An Exploration of Preservice Teachers' Reasoning About Teaching Mathematics to English Language Learners

Sultan Turkan & Ester J. de Jong

Abstract

Research indicates that many English learners (ELs) have not been effectively supported in meeting their academic learning goals. This explains, in part, the growing interest and corresponding research on the essential teacher knowledge-base for teaching ELs. Despite the attention paid to this issue, research on preservice teachers' reasoning and instructional decision-making, especially regarding teaching mathematics to ELs remains underexplored. For this reason, we examined—through the use of authentic teaching scenarios—how ten preservice mathematics teachers, at the end of their teacher training, chose to present mathematical concepts to their EL learners. We also studied, in depth, the rationale behind their choices. Qualitative analyses of these data revealed that pre-service mathematics teachers' instructional decision making was grounded in their perceptions of ELs as either a homogenous or a markedly heterogeneous group of learners. When asked how to best accommodate ELs with varying levels of linguistic proficiency, some pre-

Sultan Turkan is a research scientist at Educational Testing Service, Princeton, New Jersey. Esther J. de Jong is a professor in the School of Teaching and Learning of the College of Education at the University of Florida, Gainesville, Florida. Email address: edejong@coe.ufl.edu

service teachers opted to remove all discipline-specific language from math problems, others included math terminology and defined key terms prior to the lesson, and several changed their minds—while thinking aloud—regarding how to best present the material. The practical utility of these findings are discussed in detail.

Introduction

Linguistic diversity continues to grow in schools in the United States as English language learners (ELLs) and students from linguistically and culturally diverse backgrounds enroll in schools at a higher rate than their monolingual, Euro-American peers (National Clearinghouse for English Language Acquisition, 2011). The face of mainstream classrooms is, therefore, rapidly changing, and mainstream teachers have to work not only with fluent English speakers but also with students at varying levels of English proficiency (Zehler et al., 2003).

In recognition of the demographic realities, it is increasingly recognized that mainstream teachers need better preparation for working with ELLs (Gándara et al., 2000). When considering what mainstream teachers need to know and be able to do when working with ELLs, teacher knowledge will be affected along multiple dimensions. Yet few studies have considered the question of whether and how teachers draw from knowledge sources for decision making in teaching mathematics to ELLs. The purpose of this study is to address this gap in the literature and gain insight into what knowledge preservice teachers draw on when making instructional decisions for ELLs about mathematics content. We are particularly interested in what sources preservice teachers draw on and the extent to which preservice teachers draw from content knowledge (CK) and pedagogical knowledge (PK) sources related to math and language to respond to instructional scenarios. For the purpose of this study, we were particularly concerned with what knowledge sources have been found to influence preservice teachers' decision making for instruction for diverse learners. Mainstream teachers' abilities to use appropriate content-related and language-related knowledge to make sound instructional decisions for ELLs is arguably an important variable for ELLs' success in school and for closing the academic achievement gap (de Jong, Harper, & Coady, 2013). Understanding whether and how preservice teachers use CK and PK related to ELLs will provide teacher educators with insight into ELLs' learning process.

Teachers' Knowledge Sources

Following Shulman (1987), teaching involves a complex interaction among different knowledge sources. Shulman (as cited in Johnston & Goettsch, 2000) distinguishes between CK; general PK (pedagogical issues that transcend subject matter); curriculum knowledge; pedagogical content knowledge (the special amalgam of content and pedagogy that is uniquely the province of teachers); knowledge of learners and their characteristics; knowledge of educational contexts (at both micro and macro levels); and knowledge of educational ends, purposes, and values.

Several scholars have described the CK and pedagogical skills that mainstream teachers need to develop as part of a preservice teacher preparation program (e.g., de Jong & Harper, 2005; Lucas & Grinberg, 2008; Lucas & Villegas, 2013; Lucas, Villegas, & Freedson-Gonzalez, 2008; Téllez & Waxman, 2006; Wong Fillmore & Snow, 2000). When preparing preservice teachers for working with ELLs, each of Shulman's knowledge areas thus needs to be extended to explicitly include attention to the role that language and culture play in school for ELLs (de Jong & Harper, 2005). Consideration of ELLs would suggest, for example, that disciplinary knowledge or CK is expanded to include knowledge about language and second language and literacy development. Similarly, PK needs to include the knowledge needed to teach language in general and in the context of specific disciplines. Some have referred to this dimension as pedagogical language and disciplinary linguistic knowledge (e.g., identifying instructional foci and explaining a grammar point; Bunch, 2014; Johnston & Goettsch, 2000; Turkan, de Oliveira, Lee, & Phelps, 2014). All in all, math teachers need to have a strong CK base in mathematics as well as the pedagogical skills to teach mathematics. When working with ELLs, they also need to add a linguistic and cultural dimension to this knowledge base, in terms of both content (knowledge about language and language learning [Wong Fillmore & Snow, 2002] and culture [Gay, 2007; Gonzales, Moll, & Amanti, 2013; Nieto & Bode, 2006]) and language pedagogy as it relates to the language of math (Turkan et al., 2014).

Preservice Teachers' Instructional Decision Making and ELLs

In-practice instructional decision making is complex, dynamic, and influenced by various factors, including teachers' personal and professional experiences, contextual factors, their general knowledge of their subject and grade level, and knowledge about individual students (e.g., Borg, 2009; Breen, Bird, Milton, Oliver, & Thwaite, 2001; Feryok, 2010; Gill & Hoffman, 2009; Paterson, 2007). Although the literature on macro- and micro-level instructional decision making has a long tradition in the field (e.g., Corno, 2008; Griffith, Massey, & Atkinson, 2013), fewer studies have considered the types of knowledge sources preservice teachers use to help inform decisions. Even less is known about this question in relationship to culturally and linguistically diverse students.

Preservice teachers' choices for their practices are influenced by a range of factors, including course work, their personal experiences and beliefs, the recommendations or feedback from their mentor teacher or supervisor, and contextual constraints such as curriculum or assessment mandates (Busch, 1986; Sampson, Linek, Raine, & Szabo, 2013). Penso and Shoham (2003) considered how preservice teachers explained their instructional decisions during preplanning and after teaching and identified five different sources that informed their decisions, including content (e.g., degree of difficulty and of abstraction); learner characteristics (e.g., cognitive characteristics, such as previous knowledge, misconceptions, and understanding, or affective characteristics, e.g., anxiety, interest); teacher characteristics (e.g. cognitive characteristics, including knowledge of subject matter, focus on subject matter, or memory, and affective characteristics, such as self-confidence or anxiety); and environmental features (e.g., discipline, cohesiveness of the class, competitiveness, order and organization; see Penso & Shoham, 2003, p. 318). They also found that preservice teachers' reasoning during their internship focused on the student during preplanning but on the teacher when considering instructional decisions after the lesson. The frequency of arguments referring to the content and to the environment was low in both preplanning and postinstruction stages.

