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# Mathematics Lesson Design for English Learners Versus Non-English Learners From Perspectives of Equity and Intersection

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*Calls for "mathematics for all" or "mathematics for social justice" bring light to the importance of equity issues within and through mathematics education. Employing the theoretical perspectives of equity and social justice for mathematics education, and the intersection of language, culture, and mathematics, this study examined how a group of in-service teachers working in inner-city settings designed mathematics tasks and strategies for English Learners (EL) in comparison with non-ELs. The data, 23 sets of lesson design responding to two learner profiles, was analyzed using inductive content analysis. Findings suggest that meaningful opportunities to learn the same mathematics concept were presented less often to ELs, who also were more likely to experience a lack of active participation and engagement than non-ELs. From the intersectional perspective, teachers heavily relied on ELs' native language support rather than exploring the complexity of mathematical discourse. The lack of cultural integration in their lesson designs was also notable. These findings imply that the attention of mathematics education for ELs needs to be redirected from language support per se to the interplay between language, culture, and mathematical concepts in order to create a level playing field.*

**KEYWORDS:** culturally responsive mathematics teaching, English learners, equity of mathematics education, mathematical discourse, mathematical instructions for English learners

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Calls for "mathematics for all," or "mathematics for social justice," demonstrate the efforts to address persistent disparity issues within and throughout mathematics education. The issue of inequity within mathematics education lies in its failure to provide historically marginalized students with meaningful opportunities to learn mathematics (Van de Walle et al., 2019), perpetuating gaps in learning outcomes between students of diverse backgrounds and their mainstream counterparts (Abedi & Herman, 2010; Barajas-López, 2014; Bartell, 2013; Mosqueda, 2010; Welner & Carter, 2013). As such, the National Council of Teachers of Mathematics (NCTM) recommends mathematics teachers to ensure high-quality mathematics instruction for all students, including students whose first language is not English. In order to support English language learners' (ELs) mathematical understanding and proficiency, research suggests that mathematics teachers provide ELs access and opportunities to learn mathematics through accommodated instruction and extended learning opportunities (Abedi & Herman, 2010; Kersaint et al., 2013; Moschkovich, 2013). Furthermore, every student's diverse cultural and linguistic backgrounds should be respected and included in the learning environment (NCTM, 2014). Similarly, English as a Second Language (ESL) education provides preK–12th grade proficiency standards that explicitly state that ESL education should help ELs successfully communicate information and mathematical concepts (Teachers of English to Speakers of Other Languages [TESOL], 2006).

Thus, both the fields of mathematics and ESL education stress that teaching mathematics to ELs should be a collaborative effort between ESL teachers and mathematics teachers (Ewing et al., 2019; Kurz et al., 2017; Nutta et al., 2012; Song & Coppersmith, 2020). Furthermore, instructional approaches such as Content-Based Instruction (Cenoz, 2015) and Content and Language Integrated Learning (Moore & Lorenzo, 2015) underline the importance of content integration in language learning.

Furthermore, there is a growing understanding that mathematics has its own complex language that could further challenge traditionally marginalized students with different language and cultural backgrounds. Research has shown how language and culture intersect with mathematics (de Araujo et al., 2018; O'Halloran, 2015; Zahner et al., 2018). Despite the importance of equity in mathematics education and teachers' shared responsibilities for ELs' mathematics education, it is less known how teachers are prepared to meet the unique needs of ELs in mathematics lessons. Thus, this study investigated how a group of in-service teachers in a graduate TESOL program responded to two learner cases involving ELs and non-ELs with strategies and tasks to teach a 5th grade mathematics standard.

## Theoretical Perspectives and Literature Review

The theoretical perspectives of equity and social justice as well as the intersection of mathematics, language, and culture provided us with a critical lens to examine the present study. The equity and social justice perspectives underpin culturally responsive mathematics teaching in that it promotes equal access to meaningful learning opportunities and empowers traditionally underprivileged students through academic engagement and success. The perspective that views mathematics education as an intersection of mathematics, language, and culture enabled us to study mathematics education for ELs in a more inclusive and comprehensive manner, as will be delineated in the ensuing sections.

