# EARLY CAREER ELEMENTARY MATHEMATICS TEACHERS' NOTICING RELATED TO LANGUAGE AND LANGUAGE LEARNERS

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*There has been limited attention to early career teachers' (ECTs) understandings and practices related to language in teaching and learning mathematics. In this qualitative case study, we drew upon frameworks for teacher noticing to study the language practices of six early career elementary and middle school mathematics teachers. We describe multiple themes that cut across teachers' noticing related to language and language learners, and discuss one theme (i.e., Perspectives on multiple languages) in more detail, including evidence of specific forms of noticing. Implications for teacher education and professional development are discussed.*

Keywords: Elementary School Education, Teacher Education-Inservice, Instructional Activities and Practices, Equity and Diversity

Various calls have been issued to better prepare teachers to address the mathematics learning needs of a growing multilingual student population (Diversity in Mathematics Education Center for Learning and Teaching [DiME]; 2007; Grossman, Schoenfeld, & Lee, 2005; National Council of Teachers of Mathematics [NCTM], 2014). However, despite a sociopolitical turn in teacher education (Gutiérrez, 2013), serious attention to equity has been slow to gain hold. Mathematics teacher educators have argued that a key component of equitable mathematics instruction is drawing on the diverse experiences and understandings that children bring to the classroom, including children's mathematical thinking and children's linguistic and cultural funds of knowledge, or what we refer to as children's multiple mathematical knowledge bases (Turner et al., 2012). Prior research has documented preservice elementary teachers' learning related to children's multiple mathematical knowledge bases in the context of mathematics methods courses (Turner et al., 2012). Yet few studies have investigated how preservice teachers take up these practices in early career teaching. In particular, there has been limited attention to early career teachers' (ECTs) understandings and practices related to *language and language learners* in teaching and learning mathematics (Janzen, 2008). Given the increasing linguistic diversity among public school students (National Center for Education Statistics, 2014) and the fact that as many as 88% of teachers work with English learners (Karabenick & Noda, 2004), increased attention to teachers' language practices is critical.

Noticing includes attending to classroom actions and interactions, as well as reflecting, reasoning, and responding (Hand, 2012; Jacobs, Lamb, & Philipp, 2010; Mason, 2011; van Es, 2011). In this study, we drew on Jacobs et al.'s (2010) and Jacobs, Lamb, Philipp, and Schappelle (2011) three components of noticing (attending, interpreting, and deciding to respond), to investigate early career teachers' understandings and practices related to language and language learners. While Jacobs et al. (2010, 2011) focused on teachers' noticing of children's mathematical thinking, in this

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study, we extended the noticing framework to explore teachers' noticing related to language. Specifically, we investigated the following research question: How do ECTs notice language in planning, enacting, and reflecting on mathematics lessons?

## Literature Review and Analytical Framework

### Mathematics Teachers' Practices with Language

Several emerging areas of research relate to teachers' practices and understandings about language and language learners in mathematics. For example, McLeman, Fernandes and McNulty (2012) studied preservice teachers' beliefs, and found that opportunities to learn about English learners supported non-deficit oriented views. In addition, broader sociopolitical forces have been found to shape teachers' understandings of language in mathematics teaching. Barwell (2014) documented consequences of institutional mandates to use English as the sole language of instruction. Barwell found that in mathematics classrooms taught by monolingual English speaking teachers, linguistically diverse students' use of language was painstakingly monitored for grammatical accuracy. Researchers have also investigated the impact of professional development (PD) on mathematics teachers' understandings and practices with language. For example, Ross (2014) found that PD specifically focused on working with English learners in mathematics classrooms correlated with teachers' increased self-efficacy. Additionally, Takeuchi and Esmonde (2011) found that participation in an inquiry-based PD program positively changed mathematics teachers' discourse about linguistically diverse students and families. Teacher participants initially described language as a barrier for English learners when learning mathematics. During the project, teachers' discourse began to shift and teachers ultimately focused on the importance of making their students' linguistic diversity more visible in their classrooms (Takeuchi & Esmond, 2011). Similarly, Chval, Pinnow, and Thomas' (2014) found that focused PD supported a third grade teacher in understanding that language could be used to build students' mathematical knowledge and, conversely, mathematical instruction could support language development. This led to the teacher providing more explicit language instruction during her mathematics lessons for all of her students.

In summary, prior studies have focused on the role of teacher beliefs and PD experiences in shaping teachers' practices related to language in mathematics. In this study we draw on frameworks of noticing to make sense of how teachers notice language in planning, enacting, and reflecting on mathematics lessons. Noticing frameworks are particularly well-suited for understanding how teachers make sense of complex situations in classrooms (Sherin, Jacobs, & Phillips, 2011), such as teaching and learning mathematics with students of diverse linguistic backgrounds. Moreover, given that what teachers notice and how teachers interpret what they notice impacts what teachers do in the classroom (van Es & Sherin, 2008), a focus on teacher noticing is warranted.

