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Introduction and Purpose

Research has indicated over the years that English learners (ELs) are not supported to achieve their goals in learning academic content and acquiring English (Jimenez & Rose, 2010; Menken, 2008). Further, teachers have negative attitudes towards ELs and/or low expectations from them (e.g., Cho & Reich, 2008; Reeves, 2006). In fact, many content teachers do not feel adequately prepared to meet the linguistic and academic needs of ELs (Gándara, Maxwell-Jolly & Rumberger, 2008; Menken & Antunez, 2001). During teacher preparation, according to Hollins and Torres-Guzman (2005), issues related to teaching diverse student populations are often treated as part of the "add-on 'diversity' or 'multicultural education' courses" (p. 480). On the other hand, all teachers need to feel prepared to address the needs of the EL students (de Jong & Harper, 2008, 2011; Lucas, 2011; Lucas, Villegas & Freedson-Gonzalez, 2008) as their numbers have been growing exponentially over the decades (National Clearinghouse for English Language Acquisition [NCELA], 2011). More than 5 million ELs, speaking over 150 languages, attend public schools (Batalova & Terrazas, 2010). This growing population needs to receive educational services not just because of the increasing numbers but also the achievement gap in reading and mathematics between ELs and non-ELs (Aud et al., 2011). To reiterate, most ELs do not receive the support they need to achieve in and out of school.

As 'teaching' quality matters for EL student success and teacher education makes a difference in teacher quality (Darling-Hammond, 2000), more research is needed to understand what is involved in learning to teach content to ELs. Despite a growing body of research on the essential teacher knowledge-base for teaching ELs (Bunch, 2013; Galguera, 2011; Turkan, Oliveira, Lee & Phelps, 2014) and effective linguistically-responsive teacher education (Lucas, Villegas & Freedson-Gonzalez, 2008), there is still a dearth of research on candidate content teachers' reasoning and instructional decision-making regarding teaching ELs.

More specifically, little is known about how secondary-level mathematics teacher candidates reason about the work of teaching mathematics in relation to EL characteristics and ELs' content and language learning needs. Due to our limited understanding regarding how the mathematics teacher candidates reason about the pedagogy of teaching typical middle-grade mathematical content to ELs with various learner characteristics, this study mainly explored how a group of mathematics teacher candidates reasoned about a number of instructional scenarios illustrating ELs with various learner characteristics and learning challenges. A few of these scenarios were also rated in terms of importance and relevance to the work of teaching mathematics to ELs.

Theoretical Perspective and Review of Literature

This study is grounded on a theory of situated cognition (Brown, Collins & Duguid, 1989), which supports the proposition that one learns about a set of knowledge and skills situated in particular settings and contexts. When applied to teacher learning, this perspective affords the view that teachers best learn to teach or apply a set of knowledge and skills through examining and reasoning via a set of instructional cases as part of a professional peer group (Putnam & Borko, 2000). That is, through examining the characteristics of the cases in which teaching occurs, teachers get to reflect on their emerging practices (Masingila & Doerr, 2002). Illustrations of teaching practice can be viewed as authentic representations of teaching (e.g., case studies, depictions of instructional scenarios, video footage) that highlight various aspects of teaching for pre-service or in-service teachers to reason through or learn (Grossman et al., 2009). Using instructional scenarios as tools for pre-service teachers particularly to elicit their thinking aligns well with the situated nature of learning to teach. Further, new lines of research (Lai & Howell, 2014) show that formatting representations of authentic classroom scenarios into an assessment environment can serve as powerful tools for eliciting teacher thinking and improving reflective teacher learning. Framing this study with this view, we explored pre-service teacher reasoning about specific scenarios of teaching mathematics to ELs formatted in an assessment environment.

There is hardly any research on pre-service teacher reasoning about the work of teaching mathematics to ELLs. Most of the existing research focuses on how to educate teachers of ELLs while little do we know about teacher candidates' reasoning about effective ELL instruction. For example, Daniel (2014) reviewed literature on how teacher education programs help teacher candidates incorporate linguistically and culturally responsive teaching principles. This review revealed that some efforts focus on raising ELLs' cross-cultural awareness (e.g., Allen & Herman-Wilmarth, 2004; Nero, 2009) while others aimed to foster pre-service teachers' awareness about bilingual education (Capella-Santana, 2003). Other efforts focus on cultivating candidates' understanding of unique challenges ELs face in the content classrooms (e.g., Fernandes, 2012). Other existing research on pre-service teacher learning about ELL teaching points to the changes in their attitudes towards ELs at the beginning and end of their teacher education program (Enterline, Ludlow, Mitescu & Cochran-Smith, 2008). Existing research, albeit limited, on teacher reasoning about ELL teaching shows that ELs' language proficiency is one of the main considerations pre-service teachers take when explaining the reasons for ELs' classroom learning difficulties (Cheatham, Jiminez-Silva, Wodrich & Kasai, 2014). In this study, when presented with information about a fictional student's native language and English proficiency level, teacher candidates mostly attributed the EL student's classroom learning difficulties to the language proficiency.

However, we still do not know how teacher candidates reason through specific scenarios of teaching mathematics to ELs and what sources of knowledge they draw on when reasoning about teaching; specifically, envisioning solutions to ELs' challenges in carrying out the specific mathematics learning objectives in the classroom. To explore answers on how future teachers reason about teaching ELs when they are about to leave the teacher education programs and how math teacher educators view the illustrative scenarios of teaching math to ELs, we raised two main research questions:

1. How does a sample of ten senior level pre-service teachers reason through the instructional scenarios of teaching mathematics to ELs?
2. How does a sample of 70 teacher educators rate a select sample of instructional scenarios depending on whether or not their teacher education programs offer coursework on teaching mathematics to ELLs?

Context of the Study

One of the main motivators behind the study was the policy decision of the Common Core State Standards (CCSS) to include *all learners* in learning complex cognitive and linguistic skills. The CCSS, adopted by 48 states and the District of Columbia, require students to think critically, solve complex problems, and explain their reasoning logically. The requirements of the CCSS heighten the linguistic demands on all learners. As such, non-native speakers of English, or ELs, are held to the same standards as their non-EL peers (CCSS, 2010a). With the heightened emphasis the CCSS puts on preparing *all learners* for college and careers, content teachers must be prepared to teach ELs.