*Mathematics Education From an Equity Perspective*

Mathematics education from an equity perspective concerns equal opportunities and access to mathematics learning for all learners. Research indicates that students of color are disproportionately placed in tracking and lower level mathematics courses, further preventing them from advancing their studies (Bartell, 2013; Gonzalez, 2009; Larnell et al., 2016). Welner and Carter (2013) argued achievement gaps are the direct result of opportunity gaps. The practice of tracking affects mathematics performance, but also low expectations and low quality of instruction leads to low student engagement (Larnell et al., 2016). Culturally relevant/responsive pedagogy, which Gloria Ladson-Billings (1995, 2014) pioneered and Gay (2010) expanded into curriculum, highlights the ways that teaching enables equity, social justice, and empowerment of students from diverse backgrounds. Specific to mathematics education, incorporating students' lived experiences, interests, and cultural backgrounds into mathematics lessons and curriculum is crucial (Banse et al., 2017; Driver & Powell, 2017). When students are able to make connections with mathematics concepts, learning improves. Thus, the equity perspective highlights the importance of meaningful opportunities for disadvantaged students. This is one way to manifest social justice in mathematics education.

Another way to address social justice is incorporation of mathematics lessons that help students understand, question, and critique social equity and justice issues (Felton-Koestler, 2020; Gower, 2015; Leonard et al., 2009). Felton-Koestler (2020) gave an example about a response to the events in Charlottesville where students discussed the difference between individual and institutional racism and were given graphs with topics such as median income by race from 1967–2014 and White and Black people's views about how far our country has come in addressing equal rights. The students then responded to specific questions about their reaction to the graphs. Students could also do further work examining the difference in median incomes (Morin et al., 2017) or examine the rates of segregation in large cities where demographic data is easily accessible (Felton-Koestler, 2020). Other examples that might be easier for elementary students include calculating revenue for fair trade and non-fair-trade chocolate bars or using population figures to determine the probability of being born in a different country (Gower, 2015).

*Intersection of Mathematics, Language, and Culture*

Unlike commonly held misconceptions that mathematics consists of numbers and words and therefore ELs can catch up to grade-level mathematics quickly (e.g., Simpson & Cole, 2015), a number of studies have explained that mathematics uses its own complex mathematics language and that different cultures may have different ways of presenting mathematical concepts (see de Araujo et al., 2018; O'Halloran, 2015). Supporting this claim, recent research on the mathematics education of ELs has expanded from focusing on only cognitive aspects—"how language might be a barrier for ELs' mathematics learning"—to a sociocultural aspect—"how ELs gain access to the mathematics register through teaching and learning processes" (de Araujo et al., 2018, p. 880). Although different studies have adopted different terms, such as *mathematics register*, *multi-modal,* or *multi-semiotic*, to describe approaches to mathematics language, they confirm that mathematical discourse has complexity and density with symbolic notations and images that convey meanings and commands (Civil, 2018; Moschokovich, 2015; O'Halloran, 2015). We further explore how languages and cultures have been presented in mathematics in other literature in the following sections.

*Mathematics intersecting with language*. Gee's (1989) concept of *discourse* views discourse as special ways of thinking, speaking, writing, and interacting with each other within the community of an academic field. Simpson and Cole's (2015) meta-analysis of the language of mathematics defines that mathematical discourse not only includes academic vocabulary but also grammar features and the ways that mathematics concepts/problems are organized and asked. The discourse of mathematics is also multi-semiotic in that numeric numbers, mathematical symbols, images, graphs, and charts have their own communicative meanings that could be understood and interpreted within the mathematics discourse community. For example, $x$ in the problem $x = 2(3+1)$ means "unknown number," which is to be solved, while the parentheses regulate the sequence of problem solving and "+" denotes a command to add. Furthermore, mathematical discourses include written text and spoken form, such as explaining multi-step problems, justifying the answer, and demonstrating the reasoning process. Thus, mathematical discourse is interlinked with the mathematical concepts rather than a discrete decontextualized language to learn (de Araujo et al., 2018; Peng et al., 2020).

Similarly, Zahner et al. (2018) identified languages that intersect in mathematics as "mathematical explanations, justification, generalization," "specialized notation and symbols," and "everyday language with content-specific language" (p. 34). Thus, some studies have suggested utilizing specifically focused instructional strategies to support mathematical language, particularly for ELs. For example, ELs can connect with these practices best when teachers use multiple resources and communication modes while encouraging students to use home languages as a resource (Chval & Pinnow, 2018; Sorto et al., 2014). Teacher modeling through think-alouds, reformulation or expansion of students' responses, and questioning also add to the effectiveness of the applied standards (Banse et al., 2017; Driver & Powell, 2017; Hansen-Thomas, 2009). Such mathematical discourse practices represent how students and teachers can process mathematical information and engage in teaching and learning of mathematics. Without the engagement of mathematical discourse, simple translation turned out to be ineffective in ELs' learning (Turkan & de Jong, 2018).