Within this broader field, a largely unexplored area of research is preservice teachers' instructional decision making as it relates to linguistically and culturally diverse students in general and ELLs in particular. Cheatham, Jimenez-Silva, Wodrich, and Kasai (2014) examined variation in interpretation of student behavior based on the kind of information provided about the student. They found that when ELL-specific information was provided, it was more likely that the teacher attributed student behavior to language proficiency. When language proficiency information was not provided, the teacher explained student behavior more in motivational terms. The authors noted that, in both cases, teachers operated on a deficit perspective. A study by Buxton, Salinas, Mahotiere, Lee, and Secada (2014) is worth mentioning, despite its focus on practicing teachers, as it is one of few studies to have focused specifically on mainstream teacher pedagogical reasoning and practices as they related to ELLs' science problem solving. In this study, teachers participated in professional development activities that encouraged teachers to leverage ELLs' linguistic and cultural resources for teaching problem solving in science. The study analyzed teachers' reasoning about student performance on specific problem-solving tasks and their ability to link instruction to students' home and community experiences. One key finding is that teachers demonstrate little complexity in their reasoning (as measured by providing justification and explanation) and are "much less likely to support their assertions with theory-based explanations than they were to give more anecdotal types of justifications" (p. 38).

Few studies have considered preservice teachers' reasoning as it relates to teaching mathematics to ELLs. The few focused on preservice teachers' conceptions of ELLs and their challenges in teaching mathematics. For example, Fernandes (2012) implemented an intervention that aimed to foster preservice teachers' awareness of the challenges that ELLs face and the resources that ELLs draw on as they learn mathematics and communicate their thinking in English-only classrooms. Thirty-one preservice teachers participated in the study, and the findings reveal that the candidates noticed the linguistic challenges that some ELLs face and understood language assistance could make a difference for ELLs. The second finding was that the candidates found that the ELLs struggled with explaining their thinking in writing. Moreover, the candidates mentioned that students' written work was difficult to understand. Regarding the resources that ELLs draw on, the candidates reported that concrete materials, such as strings and cutouts, were very helpful for ELLs. Also, McLeman, Fernandes, and McNulty (2012) examined how preservice teachers' background characteristics might explain their conceptions about teaching mathematics to ELLs; 292 candidates from universities in urban settings participated in the study. The survey instrument included 26 items asking the candidates to rate the strength of their agreement or disagreement with conceptions about mathematics education of ELLs. The findings show that exposure to working with ELLs, field experiences, and gender might influence how candidates come to conceive the mathematics education of ELLs.

Furthermore, to study how teachers reason about the work of teaching, there is a rich tradition of use of instructional scenarios or case studies. Through examining the characteristics of the cases in which teaching occurs, teachers have the opportunity to reflect on their emerging practices (Masingila & Doerr, 2002), a perspective that aligns with the situated nature of learning (Lave & Wenger, 1991). Illustrations of instructional cases are essentially used as tools for developing preservice teachers. These illustrations can be viewed as authentic representations of teaching (e.g., case studies, depictions of instructional scenarios, video footage) that essentially depict characteristics of instructional practices, highlighting features for novices and in-service teachers to learn (Grossman et al., 2009). In fact, Lampert and Ball (1998) showed how combinations of videotapes of classroom mathematics lessons, student work, and instructional materials portray the richness of the classroom activities. Furthermore, new lines of research (Lai & Howell, 2014) have shown that formatting representations of authentic classroom scenarios into an assessment environment can serve as powerful reflective teacher learning and professional development tools.

Informed by this research, we employ instructional scenarios in our attempt to explore how preservice teachers reason about teaching mathematics to ELLs in the elementary grades. To this end, we raise the following research question: What knowledge sources do elementary preservice teachers draw from when considering various mathematics instructional scenarios? Furthermore, what do the sources they draw from tell us regarding their understandings about effective content (math) teaching for ELLs?

Methods

To address the research questions, we administered a set of 20 scenarios, 19 of which provided multiple choices of instructional strategies or resources to address the particular issue raised in the scenario. The remaining one scenario allowed candidates to construct their open-ended responses to the given scenario. A scenario was constructed first with a focus on mathematical content relevant and typical to the work of teaching mathematics. This focus then determined the learning objective for the particular scenario. The learning objective helped to define the language objective that the ELLs are expected to perform as part of the classroom task. The scenario also described the general characteristics of the ELLs and their language proficiency level descriptors defining what they can and cannot do. See the appendix for an example scenario, in which the teacher wants to help the students clearly and logically explain how they used the Pythagorean theorem to find the length of the hypotenuse of a right triangle. The teacher is considering a combination of two worksheets out of four to help the particular ELLs with the task. The responding teacher had to choose one combination of two worksheets that would help best with the task of the teacher in the scenario, considering the given characteristics of the ELLs.

These scenarios were developed based on a national survey and panel of expert teacher educators and teachers (for more details, see Turkan, Croft, Bicknell, & Barnes, 2012). The instructional scenarios in the form of assessment items were used to elicit preservice teacher reasoning and instructional decision making. We took this methodological approach based on the argument in the earlier cited literature that authentic representations of classroom scenarios can be used as tools for investigating teacher reasoning and developing or improving teacher learning (i.e., Grossman et al., 2009; Lai & Howell, 2014; Lampert & Ball, 1998). Furthermore, including scenarios could be considered as important in culturally responsive teacher education toward teaching *practical knowledge* for mainstream teachers of ELLs. Through this lens, we developed a total of 60 instructional scenarios in mathematics but, for this study, selected 20 scenarios that were representative variants of the targeted instructional domain in sixth- to eighth-grade mathematics.

For the purpose of this study, we invited candidates from an elementary teacher education program in the southeastern United States to participate in interviews. The choice of this target population was informed by the fact that they had participated in a program that specifically prepared them to work with ELLs, had completed an ELL-specific course, and had attended a second ELL-specific course. Each candidate was asked to respond to the scenarios online and was interviewed within 48 hours of responding. We chose to conduct the interviews within 48 hours because we wanted to avoid threats to memory retention when eliciting participants' reasoning about the scenarios. Data collection occurred over a 3-month period.

During the interviews, candidates were asked to share their reasoning about the scenarios through the following main questions:

1. What answer did you select? Can you explain your choice?
2. Why did you select this answer and not [alternative options]?
3. How useful was it to be informed about the proficiency level of the ELL?

Participants

The 11 participants were female preservice teacher candidates preparing to teach in elementary grades. Since the mathematical content covered in the scenarios did not require a level of mathematical knowledge that only secondary mathematics majors would have qualified to address, we felt that the scenarios were appropriate to use for this population. Only one candidate was of Hispanic origin, and the others were White. All teacher candidates were about to graduate from a 5-year teacher preparation program with a master's degree in elementary education and an English for Speakers of Other Languages endorsement or certificate. None had teaching experience beyond their field placements, but all reported working with ELLs at some point during the program. All had completed one required course specifically related to working with ELLs, which focused on foundational understandings of language and culture in school. Most had completed their internships and/or were almost completing their internships. When asked how frequently the candidates had collaborated with English as a second language (ESL) teachers on working with ELLs, four of them stated one or two times a week, and three of them reported to have worked with ESL teachers three to six times a week. Only one teacher candidate said that she had never worked with an ESL teacher.