### Teacher Noticing in Mathematics

In framing our study, we found that Jacobs and colleagues' definition of *professional noticing of children's mathematics thinking* provided a useful foundation from which to build (Jacobs et al., 2010; Jacobs et al., 2011). Noticing consists of a set of three interrelated skills. First, *attending* to children's strategies includes focusing on "noteworthy aspects of complex situations" and discerning patterns in children's mathematical strategies and understandings (Jacobs et al., 2010, p. 172). Second, *interpreting* children's mathematical understandings involves teachers reasoning about children's strategies and how they construct a picture of children's understanding based on details of a child's work and research on children's mathematical thinking. Finally, *deciding how to respond* on the basis of children's understandings reflects the decisions teachers make for instruction and whether these decisions draw on specifics of children's thinking as well as research on children's learning and development (Jacobs et al., 2010, 2011).

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Noticing skills develop over time, and much of the existing research has focused on teachers' development of noticing through teacher education or PD programs (McDuffie et al., 2014a, 2014b; Star & Strickland, 2008; van Es, 2011). For this study we take a different approach in three ways. First, instead of looking for changes in teachers' noticing over time, our aim was to understand what and how teachers notice during their first years of teaching to investigate noticing skills as teachers begin their career. In other words, our intent was to map the noticing terrain for early career teachers (ECTs) so that we might better understand what is possible for those new to teaching and also glean what areas will need support for teachers' professional development across their career. Second, instead of focusing on teachers' noticing of children's mathematical thinking, we shift the object of noticing to *language* in mathematics teaching and learning. Although we view language as tightly linked to children's mathematical thinking, our intent was to bring language to the foreground of study. Third, unlike Jacobs et al.'s (2010, 2011) focus on interviewing teachers to examine how they notice children's mathematical thinking, we extended our data collection to include classroom observations, and correspondingly, we studied both teachers' decisions for responding and their actions resulting from in-the-moment decisions during lesson enactments.

## Methods

We used a qualitative case study design (Creswell, 2013; Stake, 1995), to study the practices of six early career elementary and middle school mathematics teachers. The ECTs were part of a larger study (Aguirre et al., 2012; Turner et al., 2012; McDuffie et al., 2014a, 2014b) that followed participants across math methods courses, student teaching, and into their first or second year of teaching. The ECTs attended one of two universities located in different regions of the U.S.

### Participants

Table 1 outlines the background and teaching context of each ECT participant.

**Table 1: Participating Teachers**

| Teacher | Grade | Teachers' Linguistic and Ethnic Background | Students' linguistic background | Linguistic Context of Instruction |
|---|---|---|---|---|
| Evelyn | Y1 & Y2: 7th | English and some Spanish; Mexican American | Some bilingual (Spanish L1); All English proficient[2] | English; non ELD[3] classroom |
| Estelle | Y1 & Y2: 2nd | English; European American | Many students bilingual (Spanish, L1); All English proficient | English; non-ELD classroom |
| Padma | Y1: 4th Y2: 3rd | English; Indian American | All students bilingual (Spanish, L1); Range of English proficiency | ELD classroom |
| Kara | Y1: 5th | English; some Spanish; European American | All but one bilingual; All English proficient | English; Spanish encouraged |
| Natalie | Y1: K | English; some Spanish; European American | Many bilingual (Spanish or dual L1); All English proficient | English; Spanish encouraged |
| Elena | Y1: 1st | Bilingual (Spanish/ English); Mexican American | All bilingual (Spanish L1) | Bilingual 90/10 Spanish/English |

[1]All teacher and district names are pseudonyms.
[2] English proficient as determined by district language assessment and placement policies.
[3] ELD refers to English Language Development classrooms for English learners.

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**Data Sources**

Data sources included classroom observations of mathematics lessons, coupled with pre and post observation interviews. Observations were clustered so that we observed a sequence of mathematics lessons on two or three consecutive days. We observed 8-12 mathematics lessons per year in each ECTs' classroom. We recorded detailed field notes for each lesson, and collected lesson artifacts including student work samples. We conducted pre-observation interviews prior to each set of observed lessons, and post observation debriefs for the first and final lesson observed. These interviews probed ECTs' perspectives and reasoning, and provided opportunities for ECTs to recount, interpret and respond to key moments from lessons. We conducted interviews at the beginning, middle and end of the year to capture reflections about teaching and learning across the year (not just at the level of the lesson), and information about their teaching contexts (e.g., leadership, PD, curriculum, assessment, policies.) Interviews lasted approximately one hour, and were recorded and transcribed for analysis.