*Mathematics intersecting with culture*. The ways that culture intersects in mathematics can include integrating students' culture and cultural resources into mathematics instruction. Students' *funds of knowledge* and out-of-school mathematics-related activities could be incorporated into mathematics curriculum and lessons to help engage and empower students (Civil, 2014; González et al., 2005; Rios-Aguilar et al., 2011; Wagner, 2012).

More specifically, Wagner's (2012) study examined how a group of mathematics teachers incorporated students' out-of-school mathematics into their lessons, and she argued that the gaps between students' out-of-school mathematics practice and school curriculum have increased. In the endeavor to reduce this gap, Wagner provided a professional development program for in-service mathematics teachers through which she discovered four types of practices that the teachers had adopted. Among them, the most frequently employed practice was using cultural contexts in mathematics problems. For example, a teacher might use the image of a soccer field to introduce the concept of area. Although the authenticity of such activities is questionable because in real life students use soccer fields to play soccer rather than to measure the field, the practice is easily employable and could motivate students. Wagner (2012) further proposed that mathematics-embedded practice in out-of-school contexts such as family grocery shopping could be the most authentic practice of mathematical concepts. However, it takes effort and time to identify authentic mathematics practices in students' households. Nevertheless, her study demonstrated how out-of-school activities representing students' culture, resources, and lived experiences could be well integrated into mathematics lessons.

Another illustration of cultural differences in mathematics education is when different cultures stress different skill sets. For example, U.S. mathematics education emphasizes demonstration of reasoning and proof processes, while some other cultures assume mental mathematics and do not necessarily emphasize students showing their thinking processes and reasoning steps (Yang & Huang, 2014). As another example, the methods of presenting decimals in thousands units by using commas and periods vary in different countries. Furthermore, how to do division can differ in other cultures (Son & Senk, 2010). Different metrics systems could further confuse students who are not used to U.S. measurement systems, such as “ounce,” “pound,” “inch,” “feet,” etc.

The collective results from these studies indicate that cultural aspects in mathematics education should not be overlooked. Rather, they should be actively utilized and integrated into mathematics lessons to help students learn. Hence, one of our focused analyses entailed how mathematics, language, and culture intersected in teachers’ mathematics lesson development.

## Research Methods

For this study, we employed a qualitative descriptive study to seek how a group of in-service teachers approached mathematics instruction design for non-ELs versus for ELs. The main research question guiding our study was the following: How does a group of in-service teachers in a TESOL graduate program design mathematics lessons responding to learner-specific cases? Specifically, how different or similar were their instructional support and procedures for ELs versus non-ELs in their mathematics lesson?

### *Research Contexts and Participants*

The participants of this study were a group of in-service teachers who were already certified in areas other than ESOL, such as Childhood Education and secondary level subject areas. They were taking TESOL graduate courses for an additional certificate in ESOL at the time of study. Among the participants ($N = 23$), 14 teachers reported that they were certified in Childhood Education (Grades 1–6), while seven teachers reported that their certification area was in secondary subjects. Two teachers indicated that their initial certifications were in the category of “Other,” such as bilingual education or special education. Twenty participants had received some form of training related to ESL from graduate and/or undergraduate courses as well as professional development workshops. In addition, all of the participants reported that they had worked with ELs. Their years of teaching experiences ranged from two to 20 years.

All participating teachers in the study were teaching in school districts in inner city settings where ELs make up about 15% of the entire population. According to 2018 state-wide mathematics assessment data, ELs performed approximately 31% to

33% lower than their non-EL counterparts (New York State Education Department, 2019). Although it is not clearly known to what degree the teachers had learned how to teach ELs, all of them had worked with ELs at the time of this study. Thus, it is fair to say that these participating teachers had been exposed to cultural and linguistic diversity on a daily basis and were familiar with ESL students. It is of note that teachers with more field experience and exposure to ELs better understand the interconnection of language and mathematics teaching than their counterparts (McLeman et al., 2012).