The CCSS dynamic happening in the macro level of the US educational system, we were interested to explore senior level teacher candidates' reasoning about teaching mathematics to ELs. We undertook this exploration through utilizing a set of instructional scenarios formatted into a virtual assessment environment. As presented above, the assessment environment provides a unique context to elicit teacher reasoning. In this context, the instructional scenarios embedded in assessment items serve as prompts to get teacher candidates to draw on their sources of knowledge to resolve the problem raised in the scenarios. The scenarios used in this study allowed the future teachers to reflect on effective teaching of mathematics to ELs as they were retrospectively explaining how they came to find the answers on the assessment. This exploration was done at candidates' senior year in pursuing a teaching degree in mathematics education. The last year is a critical one, especially given the benefits of student teaching experiences in the development of teachers' professional practices (Briemfield & Leonard, 1983). That which is learned by student teachers during their apprenticeships may strongly shape their core sets of beliefs, priorities, and schemes of effective practices in an enduring manner. Furthermore, we chose to engage the teacher educators in evaluating a select sample of instructional scenarios in terms of significance to teacher candidates' work of teaching mathematics to ELs. Doing so allowed to further contextualize the verification of the scenarios.

The scenario-based assessment targeted the elicitation of teacher reasoning in two broad domains: (a) identifying linguistic features in mathematics and (b) modeling how to communicate disciplinary meaning in mathematics (for more information, see Turkan, Oliveira, Lee & Phelps, 2014). Within the first domain, we aimed to elicit teachers' knowledge of disciplinary linguistic features at the word, sentence, and discourse levels as it applies to secondary mathematics. Similarly, within the second domain, we explored how teachers' disciplinary linguistic knowledge (Turkan, Oliveira, Lee & Phelps, 2014) and knowledge of second language acquisition theory as it is needed to model for ELs the language of the discipline and to engage them in using the language of the discipline might surface. In the next section, we explain how each of the research questions was addressed by detailing the research methods.

Method

The first research question was addressed through administering a set of instructional scenarios formatted into an assessment format to senior level teacher trainees and interviewing them about their reasoning on each one of the scenarios. To address the second question, we conducted a survey of teacher educators. The survey not only allowed us to collect high-level information about what kind of coursework and training practices geared towards teaching mathematics to ELs are offered at the mathematics teacher education programs but it also provided teacher educators' rating of the scenarios and discussion as to how they evaluated the scenarios. Details on the three data collection tools are described next.

Data Collection Tools

Scenario-based Assessment

Two days prior to the cognitive interviews, a mathematics measure of 20 items was administered to 10 mathematics teacher candidates to elicit their reasoning about effectively teaching mathematics to ELs (for more information about the measure development process, see Turkan, Croft, Bicknell & Barnes, 2012). There were 19 multiple choice items and one was an open-ended item.

Each participant took the scenario-based assessment online and identified, and notified us of a unique code number when taking the assessment. Codes were matched to each participant's name, and these linkages were kept in a secure database; each participant's unique numerical code was the only identifier recorded on his or her answer sheet. To increase the likelihood that pre-service teachers could recall their responses to the scenarios, telephone interviews were conducted no more than 48 hours after participants had taken the assessment. Math topics within the scenario-based assessments administered to all participants ranged from the Pythagorean Theorem to introducing the distributive property, integers, slope, and probability. Each scenario described the World-class Instructional Design and Assessment (WIDA) levels of ELs in the class, the mathematical topic to be taught, and a set of four possible ways to introduce or present the material to this group of learners. In describing the ELL characteristics, WIDA levels were incorporated because these levels are the most commonly used by states in providing information about what ELLs can or cannot do with their academic language skills.

Survey of Teacher Educators

Similar to the assessment, the survey was administered and results were collected online. The first section of this survey required the teacher educators to answer a few questions and describe, in their own words, the required coursework and/or training offered by the universities where they teach in order to prepare future mathematics educators to effectively instruct ELs. The second section of this survey required rating of a few sample scenarios (on a Likert Scale) in terms of their importance and relevance for the work of teaching mathematics to ELs. All of these scenarios were transformed into prose format from the assessment environment. Building upon this, the third section of the survey required reflection on whether a licensure test, analogous to the scenario-based prompts enumerated in section two, would potentially influence the pedagogical practices on behalf of themselves and their departmental colleagues, and if so, then how. Data collected from this section of the survey fall outside the scope of the current paper.

Cognitive Interviews

The assessment eliciting what mathematics teacher candidates know about teaching mathematics to ELs was administered 48 hours prior to the interviews. Interview participants received different combinations of the 20 assessment items in a way that each item would be discussed by at least two candidates. The interviews included the below questions addressed to the pre-service teachers of mathematics. The first two questions were intended to elicit what they perceived the scenario to be about and what their answers were. The follow-up questions were raised to see what part of the scenario teacher candidates focused on while answering the questions and eliminating the options. Also, candidates were asked to respond to a hypothetical scenario asking whether taking a test such as the current one would influence the quality of their teacher preparation, as described below.

1. Can you tell us what the question is asking you to do? Please tell us what you know about this student (i.e., EL) after having read about his/her WIDA levels.
2. What was your answer and why? This question included follow-up questions:
    a. You indicated that you chose __ as the answer. Why do you think that's the best answer?
    b. Let's go through the other options. Why didn't you select __?
    c. If you were to present this problem to your class, how would you describe or introduce it to your students (assuming they were at the same WIDA levels as the students in this scenario)?

We then asked participants to respond to the following hypothetical situation:

> Let's assume that a large number of families who speak Urdu just moved into town, and their kids will be attending the school where you teach. You are told in September that seven of your 23 students are ELs and that in order to retain your job as well as your status as a highly-qualified teacher, you will have to take an additional Praxis exam, similar to the scenario-based questions you just answered. Would you find this test to be helpful in any way? Why or why not? Would knowing you have to take this test influence your teaching or preparation to teach in any way? Please be specific.

This hypothetical situation helped to elicit what the teacher candidates thought about the test and how they imagined it would affect the way they would teach content to ELs. The data collected in response to this hypothetical situation is not included within the scope of this paper.

Next, we explain the recruitment of the teacher candidates who took the math test and participated in the cognitive interviews and teacher educators who took the survey.

