problem this way, the PST could get at the student's understanding. I noticed this flexibility in the PSTs' probing as they gained more experience with the interviews. The level of detail that the PSTs provided in their descriptions were more aligned with Mason's notion of *accounts-of* as they made fewer statements that were evaluative or could not be verified by another observer (if one was present).

## Discussion

Overall, the interview experience along with the composition of accounts and feedback from the instructor have the potential for helping PSTs notice the linguistic challenges that ELL students face and resources that they use to communicate mathematically. The guiding questions, based on *accounts-of* and *accounts-for*, serve to focus PSTs on the linguistic aspects of students' responses. The potential for noticing is maximized initially when the instructor uses the PSTs' descriptions to provoke further thinking about the possibilities in the student work. This allows the PSTs to look beyond the familiar methods to solve the problems; probe students appropriately; and notice the challenges of understanding the questions and the resources, including gestures, drawings and concrete materials, that ELL students use to build meaning that goes beyond speech. Videotaping the interview allows the instructor and the PST to recall incidents and interpret them in new ways. The videotape is also useful in bringing to the fore incidents, especially those involving linguistic issues, that may not be captured in the initial descriptions as the PSTs may not consider them important. The continued informal interactions with the instructor over the course of the project also add to the PSTs' overall learning.

The interview experience goes beyond fostering PSTs' awareness to developing concrete strategies that assist ELL students and are aligned with best practices advocated in the research. Some of these strategies include isolating linguistic challenges in the wording of a question, using concrete materials and drawings to help the students understand the problem and communicate their thinking, adapting speech, providing more time for the students to work on the problem and communicate their thinking, and analyzing and critiquing the students' written work—all skills that will be useful in PSTs' future classrooms for teaching all students.

In his review of research on how to prepare mainstream secondary content-area teachers to work with ELLs, Bunch (2010) emphasized the need for integrating the focus on language and content so that the teachers have the "opportunity to understand the language demands in their own lessons" and can "capitalize on the linguistic resources that ELLs already bring to the classroom, and create instructional settings that expand students' access to content learning and development of language and literacy" (p. 374). The task-based interviews, along with a framework of *noticing* can provide the needed integration of the content and the language so that PSTs can notice the linguistic challenges that ELLs face and the resources that they draw on to communicate their thinking. The ultimate aim of teacher preparation is not to prepare expert teachers, but to prepare teachers who can continually learn from their teaching (Hiebert, Morris, Berk, & Jansen, 2007). Developing their skills of interviewing and *noticing* can help teachers continually learn from *all* their students.

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