Analysis

The collected data from 11 interviews about candidates' assessment answers were first transcribed. The quality and accuracy of the transcriptions were verified by independent parties other than the two authors. The data were then imported into NVivo Version 10 (QSR International) for computer-assisted analysis. Following Creswell's (2005) multistep design for qualitative analysis, the two authors independently read each one of the transcriptions and convened to discuss general and specific codes emerging from the data. Together, we identified specific themes, such as knowledge of language, knowledge of culture, and positioning of ELLs in relation to their learning and corresponding codes. Our initial coding of candidate reasoning suggested that candidates draw on multiple sources. Disciplinary language knowledge was represented by reference to (a) the ELL proficiency descriptors and (b) candidates' references to the language demands embedded in the scenario as well as to sentence structure and vocabulary as sources of language demands that they considered as part of addressing the instructional problem.

Additional sources included candidates' references about their prior experiences about ELLs' familiarity or cultural experiences with a topic, CK, PK, and ELL-specific instructional strategies. We then independently applied the preliminary codes to two interviews and checked the areas of convergence and divergence. Discrepancies and agreements were discussed to refine and revise the initial codes. Once the final coding scheme was reached (see appendix), we independently analyzed a set of interviews and cross-checked each other's analyses. Once the analysis and verification of the analysis was complete, we cross-tabulated how responses to each scenario interacted with each one of the codes.

We provide frequency analysis on this cross-tabulation to frame the patterns emerging from candidates' reasoning about the instructional scenarios. For the emerging themes to be considered a pattern, the themes need to be repeated enough times (i.e., 10% of the coded references) and relate to one another to form a coherent story. In what follows, we first provide an overview of emerging sources of knowledge, which is followed by a discussion of each source of knowledge.

Results

Emerging sources of knowledge could be viewed under two broad umbrella categories: (a) scenario-embedded sources or (b) participant-driven sources. Scenario-embedded sources included, namely, drawing from ELL-specific characteristics, drawing on language-related knowledge while participant-driven sources included sources such as drawing from CK sources, drawing from pedagogical sources, and drawing on culture-related sources. Each source was derived from emerging themes. Table 1 shows the distribution of themes under each knowledge source. As a scenario-embedded source, drawing from ELL-specific characteristics emerged when all 11 candidates referred to the ELL language status or proficiency descriptors provided in the scenarios. Tapping into this knowledge also facilitated access to candidates' drawing on language-related knowledge, which was also a participant-driven source. This source manifested as the candidates' responses were coded into the following themes: language demands, sentence structure, and vocabulary. This knowledge source showed what teacher candidates thought *language* entailed. Also, drawing on culture-related sources, which was participant driven, mostly referred to how familiar the candidates thought ELLs were with a topic of interest. It was more

Table 1
Frequently Coded Sources and Emerging Themes

Source/theme	*Frequency of occurrence*
ELL specific	
Language status	98
Language related	
Sentence structure	57
Vocabulary	45
Culture related	
Cultural experiences	58
Content knowledge	58
Pedagogical	
ELL teaching	72
Pedagogy	70

about the relevance of a topic to ELLs' lives. CK, as a participant-driven source, was more about how candidates reasoned at the intersection of content, language demands, and ELL proficiency descriptors. Lastly, PK manifested as candidates reasoned about nonlinguistic ways of representing the content. Table 1 presents the number of times each corresponding theme, organized under a knowledge source, was coded. We then considered whether particular knowledge sources were more frequently evoked by particular scenarios. The themes appeared to occur most frequently (i.e., in more than 10% of the coded references) in candidates' responses to 11 specific scenarios (see Table 2). That is, we identified the scenarios that received 10% or more of coding with a particular theme. The weighing of reasoning received from each participant on each of the scenarios was equal because all the participants had to respond to the structured interview protocol. Therefore the percentage of coding done on each scenario is not reflective of most talkative candidates' responses. In our report of the major findings, we highlight the scenarios that seemed to elicit the use of a particular knowledge source the most (Table 2) based on our analyses of those scenarios in more depth.

We observed that knowledge of linguistic demands informed participants' reasoning particularly for Scenario 7 and Scenario 6. Cultural awareness was prominent in the case of Scenario 17, CK in Scenario 20, and general PK in Scenario 20. In the following, we discuss these scenarios and the specific source of knowledge as they emerged in our coding. Before discussing the participant-driven sources, we begin our presentation of findings with a scenario-embedded source of knowledge, namely, drawing from ELL-specific characteristics, that is, ELL proficiency descriptors or language status.

Table 2
Percentage of Total Coding of Each Theme in Relation to Each Scenario

Scenario	*Language status*	*Language demands*	*Sentence structure*	*Vocab-ulary*	*Cultural experien.*	*Content knowledge*	*ELL teaching*	*Pedogogy*
1	**11**	<10	<10	<10	<10	<10	**10**	<10
4	<10	<10	**11**	<10	**14**	<10	<10	<10
5	<10	<10	**11**	<10	<10	<10	**10**	<10
6	<10	**11**	<10	**20**	<10	<10	<10	<10
7	**10**	**17**	**25**	<10	<10	<10	<10	<10
9	**13**	<10	<10	<10	<10	<10	<10	<10
12	<10	<10	<10	<10	<10	<10	**10**	<10
13	<10	<10	<10	<10	<10	**10**	<10	<10
14	<10	**15**	**12**	**18**	<10	**12**	<10	<10
17	<10	<10	<10	<10	**48**	<10	<10	<10
20	<10	<10	<10	<10	<10	**16**	<10	**14**
Total	100	100	100	100	100	100	100	100

Note. Boldface indicates percentages higher than 10%.

Drawing from ELL-Specific Characteristics

Here, we describe the scenario-embedded knowledge source, drawing from ELL-specific characteristics. Each assessment scenario presented information about the ELL status of the students described in the scenario. This information varied in form, including descriptive statements such as "The students in the class are newcomers" or "weak in mathematics and low in proficiency in English." We also provided world-class instructional design and assessment (WIDA) levels in some scenarios (e.g., WIDA Level 2 in speaking). When asked whether it was important to have information about proficiency levels, one candidate stated, "Knowing that it was low proficiency in English, that's how I formed my answer. That's how I came to what I got." About 50% of the participants related back to the ELL information and provided different examples of how this information affected their choices. Three candidate reasoning patterns emerged: (a) separation of content and language, (b) application of proficiency level, and (c) asking for more background information. As we describe these patterns, we do not highlight any particular scenario as information about ELL characteristics was a feature across all items.

Candidates showed an awareness of the importance of separating math knowledge from language proficiency for making instructional decisions. One candidate described the following related to one scenario:

> They have the basic math vocabulary and so that's not something that they really need . . . they don't need to understand addition, or multiplication or division, that sort of thing. They just mainly need to understand how the process the sentence, so their issue is more of the English side of things.