Participants

Cognitive interview participants. Ten math education students who already student taught consented to participate in this study. This was because one of our criteria was to select the participants who already completed their student teaching. Further, care was taken to ensure (a) participants were drawn from different geographic locales, (b) participants attended teacher training programs that varied in selectivity, and (c) half of the participants (i.e.,, five out of 10) attended schools that reported the inclusion of coursework relevant to teaching ELs. The variation was because we aimed for a diverse small sample from various geographic locations and varying quality of teacher education programs. During recruitment, prospective participants were told that they would be asked to respond to a set of educational scenarios by choosing what they believed would be the best approach in teaching a specific math concept to ELs. In addition, they would be asked to participate in a one-hour telephone interview with a member of the research team to describe the reasoning about their answers as well as why they did not choose the other answer choices provided.

To recruit senior level candidate teachers, staff members from several graduate school departments of education throughout the United States were contacted to see if they would be willing to disseminate a flyer describing this study on their graduate student list-serves. The schools contacted were chosen strategically in order to maximize the probability of ascertaining data from a representative sample (i.e., math teachers-in-training who student taught in varied demographic and geographic locales and who will soon be graduating from teacher education programs of various levels of selectivity). Approximately 15 schools of education throughout the nation agreed to email a flyer to all eligible participants.

Geographic and program-based representation. Two of the interview participants attended Ivy League institutions in the northeast, and two attended moderately competitive state institutions in the same region; one participant attended a state university in the south, and another participant attended a highly-rated teacher training program at a private university in the same area of the country; two participants attended highly-rated teacher training programs in the Midwest, and two participants attended the same teacher training program at a large, selective state school on the west coast.

Of the ten participants—who have been trained to teach mathematics—three were males and seven were females. Each program varied in terms of the coursework offered as well as the amount of time participants had spent in the field. For example, three participants were enrolled in programs that required students to spend several months in the field while concurrently taking coursework. Other programs required students to take their coursework and then student teach for one semester. Some, but not all, participants had experience teaching ELLs, and some took coursework on cultural awareness as well as related topics. Thus, the training experiences between participants varied.

Survey participants. We targeted a representative sample of teacher educators from every region of the United States such as West, Midwest, Southwest, Southeast, and Northeast. A national database, Market Data Retrieval, which has access to faculty in secondary mathematics education programs across the country was utilized to identify the targeted sample. Through two email blasts to the targeted sample, 70 mathematics teacher educators from colleges and universities across the country participated. This participation was from across 25 states: OH, MI, WI, NY, IL, IA, TX, SC, NC, GA, CA, AZ, KY, FL, PA, MD, OK, CT, AR, ID, WA, IN, MO, AL, VA. All participants specialized in middle and secondary grade mathematics teacher preparation.

Next, we provide information on data analysis.

Data Analysis

Answers to the scenario-based multiple-choice questions were analyzed to elicit participants' reasoning about effective teaching of a specific group of ELs whose written and spoken language competencies varied. To detect emergent themes within the transcripts of 10 participants' responses, we independently read the cognitive interview transcripts several times and made notations on the sections that seemed to be important. This reiterative process enabled us, again working independently, to detect broad, emergent categories as well as the discrete ones therein. We convened to determine the degree to which we agreed upon the emergent themes and codes; our sources of disagreement were re-examined more precisely to clarify the codes and to draw parameters around when to code and when not to code data with the particular codes. Once the codes were clearly defined and could be well-differentiated from one another, we once again independently rated excerpts of the transcripts that illustrated these classifications. At this juncture, there was consistent agreement between the two coders regarding the characteristics of participant responses that should be included in a given category. Axial coding (Strauss & Corbin, 1990), a process of vetting the categories inductively and deductively, was used to make the connections between discrete categories as well as frame these data into overarching thematic relationships. Finally, selective coding was used to bring together previously identified concepts and categories to tell a larger story.

Results

First, in response to research question number one, we present teacher candidates' conceptions of ELs and effective EL mathematics teaching as they emerged in their reasoning about the instructional scenarios given in the assessment. Second, we present teacher educators' ratings of similar scenarios in terms of their relevance and importance to the work of preparing future mathematics teachers to effectively educate linguistically and culturally diverse learners.

One central theme woven throughout teacher candidates' reasoning about the scenarios was their perceptions of ELs as learners and views about how to most effectively teach them mathematics. Three general categories emerged within this central theme as participants talked about how they would choose to teach the particular content and scenario laid out in each of the questions. First, pre-service teachers referred to their conceptions about ELs' language proficiency levels. This was, in part, because the test question scenarios included either ELs' proficiency levels according to the WIDA descriptors and/or their statuses such as "newly arrived ELs." Second, their conception of ELs was driven by their beliefs regarding ELs' familiarity with the topic or experience mentioned in the scenario. Third, candidate teachers drew upon their understandings of what effective EL teaching means or should mean, thereby revealing their thoughts and perceptions of what ELs' knowledge, interests, and experiences are likely to be. Recognized within these categories were patterns shared by all participants. The first pattern was that pre-service mathematics teachers' perceptions of ELs fell on a continuum ranging from viewing ELs as one homogenous group of learners to viewing them as heterogeneous in their proficiency levels, cultures, and academic needs. The second pattern was related to candidates' views as to what effective EL-teaching meant to them. In that, their views about effective EL-teaching also fell on a continuum ranging from the belief in removing all the linguistic demands from the particular mathematics content to convictions about recognizing and incorporating the linguistic demands of the content. The perceived need to remove the language demands also seemed to be linked to candidates' assumptions that effective EL-teaching required simplifying linguistic complexity in order to differentially meet the needs of ELs.

Next, we unpack teacher candidates' conceptions of ELs as learners who were viewed as homogenous or heterogeneous. Then, we discuss how the participating teachers' knowledge of content and pedagogy interacted to influence their decisions about effective EL teaching practices. Finally, we present teacher educators' ratings and views of the given instructional scenarios. Next, we discuss each of these themes supported by excerpts from the particular teacher candidates.