*Data Source and Instrument*

The study was conducted through a case study teaching approach, which allows teacher educators to present targeted experiences that connect the preK–12 classroom and methods courses (Jeffries & Maeder, 2011; Turkan & de Jong, 2018). According to Biza et al. (2007), teachers are invited to answer highly focused mathematical and pedagogical case study questions that allow them to generate best practice with scenarios similar to what they are facing or will face. Thus, the classroom scenario-based case study teaching approach has a clear purpose in that it helps teachers develop a deeper understanding of teaching mathematics to diverse students (Turkan & de Jong, 2018). Teacher educators find that classroom scenario-based cases are a valuable research data collection method because they approximate the situations and students they encounter in real classrooms (Erickson et al., 2021; Kennedy, 1999).

Upon IRB approval, the participating teachers enrolled in a TESOL graduate course that covered how to teach ELs across content areas, such as mathematics, science, social studies, and English language arts. The participants were asked to respond to two learner profiles with tasks and strategies right before they learned how to support ELs in mathematics lessons. First, a standard titled "Numbers and Operations—Fractions" was given to them with the following word problem: "If each person at a party will eat 1/4 of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?" Following this, two learner profiles were provided—one for a general education non-EL, whom we named "Lenny," and one for an EL, whom we called "Marcella." Following this, the participants were asked to design the main body of the lesson with instructional strategies and tasks that serve students like Lenny and Marcella (see Appendix A). The word problem that was given within the standard was intentionally created because word problems present opportunities "to study culturally and linguistically responsive mathematics instruction, because of the role of context as well as linguistic complexities inherent in problems" (Driver & Powell, 2017, p. 43). First, the provided word problem contextualized the mathematics standard that the participants needed to teach. Second, we wanted to examine how the participating teachers handled the challenge of presenting a social situation, in this case a dinner party, and a measurement system that might not be relevant to learners. This particular word problem was not to trick the participating teachers but intended to find out how the teachers responded to the context of the story problem. The nature of the task was diagnostic with the intention of finding what these teachers already knew and what their needs were rather than measuring the impact of instruction.

*Data Analysis*

We adopted inductive content analysis to examine tasks and strategies that the teachers developed to teach a 5th grade mathematics standard on fractions to ELs and non-ELs. Content analysis has been used "to classify written or oral materials into identified categories of similar meanings" in descriptive research (Cho & Lee, 2014, p. 3). Our approach was inductive in that we drew the patterns and themes through multiple coding processes beginning with open coding as detailed below (Cho & Lee, 2014; Schreier, 2012). Thomas (2006) defined the development of categories into a model or a framework with the outcome of an inductive analysis while conveying key themes and processes. The inductive reasoning approaches to open-ended response data involves finding patterns while analyzing the data without testing any pre-existing hypotheses or theories (Creswell, 2013; Thomas, 2006). This study followed the general inductive approach, coding steps, and the development of key themes processes (Creswell, 2015, Elliott, 2018; Richards, 2015).

The final themes of the study were developed through multiple steps (see Table 1). During the initial coding process, each of us identified processing codes in teachers' lesson designs (first-level code). These processing codes were a word or a phrase, such as "home language," "student interests," "manipulative," "explain," and "step-by-step breakdown." For example, when Teacher #23 responded to Lenny, "I would use a number line and manipulatives such as fraction tiles to help Lenny solve the problems and master the skill of multiplying with fractions," our processing code was "manipulatives" for "fraction tiles" and "number line." In comparison, when the same teacher responded to Marcella, "She can join another group in the class in order to be assisted by her classmates who may be on a higher level of English than her, but working collaboratively with her peers will help her even more," our processing codes were "peer tutoring" and "home language."

Second, we, as a group, compared our own processing codes with each other and reached a consensus on a set of categories through discussions. For example, we categorized the processing code "manipulatives" as "instructional resources" and "home language" as "language support." These categories were "language support," "cultural support," "instructional resources," "instructional procedures," and "collaborative learning." In this phase, we also analyzed frequencies of these patterns. Although our initial intention was not to quantify qualitative data, similar recurring remarks afforded us the opportunity to quantify for clear comparison between ELs and non-ELs. Next, we reread the original data to confirm and/or find further nuanced patterns. For instance, we found "language support" could be divided into general language (English or home language) and mathematical discourse. Finally, we developed these patterns into a few themes from two main theoretical perspectives—equity and intersection—as we will describe them in the following sections.