They also referenced the English proficiency level in relation to instructional choices in general and (only in a few cases) specific to the scenarios. For example, one candidate generalized her approach for intermediate students as follows: "If they're only intermediate in listening . . . you're going to want to be careful on how you guide them and go slow and step by step. Because it's going to be harder for them to kind of pick it up."

A number of participants indicated that they were unfamiliar with the WIDA standards (these had not been covered in the program at the time of the assessment), which affected their ability to use language proficiency information. The given information was used to reason whether the ELL students would be able to process the content or learning objective mentioned in the scenario. For example, in the case of one candidate, the scenario indicated the students were at WIDA speaking level 3 and WIDA reading and writing level 2. The candidate was not sure what these proficiency levels meant but concluded that the proficiency level was too low for answer D:

> I didn't pick *D* (have students explain in their own words and writing how they

> solved the problem) because I was still confused on the listening level, reading, speaking and writing, so I didn't know how proficient they really were.

She continued to elaborate on why she did not select answer D later in the interview:

> *D* was have the students explain their thought processes orally to a partner who monitors the description for technical language. Again, if the ELL student isn't comfortable speaking, or if the other student doesn't understand them because of their accent or something or they mispronounce something, that could be really embarrassing.

When the scenario incorporated a description of the ELLs' actual language skills, the candidates did use those details to inform their reasoning and decisions. One candidate explained why she did not select answer *A*—"Use the formulas to find the perimeter and the area of a rectangle. Write a paragraph explaining how they know their answer is correct":

> And my ELLs in the class, they have had 2 years of schooling in the U.S. and have a considerable amount of content knowledge, but they received a low placement on the state English language proficiency test. So writing a paragraph, I think, is too extensive.

As for asking for more background information about the ELLs, when the scenarios only stated that ELLs were recent arrivals, candidates particularly pointed out that they needed more background knowledge to make sound decisions, whether it be math knowledge, and information that might help with identifying cultural knowledge. One candidate noted the following:

> If they're ELLs and they're newly arrived, are they from the country or not from the country? Because if you're from the country you might know, like ice hockey would be relevant. Maybe if sports are relevant, they would know the win-loss. There's just so many more things that go into it than just knowing you're newly arrived.

Drawing on Language-Related Knowledge

In terms of drawing on knowledge of language, candidates were drawn to word-level instructional scaffolding if their conception of language instruction was limited to unpacking the *important terminology* for ELLs. Furthermore, some candidates were drawn to simplifying the language demands or *throwing out the extra words* when asked how they would rephrase ELLs' language constructions about the particular content. The emphasis on vocabulary as a main target of language modification has also been found in other studies where teachers conceptualize academic language proficiency in terms of discipline-specific vocabulary (cf. Scarcella, 2003). Candidates' sources of knowledge about language and language-related considerations (grammatical difficulty, vocabulary) were most frequently coded for Scenario 7 (see the appendix).

Scenario 7 description. This scenario involves showing ELLs how to solve for the unknown side of a right triangle when the unknown side is the hypotenuse and when the unknown side is a leg and facilitating their engagement in solving and explaining the problems. The ELLs in the class are characterized as hesitantly conveying ideas in simple sentences using the present tense, making errors that may interfere with communication, and using everyday English vocabulary. In this scenario, teacher candidates were asked which combination of four given worksheets they would use to help ELLs clearly and logically explain how the Pythagorean theorem is used to find the length of the hypotenuse of a right triangle.

Candidates' responses analysis. Candidates referred to textual help that the particular ELLs in this classroom would most benefit from, and they most frequently chose Worksheet A because it provides scaffolding for the right level of academic language needed for the task in hand:

> I was torn because I really liked A, a little bit, because it says, "I label the side with blank as blank." I liked how like laid out it was, and the language was, I don't want to say more simplistic, but it was. It wasn't considered like high academic language.
>
> I picked A because there was a lot of text and I thought the text would really help them, like because it was fill in the blank, so they could pick up on, since they do use like everyday English vocabulary, like they would know like I labeled the side the, because that's not; and they were more filling in the academic language rather than everything else.

In other candidates' reasoning, the focus on vocabulary was pronounced, which drove their decisions in choosing Worksheet C, since it provides the necessary terms for the task: "C gave them the definitions and as an ELL it's important for them to know. They don't know a lot of the words, and obviously the vocabulary is important terminology for them to learn."

Other scenarios that predominantly elicited language-related reasoning were Scenarios 1, 6, 9, and 14. The coding within these scenarios confirmed that candidates were focused on finding the most linguistically simple option, just as the two following excerpts indicate:

> I chose the last one because the vocabulary is, it's simplest. It gets to the point. I'm not throwing in extra words to convey the meaning. So I mean in the form *y* that part still would be a little confusing.
>
> When the equation is in the *y* equals mx plus b, the slope is the number that multiplies the *x* and the *y*, that just seemed wordy. That seemed like, you know, if you come to a student and say that, there's so much information coming out of your mouth that that would be confusing. I picked when the equation is in the form *y* equals *mx* plus *b*, the slope is *m* and the *y* intercept is *b*. That would be, you know, that is the shortest answer, the shortest, the small, you know, the clearest thing that she would, could have said out of the options.

Drawing From CK Sources

CK served as a crucial affordance for candidates to be able to reason through the scenarios. At times, candidates reasoned about the scenario without making any reference to any mathematical concept or operation related to the content presented in the scenario. Then they would resort to selecting the option that made most pedagogical sense to them. In the open-ended scenario, however, candidates were able to demonstrate their CK. Even then, their choice of using a nonexample to represent the concept of integer was not substantiated with a clearly stated nonexample. Candidates' CK appeared to be most represented in Scenarios 13, 14, and 20. Scenario 20 elicited open-ended responses that mostly represented candidates' CK as well as PK. In fact, this was the only scenario that received most coding of PK.

Scenario 20 description. The scenario involved teaching students which rational numbers are integers and which rational numbers are not integers. With that objective in mind, the teacher in the scenario uses a definition and representation of integers for ELLs who are near grade level in mathematics ability and have limited knowledge of basic math vocabulary.

In Scenario 20, the teacher is introducing the concept of integers to the class. The teacher wants to use the given definition and representation to make the concept more comprehensible to the ELLs who are near grade level in mathematics ability and have limited knowledge of basic mathematics vocabulary. The teacher candidates were asked about what other effective representation a teacher could use to help the ELLs make the connections between the definition and representation. They were also asked to explain why the representation would be helpful to the ELLs.

Candidates' response analysis. Candidates emphasized the use of nonexamples and nonrepresentations of the concept of integer. One candidate explained the following:

> basically I wrote just another representation is what; like when I wrote it I wrote that they would write a number line with fractions, and like with integers, and fractions and decimals as like a nonexample, like these are not all integers. So I did like a nonexample. That was what I; but that's the same as like; I mean it's a nonrepresentation.