**Data Analysis and Analytical Framework**

Through multiple and iterative cycles of analysis, we conducted within-case analysis and cross-case analysis for these cases of teaching (Creswell, 2013; Stake, 1995). As part of the larger project, we conducted preliminary analysis with first-cycle coding to summarize segments of data and identify themes relative to our research foci (Miles, Huberman, & Saldaña, 2014). This initial phase resulted in a code book including the following codes that were relevant to the study reported here: context and background; language; connections to students; connections to family/community; equitable participation. When creating the code book, we developed decision rules for the coding process and descriptions for each code. For example, we defined a *stanza* (Miles, Huberman, & Saldaña, 2013) of text as including both the question and the participant's response, as well as additional text needed for context.

During the second phase of data analysis we used the code book to code all transcripts in the qualitative data analysis software HyperResearch (Researchware, 2011). During this phase we sorted the data by topic and continued generating themes. For example, themes related to language such as: acquiring vocabulary; multiple meanings of words; mathematical discourse; multiple languages. To achieve *interpretive convergence* (Miles, Huberman, & Saldaña, 2013) and ensure consistency in coding data so that all data on a topic were identified with appropriate codes, two researchers independently coded approximately one third of the transcripts, and then met to discuss and resolve any discrepancies.

For a third phase of analysis, we focused on our six ECT cases. For each participant, we generated a *narrative compilation* (Creswell, 2013) of practices related to language. These compilations included representative and compelling examples, along with non-examples, from all data sources to test emerging themes (confirming, refuting, or investigating further). These three phases of analysis, along with research and theory in the field, led us to teachers' noticing skills regarding language in their practice.

In the fourth phase of analysis, we adapted Jacobs et al.'s (2010, 2011) definitions for each of the three components of noticing (*attending*, *interpreting*, and *deciding to respond*) to include language as an object of noticing. We expanded *deciding to respond* to include decisions evidence in lesson enactments. We identified noticing patterns for each participant based on coding data over these two dimensions (language and noticing) and created an analytic memo for each ECT's language-related practices. Finally, we looked across ECTs for larger patterns to build our cross case analysis.

## Findings

We found that ECTs demonstrated all three forms of noticing language as they planned, enacted, and reflected on mathematics lessons. More specifically, we identified themes that cut across various

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teachers' noticing related to language. Given space constraints, we only briefly describe each theme below, discuss the final theme in more detail, and evidence how specific forms of noticing were evidenced.

**Sense-making of Mathematical Terms by Eliciting Students' Ideas**

One strategy that ECTs used to promote student sense-making of mathematical vocabulary was asking students to discuss and generate their own definitions for key mathematical terms. ECTs noticed that when they repeatedly elicited students' ideas about key vocabulary, students moved beyond memorized definitions to deeper understandings. A related pattern was that ECTs tended to introduce vocabulary as a way to help students describe and name their experiences with mathematics concepts.

**Connections Among Language, Concepts, and Everyday Contexts**

ECTs often began mathematics lessons with connections among language, mathematical concepts, and everyday contexts. ECTs explained that they aimed to engage students' interests and leverage students' experiential knowledge to support students in making sense of both the mathematical concepts and the associated terminology.

**Multiple Opportunities for Students to Hear, Say and Use Key Mathematical Vocabulary**

ECTs attended closely to students' needs to hear and say new terms repeatedly throughout a lesson. ECTs highlighted key vocabulary through voice inflection, encouraged the use of terms in classroom talk between students and with the teacher, and provided multiple prompts for students to use new vocabulary (e.g., choral response, talk to a partner and say the term, sentence frames).

**Emphasis on Precise Use of Mathematical Vocabulary**

ECTs often held students accountable for precise use of language, and stopped to question students when mathematics terms were missing or not used correctly. ECTs displayed mathematical vocabulary in the classroom, and reminded students to be precise with the use of these words during small and whole group discussions, and in written descriptions of solutions.

**Expectations for Justifying Reasoning and Explaining Thinking**

Most ECTs evidenced a consistent emphasis on mathematical discussion, and expected students to justify solutions and explain their strategies to others. ECTs viewed mathematical discussions as a key component of students' mathematical learning, and as a context for students to practice using and making sense of mathematical vocabulary.