As far as credibility of data and analysis is concerned, the participating teachers were assured that their lesson designs would not be graded and completion itself would be considered as participation in class. There were no time and space restrictions in their responses (see Appendix B for a single entire example). At the analysis level, the researchers, who specialize in mathematics, ESL, and Special Education, respectively, went through multiple steps of coding individually and together.

*Table 1*
**Coding Steps of Lesson Design Data Analysis**

| **Step 1** | **Step 2** | | **Step 3** | |
|---|---|---|---|---|
| Initial Code Examples | Common Codes/ Categories | Frequency (Non-EL vs. EL) & Percentage | Emerging Themes from Equity Perspective | Emerging Themes from Intersection Perspective |
| Home language, labeling, directions verbally, numerals, vocabulary, simple words, tiered/leveled texts, pre-prepared notes, sentence starters/stems | Language Support English language; Mathematical discourse | 2 vs. 15 (9.5% vs. 71.4%) | Participation in Learning<br><br>Expectations and Quality of Instruction | Language Support<br><br>Cultural Support<br><br>Mathematical Support |
| Student interests/likes, real-life connection | Cultural Support | 4 vs. 3 (19% vs. 14.3%) | | |
| Anchor chart, manipulatives, number lines, visual aids, examples/multiple problems, videos | Instructional Resources (Digital Resources) | 13 vs. 10 (61.9% vs. 47.6%) | | |
| Centers/stations, step-by-step breakdown, procedural explanation (step-by-step solution), conceptual explanation, additional time, slower pace, modeling, challenging/higher order thinking, have students explain, student-centered, start with inquires, I do, we do, you do | Instructional Procedures<br><br>*Discovery | 3 vs. 0 (14.3% vs. 0%) | | |
| Pairing, grouping, peer tutoring | Collaborative Learning | 7 vs.11 (33.3% vs. 52.4%) | | |

*Note*. Although 23 teachers participated in this study, two teachers who did not design the lessons were removed from the analysis. Some teachers adopted multiple resources, such as charts, graphic organizers, and manipulatives. Instead of counting these as three separate categories, they were counted as one.

## Findings

The results showed the patterns of "language support," "culture support," "instructional resources," "instructional organization/procedures," and "collaborative learning." What follows is our quantified analysis in each category to see how ELs were supported differently or similarly from non-ELs. Furthermore, results from content analysis of the teachers' lesson tasks and strategies for ELs and for non-ELs will be presented while taking a few supportive examples of the data in order to corroborate our claims.

### *Language Support*

Findings show teachers chose two types of language support: general language and mathematical discourse. General language support includes translations, simplified English sentences and words, and labeling in a home language. Mathematical discourse concerns mathematical reasoning, questioning, concluding, and showing understanding the steps in mathematical problems.

More than 70% of teachers in this study adopted translation, labels, sentence starters and stems, and home language use to support Marcella. In contrast, about 10% of teachers adopted mathematics discourse for Lenny (non-EL).

For example, Teacher #13 stated, "I would provide her [Marcella] with a vocabulary list of mathematical terms in both English and Spanish, so she can learn key vocabulary in English… Mathematics has many cognates in Spanish, and therefore I can make connections." In addition to providing terms in the ELs' home language, teachers used sentence stems or starters, as is shown in the following excerpt.

> For Marcella, I would have sentence strips for her that says ____ multiple by _____ equals to __________. I would also break down the story problem into parts guiding Marcella through it and modify the language of the story problem (Teacher #12).

It is noteworthy that teachers who explicitly introduced mathematics vocabulary and discourse to Lenny failed to do the same for Marcella. For instance, Teacher #12 (Childhood Education Certificate) stated in the design for Lenny, "…first explain vocabulary words: multiplication, fraction, whole number, product and equation." Another example is Teacher #6, who mentioned, "I would have Lenny work with a small group to share 3 strategies and engage in active mathematics discourse using domain vocabulary." The very same teachers, however, decided to provide to Marcella "a mathematical dictionary and have her work with a push-in ESL teacher to work on her basic knowledge of English." Although mathematical discourse is different from language translation and simple vocabulary instruction, teachers' lesson design tended to focus on general language support rather than mathematical discourse.