Similarly, another candidate argued for using a nonexample, even though she did not specify what a nonexample would be: "Besides using the word representation a million times, I basically said that it would be very helpful to use examples as well as nonexamples, to use removable numbers so that you haven't just put a number line up." Then, the candidate supported the reason for her choice to represent the concept with a nonrepresentation:

> And she has drawn a number line from negative 10 to 10 with the integers labeled. That's all they give us which that's a great start, but if you just put a number line up on the board with negative 10 to 10, students have seen a number line negative

> 10 to 10 and they know that there are numbers in between at this point, presumably. And one of the biggest things that I've noticed from the students that I've worked with is that if you give examples, that's perfect. But students will always think of an extra nonexample that they'll think is right because it relates in some way. So, if you don't provide nonexamples once the examples have been kind of solidified, it becomes a problem as you proceed because the student will think that something else . . . but a half, we use a half so that's an everyday number. Well, no, you know. But it's not an integer.

Analyses of the other scenarios confirmed these patterns. The following excerpt shows how a candidate's CK did not provide affordances to weigh the options:

> Well, okay, so the slope intercept form of the line is Y equals MX plus B. The slope is the coefficient of X. I think I didn't chose, I didn't choose B because it says coefficient of X and I didn't know if that was something, coefficient was like a kind of higher vocabulary term that I wasn't sure if they'd covered. You used Y equals MX M times, X plus B. The slope is the number that multiplies the X–Y intercept is added to the product MX. See that makes just as much sense. It's like I have trouble distinguishing one from the other in terms of, does this make more sense? Like I know they're both on the right track and they both sound good. And then when the equation is in the form Y equals MX plus B, the slope is M and the Y intercept is B. Yeah, so I mean I cut out B immediately just because the vocabulary, but then A, B, and C or A, C, and D I just, they all sounded the same.

The next excerpt similarly hints at the challenge the candidate was having with the content. The candidate reported to have chosen the option whereby the teacher in the scenario is restating the ELL's response to a question in the given worksheet (i.e., Option D: "when the equation is in the form y equals mx plus b the slope is the number that multiples the x, and the y intercept is b"). The candidate then added that she did not exactly know what that means in terms of "making the equation make sense":

> Just I feel like it didn't confuse me because of the; like what to do best with ELL that confused me because just the language of the math. I feel like I had to know more about the formula that they were talking about than what was, what she should do first with the kids. So basically like the objectives and like the students are trying to explain relationships between functions, and they're talking about I think it's the slope intercept form. And I mean I read it, and I know what the slope intercept form is, but then so it says, "I used y equals mx and b the slope number is next to the x, the y intercept number is at the end." And then she's trying to communicate it more precisely so what should she do first? And I guess I said when the equation is in the form y equals mx plus b the slope is the number that multiples the x, and the y intercept is number, is by itself at the end. But still I was just like, I don't know what that means. I was just, I don't know. I know I've learned this before, but I feel like it was just confusing solely because I was trying to figure out what the equation meant and how to state the equation to make it make sense, rather than which one would be best to restate, the kids. So that's what I thought about that one.

All in all, the candidates seemed either to have difficulty reasoning about the content or to rely on their existing knowledge about content. Also, they preferred using nonexamples to represent content to students; however, it was mostly unclear what they exactly meant by a particular nonexample of a mathematical concept. However, the use of nonexamples, otherwise referred to as counterexamples, is encouraging, as they are common and effective ways of illustrating mathematical concepts (Leinhardt, 2001).

Drawing on Pedagogical Sources

In terms of PK, we observed that some candidates, responding to Scenario 20, complemented their preferences for representing the concept by identifying pedagogical practices they thought would benefit ELLs in the particular classroom. They believed that using pictures and manipulatives would be a beneficial pedagogical practice for ELLs. While viewing nonlinguistic practices as beneficial for ELLs, candidates also differentiated the ELL teaching from non-ELL teaching. Most candidates were convinced that using visuals and explaining linguistic complexity explicitly is distinctly necessary for ELL teaching. This distinction also gave the impression that candidates viewed ELL teaching as "other" from non-ELL teaching rather than as the "same" as non-ELL teaching.

Candidates' response analysis. To illustrate, one candidate stated that she would use an integer jar to represent the negative and positive integers:

> So my answer was a nonnumerical representation, and then I thought maybe an integer jar with like a line in it, so anything below the line is negative and anything above the line is positive, and then have marbles that we would call integers. And so they're all in the jar and they're all integers, but the ones on the, the ones below the line is negative and the one above the line is positive.

Another candidate did not specify what physical representation she would use:

> I thought that a nonnumerical, more physical representation would be helpful for any child, and but specifically for ELLs because it's something that they could see and wouldn't, you know, and wouldn't be such, so abstract of a concept as a number line, or me just explaining to them or something like that.

However, both candidates operated from the pedagogical assumption that physical representation of a concept benefits ELLs above and beyond other students because physical representation provides a way to understand the mathematics without its language demands.

A third candidate expressed the idea that ELLs need visuals and explicit explanations more than any other students, "because of the idea that you do want to use visuals, and that you do want to like make sure that you're explaining everything explicitly." A similar idea came from a fourth candidate who highlighted the need to rephrase for ELLs. Again, the implicit assumption was that ELL teaching is distinct from non-ELL teaching:

> Especially ELLs are, you know, they're going to say something, and they're going to, the first thing that comes to their head as a way to communicate with you. But then to ask them to stop and try to rephrase it in a way that maybe makes a little bit more sense and get them to think about it is something that you're going to be doing a lot with ELLs.

The importance of providing comprehensible input through nonverbal means was an important knowledge source that the candidates' drew on as a specialized approach for ELLs. It is a widespread strategy that is promoted to scaffold instruction for ELLs at different proficiency levels (e.g., Echevarria, Vogt, & Short, 2010).

Drawing on Culture-Related Sources

Candidates' knowledge or awareness about ELLs' cultural familiarity with a topic also served as a source for candidates in that they reasoned what social situation would be most familiar to ELLs. It was noted that some candidates thought social contexts, such as ice hockey or the stock market, would be very foreign to ELLs while at the same time found it appropriate to present the scenario of dropouts to ELLs, despite the incompatibility with teaching mathematics percent problems, as noted by one candidate. A deficit perspective about ELLs might be reflected in finding the scenario of dropouts relevant to ELL instruction. As for candidates' knowledge or awareness about ELLs' cultural familiarity with a topic, Scenario 17 predominantly elicited candidates' cultural awareness.

Scenario 17 description. In this scenario, students are to solve percent problems set in real-life scenarios. The teacher selected some newspaper clippings, and the candidates were asked which newspaper clipping would be the most appropriate for the ELLs who are newly arrived to the class. Among the options were the ice hockey standings showing the games won, lost, and lost in overtime; sales ads listing the original and sale prices of different scenarios at a store; a table showing information about stock market indices; and an article listing the number of senior students and the number of dropouts. The intended answer was sales ads, which is a situation anyone, recently arrived or not, has likely contended with in life before coming to the United States and also has to contend with here.