Teacher Candidates' Conceptions of ELs

ELs as homogenous or heterogeneous group of learners. As noted, a pattern emerged where teacher candidates decided to employ particular pedagogical approaches either in light of the heterogeneity of the ELs or irrespective of the ELs' diverse linguistic and cultural backgrounds. In relation to the first group described (i.e., candidates who consistently took ELs' language proficiency levels into consideration), ELs' reading, speaking, writing, and listening proficiencies influenced their judgments regarding how to best present mathematical concepts. Other candidate teachers, however, did not consider or understand what the proficiency levels meant. Also, candidates varied regarding which real-life scenarios they believed would be familiar to ELs. Candidates' views emerged as they reasoned about the particular item that asked them to choose which of the newspaper clippings reflecting authentic and real life scenarios would be most appropriate for the ELs in the class when applying their knowledge of how to calculate percentages to the given real life scenarios. The scenarios were as follows: 1) ice hockey standings showing the games won, lost, and lost in overtime; 2) sales ads listing the original and sale prices of different items at a store; 3) a table showing information about stock market indices; 4) an article listing the number of senior students who graduated from high school and the number of students who dropped out. Some candidates thought that when ELs are studying percentages, they could easily relate to problems that are situated in charts depicting high school dropout rates, while others felt studying sale prices would make a lesson on the same concept more accessible to all learners. In this sense, some candidates associated ELs with drop-outs based on the assumption that they are more familiar with dropping out while others accurately reasoned that sale prices are universally relevant to all learners. Furthermore, candidates' views of ELs as homogenous versus heterogeneous groups of learners surfaced as they reasoned about ELs' language proficiencies and backgrounds. Next, we share interview excerpts to discuss how these views emerged.

Considering ELs' language proficiencies. Cathy (a pseudonym) was one of our participants who demonstrated considerable attention to the EL proficiency levels as categorized by the WIDA descriptors. In the excerpt below, Cathy actually took the time to look at the performance descriptors and reasoned through what the students at the designated proficiency levels are able to do when speaking and reading the question. Thus, Cathy seems to have considered the variability that might be expected in ELs' proficiency skills across the four skill areas:

> Yeah okay so, let me see here let me read the option. I think that I said that I would have the students write their explanations using sentence starters and academic vocabulary words from a worldwide because I remember when I looked at the link to the chart in spite where the speaking level and reading level were and what it said they were at.

On another point of the continuum, a teacher candidate, Alyssa, demonstrates her understanding of ELs as a group of learners who might need help with their language skills. She does not consider the specific descriptors provided for each proficiency level within each of the four skills, but instead views linguistic proficiency as one, monolithic entity. When asked if she drew upon any of the EL characteristics provided in the question, she acknowledged that she did not, but that she considered ELs' proficiencies as "little proficiency in English" and interpreted that to mean that these ELs might have a difficult time understanding English phrases. This reasoning led her to choose option B for a question that asks the candidates how they would teach the distributive property to ELs. Based on her reasoning about the proficiency levels, Alyssa thought that presenting a visual describing the distributive property would be more effective than the other options that "are thrown out of her mind because they had way too much writing and reading." Alyssa continued: "…if you are trying to explain something to someone who has trouble reading, writing a whole long sentence or a question on a board is not going to help them." However, she thought that a box that included two rows of three and four could most effectively help ELs visualize the rule of distributive property.

On the farthest end of the continuum, unlike Cathy and Alyssa, Jonathan could not incorporate the information about ELs' proficiency levels provided across four modalities. Jonathan demonstrated his lack of understanding about the WIDA descriptors even when they were readily available. He acknowledged that he is not familiar with these descriptors. He collapsed all the different levels of language proficiency either to mean "a high level" or to just broadly mean "intermediate." In his interview, Jonathan acknowledged that he did not fully understand what it meant to have ELs in the classroom that were identified at different proficiency levels in different skill areas. He just focused on the number three and essentially attempted to make sense of this input when choosing the right option: "in my answer I would take D because level three sounded like a high level to me." He also confirmed his lack of understanding about proficiency descriptors and added that he couldn't visualize what it would mean to have ELs at level three in speaking and writing: "I think that is always where I kind of have a little difficulty knowing exactly what is intermediate, knowing exactly what constitutes proficiency at level two and level three."

Familiarity with ELs' backgrounds. The extent to which the candidates were familiar with ELs' backgrounds seemed to have played a role in their perceptions about ELs' heterogeneity. This sub-theme emerged when candidates described their reasoning in reference to which real-life scenarios ELs would be most familiar with when teaching them how to calculate percentages by solving authentic, real life problems. Candidates appeared to reveal who they thought ELs inherently are. Their underlying views surfaced particularly while reasoning through a scenario in which a teacher is teaching percent problems and tries to relate them to real-life scenarios. Some candidates were able to reason that sales ads would be familiar to ELs while others took a more deficiency-oriented view and argued that the number of drop-outs would be familiar to ELs. For example, Natalie, one among the few candidates who selected sales ads, reasoned that the newspaper clipping that includes the sales ads listing the original and sale prices of different times at a store would be the most appropriate for the newly arrived ELs in this particular class because they would be familiar with this scenario as opposed to the ice hockey standings, a table showing information about stock market indices, or an article listing the number of senior students and the number of dropouts. Here is how Natalie reasoned through this question:

> …So I would guess I was trying to think about what the students could relate to the most and ice hokey, I don't know if a lot of students know a lot about ice hokey especially if they're not from the United States … I think sales ad, people.

Overall, there seemed to be a tension between candidates' understandings about the unique needs that ELs might have versus other candidates who assumed that effective teaching principles should apply to all learners and ELs should not be differentiated.

EL-teaching as removal of language. The common view amongst the teacher candidates was that ELs are a group of learners who routinely need help with their language skills. This view demonstrated itself in teachers' reasoning that the best strategy is to strip away the language from content and find a teaching move or strategy that removes the language demands. One of the teaching strategies they adopted from all the generic effective teaching strategies was using pictures or some sort of visuals within the context of teaching mathematics to ELs. For example, one candidate teacher reasoned that if she was in the shoes of the ELs, she would have difficulties with all the language load and reading. Her solution was to use pictures as "a universal language." She explained the following:

> You know if someone explained that to me in Spanish, I wouldn't understand it 'cause I don't understand the language. We have to choose the language that everyone would understand, a universal language such as pictures and [0:16:12] working together with a partner and there was too much English and too much reading for the ELL to understand the concept.