**Perspectives on Multiple Languages**

Most ECTs evidenced noticing that reflected a resource orientation towards students' home languages. That is, ECTs interpreted inclusion of home languages, and students' spontaneous use of multiple language during lessons as supportive of student learning. Notably, ECTs held this perspective despite the fact that three of six ECTs were teaching in contexts that mandated English as the language of instruction. Beyond this commonality, ECTs evidenced more variation in their perspectives and practices towards the use of multiple languages than was evident in the other themes. Three of the ECTs attended closely to challenges with mathematical language that some English learners in their classrooms faced. For example, when Evelyn noticed students using Spanish as they worked on mathematics, even though she was not able to fully understand their conversation, she positioned Spanish as a resource to support student learning and encouraged students to continue talking and thinking with Spanish. In one instance, a student started talking through one of the lesson tasks in Spanish, and then looked at Evelyn and remarked "I'm sorry, I can't do that." Evelyn responded by encouraging the student to continue (Year 1, Post observation interview).

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While ECTs in general supported connections to students' home languages in mathematics instruction, their reasons for doing so varied. For example, Elena maintained that teaching mathematics in the home language of students allowed students to focus on the concepts and deepen their understanding. This stance was consistent with the bilingual education model at her school, and Elena taught mathematics instruction almost exclusively in Spanish. Elena's primary goal was to ensure student understanding, and she used (and encouraged students to use) both Spanish and English to support learning. For example, when mathematics worksheets were only available in English, Elena translated the directions and problem text into Spanish, so that students had access to both languages to support their sense-making (Post Observation Interview). For Estelle, occasional connections to students' home language were aimed at increasing student interest and engagement, and "helping students feel proud" of their bilingualism. She explained that when she asked students to contribute Spanish translations of key words in her lessons, "they had this big smile on their face like, 'Wow! I have something that Ms. Estelle doesn't have!'" (Y1, Middle of the year interview). As noted above, Evelyn also used connections to students' first language to support mathematical understanding, but responses were also aimed at honoring students' identities. Evelyn was aware of the struggles and lack of support her mother experienced as a bilingual student learning mathematics in an all-English instructional environment, and was determined to offer a different experience for her students (Year 2, End of year interview).

Two of the six ECTs evidenced noticing related to multiple languages that in some instances reflected a mixed (deficit/resource) orientation toward language other than English. The deficit-based ideas included perspectives such as: a lack of English caused student confusion, a lack of English proficiency in parents served as a barrier to students, and when students use only English in math class this evidences progress/understanding. For example, on one hand Padma expressed strong support for students' bilingualism and consistently praised families for supporting students Spanish language development. But on the other hand, she did not view attending to multiple languages as part of her role as a mathematics teacher. She positioned English as the (only) language of school mathematics and did not invite the use of Spanish as a resource to support students' learning. She explained:

> The problem is, I don't know enough [Spanish]. The only one [term in Spanish] I remember was during my student teaching, when we were doing polygons, so like, septagon, seventh grade in Spanish is *septimo*, so that's what I used last year [when I taught the names of polygons] (Year 2, post observation interview).

Padma framed her own lack of proficiency in Spanish and her school language policy as shaping her noticing and responses related to multiple languages. Specifically, Padma explained that the school's philosophy regarding speaking any language other than English was that "it can't happen," because "we're here to teach the students English" (Year 2, post observation interview).

Finally, in some cases a mismatch existed among what teachers attended to related to multiple languages, what teachers planned for instruction, and what they actually enacted. Three of the ECTs claimed to welcome multiple languages in instruction, and described plans for using multiple languages, but the teachers' descriptions did not always match what we observed. For example, Kara explained that she attempted to use cognates whenever possible to support student understanding. She noted:

> Well I try and use as many cognates as I can. I don't know a lot, but I try and sometimes I make them up and I shouldn't because they're not what they're supposed to [be]. And then so I make sure I run them by my bilingual teachers first (Year 1, beginning of the year interview).

She explained she "welcomes" students to speak Spanish during math ("my kids are always welcome to use Spanish when they're learning math. I never limit them to English, ever"). However,

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connections to languages other than English were not evident during the lessons observed, either by Kara or her students. It is possible that Kara connected to multiple languages in lessons that were not observed, but it is also likely that Kara's noticing of multiple languages was limited to attending in her plans and reflections, and that she did not evidence responding to multiple languages in her lesson enactments. This mismatch between some ECTs' *vision* for noticing language and their *enacted practices* related to language may have reflected tensions between school contexts that on one hand encouraged the use of Spanish in instruction, and on the other hand emphasized students' acquiring academic language in English.

## Significance

Patterns in ECTs' practices indicate that beginning teachers *can* engage in complex work of noticing and drawing on language in teaching and learning mathematics. We also identified key supports and challenges that have implications for teacher education. Extended experiences in classrooms with multi-lingual students might support learning ECTs in attending to the role of language in teaching and learning mathematics and in learning about diverse students and families. Similarly, on-going prompts to consider ways to draw on language in instruction might sharpen teachers' noticing of students' resources. These findings deepen our understanding of how to support equitable instructional practices that meet the learning needs of a culturally and linguistically diverse student population.

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