Candidate response analysis. Most candidates selected the option with sales ads reasoning that it would be most relevant to everyone regardless of cultural or linguistic backgrounds. One candidate's reasoning represents how candidates found the sales ads relevant to ELLs:

> And then sales ads listing in the original and sales prices of different items at a store. On that one I was like, okay, maybe. But then again I was like, I was just thinking I mean that's like if you go to a mall and there are sales, there are, you know, 30% off. Like not everywhere has just set in stone like stores where you go to and there are sales prices, there are original prices. I mean I was like, okay,

> maybe not everyone would know what that is. And then a table showing information about stock market indices, I don't even know about stock market indices, so I don't expect; you let, I mean kids in the United States, let alone kids outside the United States, I mean that's like what adults think.

A few candidates thought that the number of dropouts would be relevant specifically for the senior-level students.

> Yeah. And then I chose an article listing the number of senior students, the number of dropouts, and I just figured that would be the most, I guess the easiest to explain to them. I mean I'm assuming number of senior students, like students in older grade levels like being seniors. And then the number of dropouts, like you could explain, okay, these are the kids who dropped out of school before they reached the max you could go to.

One candidate, though, reasoned that dropouts would be a discouraging scenario for the ELLs, and mathematically it will not be conducive to writing percentages. The candidate stated the following:

> Also, the biggest thing about percentages in real-life context and such is that the number of senior students, the number of dropouts cannot only be skewed, it can be incorrect completely. It can be just irrelevant to their lives. It's not necessarily a real-life scenario because the chances of your student calculating the number of senior dropouts is very, very slim.

Another candidate added, on a general note distinct from most responses, that it was important to get to know ELLs to judge what real-life scenarios would be even relevant.

> …because it would make sure they realized that real-life scenarios for us aren't what real-life scenarios are for everybody, and so people who have just come here might not; like their real world, their context framework in their heads isn't going to be the same thing as we're used to necessarily, and to maybe get to know them first, and then be able to build on their real-world experiences after you get to know what their real-world experiences are. Or else how can you do that first, without getting to know them?

Awareness of cultural differences and experiences and how these experiences may affect ELLs' interpretation of a task or an assessment item is an important strategy that the elementary preservice teachers' learn in their program. They encounter this notion in various classes and are prompted to consider how different cultural experiences might intersect with learning content, such as science and math (Rajagopal, 2011).

Overall, findings suggest that the participating teacher candidates predominantly drew on knowledge of specific language demands at the sentence and vocabulary levels, knowledge of ELLs' language proficiency status, knowledge of ELLs' familiarity with cultural topics, and their knowledge of content in mathematics and pedagogy. Across these sources of knowledge, candidates seem to have their own conceptions about what it means to teach mathematics to ELLs. Within these conceptions, we observe that candidates highlight the importance of knowing what ELLs can do and cannot do using language in a mathematics class. However, their conception of ELLs might be delimited to specific expectations associated with specific language proficiency markers such as "emergent." This echoed the findings from Cheatham et al.'s study in that language proficiency descriptors help teachers explain ELL student behaviors. These kinds of conceptions of ELLs drove what candidates focused on in their instructional decision making about the scenarios. Furthermore, they had certain conceptions of what it meant to teach certain concepts, such as "integers," to ELLs. In that, they thought physical or pictorial representation, devoid of linguistic scaffolding or explanations, would best serve ELLs' understanding of the concept.

Discussion and Concluding Remarks

This exploratory study examines what knowledge sources preservice teachers drew from to respond to instructional scenarios related to teaching mathematics to ELLs with varying proficiency levels. Overall, our analysis of 11 cognitive interviews with elementary preservice teachers suggests that across candidates, multiple sources were relied on to explain their answers, ranging from personal experiences, to social reasons, to their general understandings about teaching and teaching mathematics, and specific notions about language demands and cultural experiences for ELLs. In doing so, they either relied on the assessment tool–driven source about ELL characteristics or their own professional reasoning or knowledge, aka participant-driven source. This finding aligns with other studies that have found that teacher decision making is influenced by several antecedent factors, such as student and task characteristics, which is typically not participant driven (Cheatham et al., 2014; Shavelson & Stern, 1981) as well as professional experience and expertise acquired through formal preparation (Darling-Hammond & Bransford, 2007). Furthermore, information about ELL characteristics was seen as important by most participants, although only five out of the 11 candidates explicitly referenced the background information provided in the scenario and used it to explicitly guide their decision making. Similar to Cheatham et al. (2014), the descriptions of particular ELLs' language proficiencies do direct student teachers' attentions to language-related considerations about instructional practice. They acknowledged the importance of distinguishing between mathematics knowledge and language proficiency for ELLs and not assuming that one presupposes the other. This distinction is important to maintain appropriate content expectations for ELLs, even if they are at lower proficiency levels in the language of instruction (Gibbons, 2002; Pappamihiel, 2007).

Also, we observed that teacher candidates may not have much understanding of what ELLs can do within the prescribed proficiency level. Without that nuanced understanding, however, general descriptors, such as *low proficiency*, *intermediate level*, or *newly arrived*, may trigger multiple different interpretations with candidates as to what ELLs could or could not perform in the mainstream classroom. One explanation of possible different interpretations about ELLs' given proficiency levels may lie in the limited field experiences students have had as part of their programs resulting from the geographical location of their teacher preparation programs. As a result, language proficiency levels and what they mean for instructional practice remain abstract rather than connected to specific students with heterogeneous linguistic and cultural characteristics encountered in the classroom (Solano-Flores, 2008).

Furthermore, consistent with the prevalent research on mainstream teaching of ELLs is our finding that understandings about language do not go above and beyond the vocabulary level, especially in content instruction. Scholars (Halliday, 1978; Schleppegrell, 2004) have long argued that language of schooling consists of multiple layers of semiotic and social mechanisms. Discourse in a classroom instructional context that refers to ways of knowing, constructing, and communicating knowledge cannot be delimited to word-level representations of intended meanings. In this sense, culturally and linguistically responsive teacher education (Lucas & Villegas, 2013) that views language more than word-level representations could contribute greatly to reformed understandings about language and language use and what it means to integrate language-focused instructional objectives in content instruction (Crandall, 1987).

We observed in the participating preservice teachers' responses to scenarios that unpacking language demands, specifically rephrasing student language or a linguistically challenging sentence, readily refers to using pictures or manipulatives. That is, they viewed access to language in terms of nonverbal replacement of what was perceived as difficult vocabulary. In their view, this might make the ELL teaching "othered" from non-ELL teaching and therefore ELL teaching might be distinct from non-ELL teaching. However, differentiating instruction for ELLs only may be counter effective in most contexts. In fact, effective instruction for ELLs simultaneously considers both reducing language demands through nonverbal means and teaching the academic language to meet the demands of the content area adjusted for the students' conceptual and linguistic backgrounds (Gibbons, 2002; Harper & de Jong, 2004). Reeves (2006) similarly argued that effective and equitable ELL instruction does not entail watering down the content demands nor not differentiating for ELLs' needs either. Teacher education methods classes thus need to ensure candidates' abilities to both shelter their content instruction and develop academic language. Although visuals and other nonverbal supports are important, particularly for beginning ELLs, this will be insufficient to provide full access to the languages of the academic disciplines.