However, a belief in the importance of removing language and presenting visuals was not espoused by other candidate teachers. This view, as opposed to the previous view of removing language, seemed to be grounded on an understanding that language is integral to the teaching of content to ELs. For example, the excerpt from Katie's interview demonstrates a sensitivity towards guiding ELs to find what relevant input is without overwhelming them by the unknown words or complex phrases. Katie argued for the below reasoning in response to an instructional scenario where a teacher is beginning to teach students to solve one-step percent word problems after having already taught how to solve proportions and how to convert between fractions, decimals, and percents. The teacher introduces the topic working on the following problem: *Kelly buys a hoodie that is on sale for 20% off the original price. The original price of the hoodie was $37. What is the new price of the hoodie?* The candidates were asked which instructional strategies would support ELs' learning of the topic. In this classroom scenario, ELs have just arrived in the United States, and their English proficiency has been identified as being at WIDA Listening Level 3 and WIDA Reading, Speaking, and Writing Level 2. Katie argued for having students write the words they find confusing and list key words or phrases that refer to the given and the unknown.

> And I think that especially with ELL students it's important for them to be able to know what information is necessary to be able to solve the problem and what kind of like is fluff spell the word problem. And oh that's a lot of word problems are students being able to recognize what they need and what they don't need to solve it. But it's especially important for ELL students because they may look at this and feel overwhelmed because they don't know some of the words but and they can go in there and see a 20 percent in the prices of each and then know that they need to find a new price with that discount...

While Katie was one of the few candidates who did not advocate for removing the linguistic demands of mathematical content, she still reflected the commonly held view that clarifying the key words for EL understanding is the effective way to go about teaching ELs.

All in all, teacher candidates seemed to view ELs as a homogeneous group of learners. The candidates' tendencies were to identify common characteristics among hypothesized ELs to facilitate their reasoning about effective instructional practices. These tendencies manifested themselves in candidates' views of ELs as students who would most likely be familiar with drop-outs effective and EL-teaching as removal of language demands and facilitating their understanding of key words or phrases. Further, variations in teacher candidates' views about effective EL-teaching moves or strategies seemed to have interacted with how much the candidates are drawing on their knowledge of content and pedagogy. Next, we present how this interaction played out and how the study participants drew on their knowledge of mathematics while reasoning through the scenarios of EL-teaching.

Candidates' Knowledge of Content and Pedagogy: Views on Effective EL Teaching

Participants' varying rationales for making specific choices revealed varying degrees of knowledge of mathematical content and pedagogy. Here, we use the concept *knowledge of* *content* to refer to teachers' use of their content knowledge to make instruction decisions about the scenarios of teaching ELs. By pedagogy, we refer to solely instructional decisions and various representations of content and learning objectives to facilitate student learning.

In general, candidates differed on their attempts to connect the content with language demands in their effective EL teaching decisions. Although some candidates understood the association between the mathematical content and the language features, others did not see the association. For example, Jack's (pseudonym) response illustrated how he would facilitate ELs' understandings of problems requiring students to think logically about cause and effect relationships. The teacher in the given hypothetical scenario was asking the students to write an equation and solve it when answering the following word problem: *There are five times as many soccer players as basketball players in the school. If the total number of soccer and basketball players is 60, then how many soccer players are there in the school?*

To help solve the problem, the teacher in the scenario asks students to figure out an equation solving for the number of family members in one's family. Of the 10 pre-service teachers interviewed, Jack was the only participant who was able to make connections between a linguistic feature and the mathematical meaning or operation that the feature represents. Jack discussed the "if-then" statements conceptually by noting that these terms are symbolic of a function (he did not use the term "function") between an independent and dependent variable. Jack said: "So I think this more speaks to the yeah understanding of the phrasing of the question in 'if then' clause and how the second part is dependent on the first part so that is if is dependent so I would say it's a dependent variable."

When presented with the same question, another participant, Tyler (pseudonym) did not perceive the "if-then" clause to be significant enough to tell the learner what to do. Tyler's reasoning fell on the other end of a continuum in making connections between a language structure and its corresponding mathematical function: "The 'if-then' clause can get confusing, thus it would be better to read the problem aloud without the 'if-then' statement." Tyler's response may have been driven by an assumption that removing language from this math problem would make it easier for ELs—or math students in general—to solve the problem. Tyler's repertoire of an effective EL-teaching strategy clearly was different from that of Jack. While Tyler did not view the "if-then" clause to be an integral feature of the problem, Jack thought the "if-then" clause represented a mathematical function, and as such, was important to unpack for student understanding so they can solve the problem. Reasons for variation between Tyler's and Jack's responses remain unclear; only the differences are evident to present.

Furthermore, Natalia and Frank (pseudonyms) demonstrated variation in relation to their reasoning about the connection between content and language demands for ELs. They were both asked to think about how ELs could complete an activity to demonstrate their understanding of the relationship between the formula y=mx + b, the slope, and the y-intercept. They were also informed about the ELs' academic language proficiency through the given WIDA proficiency levels and a general sense of their mathematical competency. Natalia's thoughts about teaching this concept to ELs were as follows:

> So if some of the students response it's clear that the students have learned the Y=MX+B formula. 'Cause the students as I used Y=MX or I use Y=MX+B. So, and the students say the slope number is next to the X. so basically if you're looking at the formula or if you wrote the formula on the student's page you can simply say the slope is M which is the same as saying what he said was the student said the slope number if next to the X. Usually we say the slope is represented by M and the Y intercept is B. Instead of the students, where the student said the Y intercept number is at the end, that you know, that

> might not always be correct if the equation isn't written. For example you can say Y=3+2X. In that case the Y intercept isn't at the end and so just initially before explaining any of that, I might just write the equation or point to the equation on a student's paper and say okay. The slope is M and the Y intercept is B. I think that would be just an easy way to start it and then you can go into explaining in more detail.