Two main limitations should be taken into account when considering the generalizability of the findings in this study. One is that we conducted the interviews with preservice teachers attending one particular teacher education program (in the southeastern United States). Second, most candidates were elementary majors. Although none of them indicated difficulties with the mathematical content, the mathematical content represented from the secondary grade levels may have made it difficult for them to reason through some of the higher grade level mathematical content embedded in the scenarios.

Nonetheless, results of the current study hold implications for future research and teacher education. One immediate follow-up study would examine if the identified sources of knowledge hold across candidates. Another study could examine the extent to which candidates' references to and knowledge about language demands embedded in the instructional scenario are related to candidates' depths of CK. A parallel line of research could examine the extent to which preservice teachers benefit from language-specific considerations in teaching content to ELLs through the use of scenario-based prompts in teacher education programs. The use of scenario-based prompts has implications for teacher education. Scenarios may hold the potential to provide context for reasoning through complexities of teaching content to ELLs by considering heterogeneous ELL characteristics and dimensions. Particularly, various native language and second language proficiency descriptors within and across four skill areas (i.e., listening, speaking, writing, reading) might be utilized. This might in turn generate a multitude of linguistic, content-related, and pedagogical strategies to implement in classrooms.

References

Breen, M. P., Hird, B., Milton, M., Oliver, R., & Thwaite, A. (2001). Making sense of language teaching: Teachers' principles and classroom practices. *Applied Linguistics, 22*, 470–501.

Borg, S. (2009). English language teachers' conceptions of research. *Applied Linguistics, 30*, 358–388.

Bunch, G. C. (2014). The language of ideas and the language of display: Reconceptualizing "academic language" in linguistically diverse classrooms. *International Multilingual Research Journal, 8*(1), 70–86.

Cheatham, G. A., Jimenez-Silva, M., Wodrich, D. L., & Kasai, M. (2014). Disclosure of information about English proficiency: Preservice teachers' presumptions about English language learners. *Journal of Teacher Education, 65*(1), 53–62.

Corno, L. Y. N. (2008). On teaching adaptively. *Educational Psychologist, 43*, 161–173.

Crandall, J. (1987). *ESL through content-area instruction: Mathematics, science, social studies*. West Nyack, NY: Prentice Hall.

Creswell, J. W. (2005). *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (2nd ed.). Upper Saddle River, NJ: Pearson Merrill Prentice Hall.

Darling-Hammond, L., & Bransford, J. (2007). *Preparing teachers for a changing world: What teachers should learn and be able to do*. Hoboken, NJ: John Wiley.

de Jong, E., & Harper, C. (2005). Preparing mainstream teachers for English language learners: Is being a good teacher good enough? ***Teacher Education Quarterly, 32***(2), 101–124.

de Jong, E. J., Harper, C. A., & Coady, M. (2013). Enhanced knowledge and skills for elementary mainstream teachers of English language learners. *Theory Into Practice, 52*(2), 89–97.

Echevarria, J., Vogt, M., & Short, D. J. (2010). *Making content comprehensible for elementary English learners: The SIOP model. Boston*, MA: Allyn & Bacon.

Fernandes, A. (2012). Mathematics preservice teachers learning about English language learners through task-based interviews and noticing. *Mathematics Teacher Educator, 1*(1), 10–22.

Feryok, A. (2010). Language teacher cognitions: Complex dynamic systems? *System, 38*, 272–279.

Gándara, P., Maxwell-Jolly, J., Garcia, E., Asato, J., Gutierrez, K., Stritikus, T., & Gurry, J. (2000). *The initial impact of Proposition 227 on the instruction of English learners*. Santa Barbara, CA: Linguistic Minority Research Institute.

Gay, G. (2007). The rhetoric and reality of NCLB. *Race, Ethnicity, and Education, 10*, 279–293.

Gibbons, P. (2002). *Scaffolding language, scaffolding learning: Teaching second language learners in the mainstream classroom*. Portsmouth, NH: Heinemann.

Gill, M. G., & Hoffman, B. (2009). Shared planning time: A novel context for studying teachers' discourse and beliefs about learning and instruction. *Teachers College Record, 111*, 1242–1273.

Gonzales, N., Moll, L., & Amanti, C. (Eds.). (2013). *Funds of knowledge: Theorizing practices in households, communities, and classrooms*. New York, NY: Routledge.

Griffith, R., Massey, D., & Atkinson, T. S. (2013). Examining the forces that guide teaching decisions. *Reading Horizons (Online), 52*, 305.

Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. W. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record, 111*, 2055–2100.

Halliday, M. A. K. (1978). *Language as social semiotic*. London, UK: Edward Arnold.

Harper, C., & de Jong, E. (2004). Misconceptions about teaching English-language learners. *Journal of Adolescent & Adult Literacy, 48*, 152–162.

Johnston, B., & Goettsch, K. (2000). In search of the knowledge base of language teaching: Explanations by experienced teachers. *Canadian Modern Language Review, 56*, 437–468.

Lai, Y., & Howell, H. (2014). *Tasks assessing mathematical knowledge for teaching as representations of teaching practice*. Unpublished manuscript.

Lampert, M., & Ball, D. L. (1998). *Teaching, multimedia, and mathematics: Investigations of real practice*. New York, NY: Teachers College Press.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Leinhardt, G. (2001). Instructional explanations: A commonplace for teaching and location for contrast. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed., pp. 333–357). Washington, DC: American Educational Research Association.

Lucas, T., & Grinberg, J. (2008). Responding to the linguistic reality of mainstream classrooms: Preparing all teachers to teach English language learners. In M. Cochran-Smith, S. Feiman-Nemser, J. McIntyre, & K. E. Demers (Eds.), *Handbook of research on teacher education: Enduring questions in changing contexts* (pp. 606–636). New York, NY: Routledge.

Lucas, T., & Villegas, A. M. (2013). Preparing linguistically responsive teachers: Laying

the foundation in preservice teacher education. *Theory Into Practice, 52*(2), 98–109.
Lucas, T., Villegas, A. M., & Freedson-Gonzalez, M. (2008). Linguistically responsive teacher education: Preparing classroom teachers to teach English language learners. *Journal of Teacher Education, 59*, 361–373.
Masingila, J. O., & Doerr, H. M. (2002). Understanding pre-service teachers' emerging practices through their analyses of a multimedia case study of practice. *Journal of Mathematics Teacher Education, 5*, 235–263.
McLeman, L., Fernandes, A., & McNulty, M. (2012). Regarding the mathematics education of English language learners: Clustering the conceptions of per service teachers. *Journal of Urban Mathematics Education, 5*, 112–132.
National Clearinghouse for English Language Acquisition. (2011). *The growing numbers of English learner students 1998/99–2008/09*. Retrieved from http://www.ncela.us/files/uploads/9/growingLEP_0809.pdf
Nieto, S., & Bode, P. (2006). *Affirming diversity: The sociopolitical context of multicultural education*. Boston, MA: Pearson.
Pappamihiel, E. (2007). Helping preservice content-area teachers relate to English language learners: An investigation of attitudes and beliefs. *TESL Canada Journal, 24*(2), 42–60.
Paterson, D. (2007). Teachers' in-flight thinking in inclusive classrooms. *Journal of Learning Disabilities, 40*, 427–435.
Penso, S., & Shoham, E. (2003). Student teachers' reasoning while making pedagogical decisions. *European Journal of Teacher Education, 26*, 313–328.
Rajagopal, K. (2011). *Culturally responsive instruction*. Retrieved from http://www.ascd.org/publications/books/111022/chapters/Culturally-Responsive-Instruction.aspx
Reeves, J. R. (2006). Secondary teacher attitudes toward including English-language learners in mainstream classrooms. *Journal of Educational Research, 99*, 131–143.
Sampson, M. B., Linek, W. M., Raine, I. L., & Szabo, S. (2013). The influence of prior knowledge, university coursework, and field experience on primary preservice teachers' use of reading comprehension strategies in a year-long, field-based teacher education program. *Literacy Research and Instruction, 52*, 281–311.
Scarcella, R. (2003). *Academic English: A conceptual framework* (Technical Report No. 2003). Irvine, CA: University of California Linguistic Minority Research Institute.
Schleppegrell, M. J. (2004). *The language of schooling: A functional linguistics perspective*. Mahwah, NJ: Lawrence Erlbaum Associates.
Shavelson, R. J., & Stern, P. (1981). Research on teachers' pedagogical thoughts, judgments, decisions, and behavior. *Review of Educational Research, 51*, 455–498.
Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1–22.
Solano-Flores, G. (2008). Who is given tests in what language by whom, when, and where? The need for probabilities views of language in the testing of English language learners. *Educational Researcher, 37*, 189–199.
Téllez, K., & Waxman, H. C. (Eds.). (2006). *Preparing quality educators for English language learners: Research, policies and practices*. Mahwah, NJ: Lawrence Erlbaum Associates.
Turkan, S., de Oliveira, L., Lee, O., & Phelps, G. (2014). Proposing the knowledge base for teaching academic content to English language learners: Disciplinary linguistic knowledge. *Teachers College Record, 116*(3), 1–30.
Turkan, S., Croft, A., Bicknell, J., & Barnes, A. (2012). *Assessing quality in the teaching of content to English language learners* (ETS Research Report No. RR-12-10). Princeton,

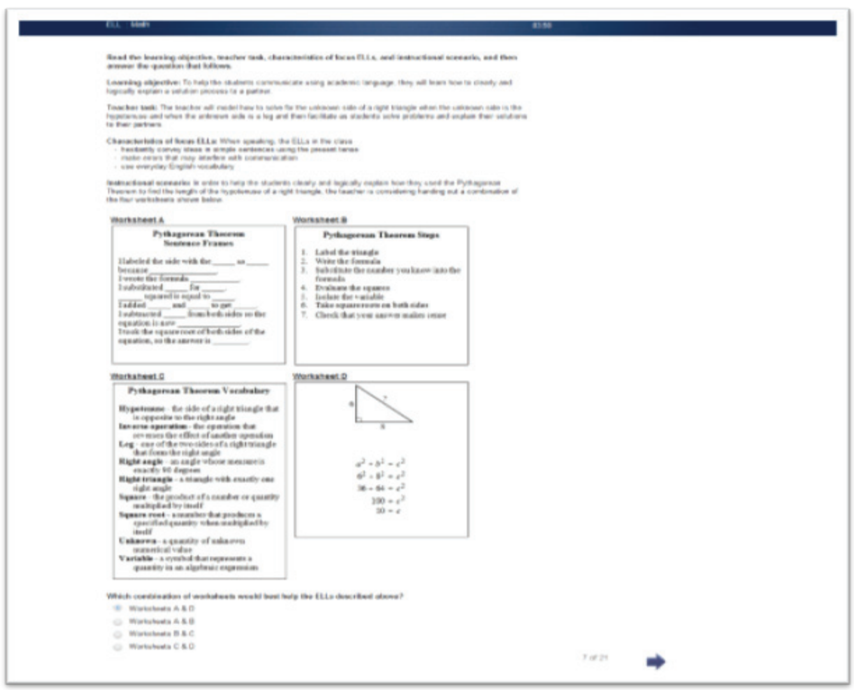
NJ: ETS.

Wong Fillmore, L., & Snow, C. (2000). *What teachers need to know about language*. Washington, DC: Center for Applied Linguistics.

Wong Fillmore, L., & Snow, C. (2002). What teachers need to know about language. In C. Adger, C. Snow, & D. Christian (Eds.), *What teachers need to know about language* (pp. 7–54). McHenry, IL: Delta Systems.

Zehler, A., Fleischman, H., Hopstock, P., Stephenson, T., Pendzick, M., & Sapru, S. (2003). *Descriptive study of services to LEP students and LEP students with disabilities: Policy report: Summary of findings related to LEP and SPED-LEP students*. Washington, DC: Development Associates.

Appendix



A. Source of knowledge:
What sources do candidates use to justify their answers?

A1. *Language status*: Candidate references ELL English proficiency level or status (e.g., newcomer) or language proficiency descriptor

A2. *Language demands*: Candidate references language skills or demands (e.g., vocabulary)

A2a. Vocabulary

A2b. Sentence structure

A3. *Cultural experiences*: Candidates references students' familiarity or experiences with a topic (non-math-related)

A4. *Content knowledge*: Candidate references ELL mathematical (content) knowledge and/or understandings about math

A5. *ELL teaching*: Candidate references (strategies for) effective teaching of ELLs

A6. *Second language acquisition*: Candidate references notions about second language learning (concepts and notions about language)

A7. Candidate references cultural experiences that she/he has had with ELLs

A8. Other

A8a. Other: test item–related reasoning: candidate chooses one particular option because of the way the item and options are structured

A8b. Miscellaneous: rationale for decision making but doesn't refer to any of the other codes

A9. Pedagogy: Candidate refers to pedagogically sound moves/activities/strategies that she/he would use irrespective of who is in the classroom

A. Views of English language learners:
How do candidates position ELLs and their learning?

B1. *Othering*: ELLs and their learning needs are described as different, in need of something special or different

B2. *Sameness*: ELLs and their learning needs are described as similar to those of mainstream students (JGT) or needing to meet the same standards (maybe with the claim that there is no special aspect of teaching ELLs)