As evidenced above, Natalia did not believe that repeating the equation and plugging numbers into it was an optimal approach (y=mx + b), as the slope is "m" and the "y" is not always at the end. Natalia then cited an example: y = 3 + 2x. She noted that the slope is "m", the y intercept is "b", and "m" is also the coefficient of "x". Natalia talked about typical student misunderstandings, and as the conversation continued, she accurately understood that for a linear equation, the y intercept is the place where the line crosses the y axis when y=0. Her flexible and conceptual understanding about the presentation of the algorithm y= mx + b, as well as her concerns about the limitations of simply plugging numbers into that equation, reflect a set of specialized knowledge of the content, which was not displayed by other participants. Natalia's response differed from Frank's even though both Natalia and Frank were going to graduate from teacher training programs at prestigious, highly-selective universities in the Northeast.

In response to the same question, Frank made the point that: (a) students need to know the formula is y=mx + b, and that should not be confused with "mx and b right next to it"; (b) the slope is the number in front of "x" and is the coefficient; and (c) "it" has to be a "constant term" and not a "regular number". Frank's response was focused on clarifying where values should be inserted within the algorithm as well as which values should be added and, possibly, which should be multiplied so the ELs would know the "mathematical meaning of displacing it." Natalia's response was focused on knowing what the values represented since the algorithm itself can be rearranged so that the Y intercept is not at the end of the equation. Both Natalia and Frank wanted the ELs to gain conceptual understanding and solve the problems accurately; however, they had different views regarding how to achieve the same ends.

Also, moments when participants changed their answers are illustrative of their varying understandings about how to most effectively approach teaching particular mathematical content. For example, Frank changed his answer when he was asked a question about distance, rate, and time as it pertained to subway trains (In addition, Frank pointed out that the if-clause sentence should be simplified or removed). Frank's response stood in contrast to another candidate teacher named Katherine who felt sure of her answer choice and could explain it coherently. For example, when asked to respond to the question regarding how to best teach ELs what an integer was, Katherine articulated an elaborate and cohesive teaching strategy:

> I think that I would be most inclined to do would be to relate it back to something that they do have a better understanding and so my example was using money or currency and saying that integers are like money, if change were not a factor. So it's like you can be in debt and that's the negative part of the integers, you can have zero dollars or you can obviously have money in your possession and it's...
>
> Like saying that you can only have whole dollars is a representative of the integers and then I think that you can use that to describe many of the sort of regular counting numbers you could say as many as you were never allowed to go below zero or with the rational numbers you could include the cents in there as well.

As exemplified above, when Katherine was asked how she would teach integers to ELs, she suggested a strategy that would be accessible to students: the use of money. She discussed how the presentation of these concepts would flow in a particular order, with one conceptual understanding built upon the foundation of another. Katherine did not wish to teach a lesson on integers by only using the number line, but she explicitly stated the salience of linking representations of integers to the number line. She also found a way to illustrate negative values as debt, zero, or having no money at all, and non-integers or fractions of whole numbers/dollar bills. This illustrates her flexible integration of content knowledge with pedagogical skills.

When asked the same question, another participant, Alicia (a pseudonym), provided a different answer. Alicia articulated a belief in the value of having students actively choose whether or not a number they grab out of a hat is an integer, as well as having students "feel a number…see it and…hear the explanation and the definition…. hopefully all of those different inputs will help them understand the process." Alicia's intentions appeared to be for students to build a well-elaborated scheme of what an integer is. The problem was that this information was presented repetitively but not elaborately; it was not embedded in a conceptual framework that illustrated what it means to have positive whole numbers, negative numbers (or a deficit), zero (or no whole numbers), and non-integers such as fractions and decimals.

In summary, candidates varying degrees of knowledge about content seemed to interact with the degree to which they could flexibly identify effective practices of teaching ELs. This interaction manifested itself in differences among candidates' understanding of content and effective EL teaching. Next, we present teacher educator ratings of a few of the scenarios in terms of importance and relevance to the work of teaching mathematics to ELs.

Teacher Educator Views

In addition to the scenarios viewed by the teacher candidates, five classroom scenarios regarding the teaching of ELs were presented to the teacher educators (TEs). The scenarios included information about EL characteristics and objectives for learning and teaching mathematics to ELs. The TEs were asked to rate the scenarios according to relevance and significance for preparing future mathematics teachers to effectively educate linguistically and culturally diverse learners. Table 1 shows the ratings of the scenarios on a 5-point likert scale by 40 TEs who offer required coursework in teaching mathematics to ELs and 30 TEs who do not. The scale ranges from 1 as not at all important to 5 as extremely important. As the general trend on the table shows, both TEs who offer required coursework and those who do not offer rated all five scenarios as either very much important or extremely important. Scenarios 3 and 4 showed a parallel pattern in ratings of the two groups of TEs. Both groups were similarly ambiguous about scenario 3 as 23% of both groups rated the scenario as ‘somewhat’ important. Similarly, scenario 4 was rated as somewhat important by 20% of both groups of TEs. In the other scenarios (1, 2, 5), we observed high ratings of importance more consistently than in scenarios 3 and 4. Since each TE was asked to explain the reasons for their ratings of the particular scenarios, we present various TE perspectives on why they thought particular scenarios were important or not.

Table 1

Ratings of the five scenarios by teacher educators' programs who offered or did not offer required coursework for teaching mathematics to ELs.

TEs who offer required coursework in teaching mathematics to ELs	Scenario 1					Scenario 2					Scenario 3					Scenario 4					Scenario 5				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
No (30)	-	-	-	67% (20)	33%	-	-	23% (7)	30% (9)	47% (14)	-	10% (3)	23% (7)	27% (8)	40% (12)	-	-	20% (6)	47% (14)	33% (10)	-	3% (1)	13% (4)	33% (10)	50% (15)
Yes (40)	-	3% (1)	15% (6)	65% (26)	18% (7)	-	-	13% (5)	40% (16)	48% (19)	-	3% (1)	23% (9)	50% (20)	25% (10)	-	-	20% (8)	53% (21)	28% (11)	5%	5%	5%	45% (18)	40% (16)

Note: Not at all: 1; little: 2; somewhat: 3; very much so: 4; extremely: 5

In the 3rd scenario, we illustrated a misconception that an EL in a mathematics classroom was having in relation to the difference between squaring a number and taking the square root of a number. The teacher, Marianne, understands that her student is confused for a variety of reasons: *squaring a number* and taking the *square root* of a number seem indistinguishable in English, particularly to an EL, (i.e., in her students' native language, the two operations were commonly expressed as one phrase) and to know the difference between the two operations, her student must understand that taking the square root of a number is the inverse or opposite of squaring the number. Marianne then rewrites the term in both her student's native language and in English. She links the algorithm to the terms (i.e., by also pointing out what the *root* is to foster conceptual and linguistic understanding), and then she elaborates by defining what the *inverse* means. After fixing her answer, it becomes clear to Marianne that her student appears to understand the difference between taking the square root of a number and squaring a number conceptually. Clearly, his native language background interfered with learning the terms properly in English.

As mentioned before, the majority of both those who offer coursework and those who do not offer coursework on teaching mathematics to ELs think it is important for future teachers to know how to handle the scenario. Specifically, altogether 65% of teacher educators both those who offer required coursework and those who do not offer thought that it was very or extremely important for future mathematics teachers to know how to handle this particular scenario. However, 23% of those who offer required coursework and 23% of those who do not offer coursework were ambivalent in rating the scenario important. For example, one teacher educator who reported to be offering the required coursework for teaching math to ELs in her/his teacher education program in Wisconsin. The teacher educator argued that the teacher education program could not possibly teach teacher candidates the linguistic variation in expressing academic math vocabulary across different languages.

> I rated this somewhat important for preservice teachers. I believe it is extremely important for practicing teachers. My reason for the difference is that the teacher is required to know the language specific meanings of square and square root. I believe that this language specific knowledge should be learned at the District/ School level when the teacher is hired. A university program cannot teach them the language specific meanings and variations for all of academic math vocabulary for all languages.

Similarly, another teacher educator who did not list any coursework related to EL-teaching thought that understanding students' native languages went above and beyond a "normal" classroom teacher's task. When advising a student teacher, she would advise asking the assistance of a bilingual teacher. This insight might arise from the dichotomous division of labor between content teachers and ESL teachers:

> This goes above and beyond what a normal classroom teacher would / should need to know. I would likely recommend for one of my student teachers in this situation to (A) enlist the assistance of a bilingual teacher or (B) ask for the help of another bilingual student in the class with better language skills. I might ask the students to dialogue with each other in Spanish (presumably) about the problem and then ask each student to talk back to me in English about the problem to see if their understanding has changed.

Also, 10% of those who did not offer coursework on teaching mathematics to ELs thought that it is of little importance for future teachers to know how to repair ELs' lack of understanding about the linguistic representation of the mathematical difference between squaring a number and taking the square root of a number. Only one teacher educator amongst the group who offers coursework on teaching math to ELs found little importance in familiarizing future mathematics educators with a scenario in which they would need to model the appropriate way of using the language of mathematics.

Another teacher educator who also rated "very little" thought that lack of understanding about the difference between squaring a number and taking the square root of a number is not an EL issue. This teacher educator might have implied that non-ELs and ELs will similarly have an issue with mathematical concepts as such. The teacher educator said:

> This issue is only partially related to the ELL's language learning. Yes, "square" is mentioned in each operation, but "root of a number" and "of a number" are also indicated. The real issue is between "square ROOT" and "square A NUMBER". This scenario would not influence instruction other than the need to stress the difference between square root and square a number. It is not really an ELL issue.

As discussed before, the other scenarios (1, 2, and 5) received ratings of high importance unanimously by both groups of teacher educators who offer required coursework and those who do not. In the interest of brevity, we offer teacher educators' reasoning on scenarios 1 and 5 only. To describe scenario 1, a mathematics teacher who recently graduated from an undergraduate education program is teaching a unit on solving rate problems to her class of 6th grade students. The teacher presents the following problem on the Smart Board: *Subway train A is traveling at 15 miles per hour. Subway train B is traveling 3 times as fast as subway train A. If subway train B travels for 30 minutes, how far does it travel?* In this scenario, students are asked to write an equation based on this word problem and then complete the algorithm in order to solve the problem. The ELs in the class are identified as being at Level 2 on the WIDA Reading descriptors. They can identify visually supported examples of perimeter, area, volume, or circumference in real-world situations (e.g., painting room). The teacher recognizes that many students are not likely to know the formula $d = rt$. The teacher also knows that there are other aspects of the problem that could be specifically challenging for ELs, such as a lack of familiarity with subway trains, confusion about the "If clause" expression, and so on.

Of the 30 teacher educators who reported that they didn't have any required coursework for mathematics teachers in-training that is geared towards preparing them to effectively teach math to ELs, 67% thought that it was very much important for future teachers to know how to handle this particular instructional scenario. Similarly, 65% of those who offered required coursework rated the scenario very important and relevant. However, there was also ambivalence, about the importance of this scenario for the work of teaching mathematics to ELs. That is, a total of 18% of the TEs who offer required coursework rated the scenario either little or somewhat important. For example, one teacher educator who offered required coursework at her/his teacher education program in Ohio demonstrated ambivalence rating the scenario. Picking on the subway issue, the teacher educator does not think that knowing how to familiarize ELs with the unknown concepts is the relevant or significant skill set.

> These types of problems are de-emphasized in the Common Core because they're not realistic applications of mathematics. I believe the problems students have in understanding the language comes primarily from the fact that the problem has little relevance to them. I am not overly concerned about future teachers knowing how to handle the "subway" issue since their students won't be able to relate to it.

This ambivalence was observed in a few other cases. For example, despite rating the scenario as very important, another teacher educator offering coursework for teaching mathematics to ELs in

Maryland added that the task itself is not very rich as it is simply an application of a formula to the given scenario:

> This sounds like a fairly routine scenario in a typical mathematics classroom. I hesitate to give it the highest rating, however, because it is not a terribly rich task and seems to be aimed simply at application of a formula to the given scenario. The pieces about understanding reading difficulties and understanding students' past experiences, however, are important.

In scenario 5, ELs are depicted studying fractions in Mrs. Barkley's 6th grade class. One EL whose performance in math is of concern tested at a WIDA listening Level 3 and a Speaking Level 2. At this level in listening, the student can match everyday examples of percents or fractions with oral descriptions if graphic or visual support is provided (e.g., amount of interest earned or taxes on groceries). In speaking, the student can also define or describe types of line segments or angles from pictures of everyday objects (e.g., "This angle is larger."). Mrs. Barkley is teaching her students how to simplify fractions to lowest terms. As the students explain their answers, the EL described above makes the following statement: "Four goes into the top and bottom of 8 over 12, so you get 2 over 3." In response, Mrs. Barkley restates what the student said using academic sentence structures and mathematical concepts such as the numerator, denominator, the least common multiple, and division. She also provides graphic representations that illustrate the equivalence of 8/12 and 2/3, as well as the logic behind what it means to divide sets of eight and twelve into four parts. All representations are repeatedly linked to the academic language used. Mrs. Barkley then asks, "Can someone explain how we reduce a fraction to lowest terms?" She checks for understanding by asking her students to write the representations and fractions with labels (e.g., numerator and denominator) for homework.

While 90% of the teacher educators who offered required coursework and who did not rated the significance of this scenario as high, 8% of them did not view future teachers' knowledge as to how to handle the scenario as significant. One of them thought that the teacher wasted the EL's time "when the student already understood how to reduce the fraction to lowest terms." Similarly, another teacher educator thought that this instructional practice was inappropriate because she interpreted that the teacher in the scenario is telling students to follow procedures. The teacher educator said the following:

> This type of instruction is grossly inappropriate. These concepts need to be modeled concretely, and the operations developed from the models. Simply "telling" students a list of procedures to follow is the worst type of instruction possible! I'd fail any student teacher I saw approaching the instruction in this manner.

In summary, teacher educators highly rated the importance and relevance of the given scenarios to the task of learning to teach mathematics to ELs. The extent to which the teacher education programs at which they teach offered EL-related coursework might have interacted with the nature of their comments.

Discussion

Many teacher education programs address the teaching of ELs within the context of coursework on teaching culturally diverse learners and/or multicultural education. There appears to be few, if any, discipline-specific methods coursework for teaching ELs. The effective teaching of ELs then becomes an after-thought for many candidate teachers during their field experiences and years in the field. Data from this study suggest that the consequences of this are for teacher candidates to cultivate generic strategies regarding "best pedagogical practices" that they think would apply to all ELs. If candidates complete teacher education programs with blanket, one-size-fit-all types of knowledge about how to teach content to ELs, it is important to consider the consequences (Paphamihiel, 2007). Does this attenuate teachers' efficacy in instructing ELs? If so, what are the consequences of this for teachers and their students?

Potentially compounding these effects are teachers' perceptions of ELs. Specifically, research has shown how societal views of immigrants and their children as problematic are reflected in teachers' approaches and attitudes towards culturally and linguistically diverse students (Horenczyk & Tartar, 2012; Walker, Shafer, & Iiams, 2004). Accordingly, several studies indicate that pre-service teachers get to know about ELs through a deficit-model lens (Suarez-Orozco & Suarez-Orozco, 2001; Paphamihiel, 2007) with perceptions of ELs as those who usually drop out of school or are academically incompetent. Views like this, among others, would not be surprising, especially in the absence of proper teacher training.

In relation to the interaction between candidates' content knowledge and teaching, earlier research findings warrant investigation of the relationship between teacher knowledge of mathematics and teaching (Kahan, Cooper, & Bethea., 2003). Kahan et al. cautions that this relationship should be analyzed with care because teacher content knowledge, especially at the pre-service level, should not be equated with teacher education coursework. Rather, attention should be paid to the quality of the preparation (Zeichner & Schulte, 2001 as cited in Kahan et al., 2003). The teacher candidate participants in this study, especially those who demonstrated good content knowledge, also seemed to reflect a considerable degree of flexibility in reasoning through the EL-teaching scenarios. This suggests, as noted previously, that high levels of content knowledge makes it possible to understand the integral role language plays in students' understanding of mathematical content. This in turn might explain how some candidates were more able to reason through the specific linguistic aspects of the problem posed in the EL-teaching scenario. For example, Jack was able to pinpoint the importance of unpacking the if-clause sentence in relation to the independent and dependent variables embedded in the word problem. One possible explanation is that deeper conceptual understanding of the particular mathematics concept might allow the teacher candidates to see its integral connection to the choice of language features (i.e., if-clause [Ball, 1991]). Accordingly, Ball asserts that conceptual understanding is different from procedural understanding of mathematics. The participating teachers in her seminal research paper demonstrated procedural understanding and understanding of how to get students to perform the procedure, but not conceptual understanding of why procedures work the way they do, or what Ma (1999) would call as "profound understanding of fundamental mathematics." Ma describes this understanding as one that makes curricular connections coherently and builds a deep and core understanding of the fundamental mathematical arithmetic while adding other areas such as fractions, geometry, and simple equations and so on. However, researchers should not assume that teachers who demonstrate more mathematical proficiency are able to teach mathematics more effectively. Similarly, in this study, we cannot conclude that a candidate who provided a sound explanation about the link between a linguistic choice and the mathematical operation essential to solve the problem could effectively handle ELs' challenges with the language. Nonetheless, the interaction between teachers' content knowledge and understanding of the mathematics-specific linguistic choices is an area worth further investigating to inform mathematics teacher education.

Concluding Remarks on Implications for Research and Limitations

As alluded to above, in the realm of mathematics teacher education, learning to teach mathematics to ELs is rarely studied. To build on the research regarding teacher trainees' attitudes towards EL-teaching (Durgunoglu & Hughes, 2010; Pappamihiel, 2007; Polat, 2010), we suggest studies should be conducted in order to determine what types of experiences would help pre-service teachers deepen their content knowledge and understandings of effective EL-teaching of mathematics. This research might include controlling for or investigating the effects of teachers' background factors such as exposure to ELs, experience learning second language(s), time spent studying or living abroad, the quality and quantity of teachers' apprenticeships, and the numbers of ESL courses teachers have taken (Polat, 2010).

Accordingly, one of the limitations of this study is that teacher candidates' exposures to ELs through various means was not assessed. Information about whether participants had learned a second language, studied or lived abroad, etc. would have helped clarify what informed their differential reasoning regarding how to best teach ELs particular concepts in math (i.e., that which was presented within the teaching scenarios). Another limitation was that we did not have an opportunity to ask our participants whether our interpretations of the emergent themes were consistent with theirs. Notwithstanding, the results of this study indicate a range of common patterns regarding teacher candidates' (i.e., those who completed coursework and student teaching) understandings of how to teach ELs math effectively. The consequences of this are vast, and we believe, warrant further investigation.

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