*Cultural Support*

Culturally responsive teaching encompasses integrating students' experiences, interests, likes, and real-life connections in mathematics lessons. Despite this broad view of cultural support in this study, approximately 20% of the teachers integrated the student's culture into their mathematics lesson for Lenny, whereas less than 15% of the teachers mentioned incorporating Marcella's culture. Among them, two teachers (#4 & #16) mentioned culture both for Lenny and Marcella but slightly differently.

For example, Teacher #4 proposed that "I would create a story with elements that Marcella may be familiar with based on my conversations with her about her culture. So maybe instead of using pizza as an object that can be cut into pieces, I could refer to a soft taco or maybe a plantain." The same teacher used pizza slice examples for Lenny. Teacher #16 similarly claimed that having real-life examples such as food is a great way to engage Marcella in the lesson because she would feel "more involved." Aside from these two examples, teachers did not consider students' cultural backgrounds overall in lesson development.

*Instructional Resources*

Instructional resources include not only traditional hands-on materials, such as manipulatives and drawings, but also digital materials, such as internet interactive activities and instructional video clips. A variety of instructional resources could engage students' learning and enhance their mathematics learning. In particular, hands-on approaches coupled with visual aids and multimedia sources help ELs learn mathematical concepts while they are still developing English language skills (Hur & Suh, 2012).

In the present study, the majority of teachers adopted a variety of instructional resources, such as number lines, manipulatives, visual aids, and anchor/reference charts, in their lesson development. However, only two teachers indicated they would use digital resources (e.g., instructional video clips) for both Lenny and Marcella. For instance, Teacher #2 and Teacher #15 both used similar manipulatives and described how they would use them: "She [Marcella] would be given fraction bars and divide them into fourths. She will then color in ¼ of them. She will also cut and paste colored squares on ¼ of a fraction bar until she has colored manipulatives to use." Another example came from Teacher #18 and regarded Lenny: "Using a graphic organizer, draw out the fractions that are needed to solve this problem. Then make a model with manipulatives once the drawings are complete." The same teacher stated, "provide manipulatives along with other necessary visuals before beginning the story problem. Have students work with a peer to 'act out' story problem with manipulatives." It was obvious that all participating teachers were cognizant of the importance of hands-on materials when students learn mathematics, whether they be an EL or non-EL.

An intriguing result, however, is that approximately 62% of the teachers adopted a variety of instructional resources for Lenny, while 48% the teachers considered using instructional resources for Marcella. Although it is expected that Marcella would need far more instructional resources to increase comprehensibility of new mathematical concepts, the results indicate that this did not happen.

*Collaborative Learning*

Collaborative learning in the form of group or pair work has been promoted for student engagement in learning. Learners can accomplish more when they work together with more experienced/advanced peers than when they work independently. An additional benefit for ELs is they feel less anxiety in group settings than in whole class or individual situations, which yields positive influences on their lesson engagement (Takeuchi, 2016).

Although teachers in this study embraced collaborative learning strategies for Marcella more than for Lenny (52.4% vs. 33.3%, respectively), their reasoning for implementing collaborative work was not always the same. Teachers chose group work for Lenny to encourage the sharing of solutions or collaborative problem solving. For instance, Teacher #3 stated, "After they have a few minutes to work on their own I would then put them in a group so they can discuss their different answers and strategies they used." Another teacher (#22) proposed using the group activity of genuine collaboration for coming up with a solution rather than for simply sharing ideas: "Group must identify the key pieces of information and set up a solution using given information and solve."

On the other hand, the main purposes of collaborative learning for Marcella were to provide language support, as Teacher #20 put: "I would also have her work with a partner that speaks Spanish as well as English if I had a bilingual student in my class who could assist with translating and partake in mathematics discussion with her." Similarly, Teacher #23 stated, "Marcella can join another group in the class in order to be assisted by her classmates who may be on a higher-level English than her." These examples confirm that teachers tend to view group work as an opportunity to help Marcella with language rather than true collaboration to solve the problem and to share solutions.

An additional thought-provoking finding in collaborative learning was peer support with different expectations. For example, two teachers, #10 and #16, mentioned asking Lenny to be a tutor to help other students. Teacher #10 noted, "He [Lenny] will work with another student who may be struggling, explaining steps he took to solve the problem." In contrast, most teachers viewed Marcella as a help receiver in group work, rationalizing that she needed help in language, vocabulary, and content skills.

*Instructional Organization*

While analyzing the data, we noticed how teachers organized their instruction differently for ELs versus for non-ELs. One was the discovery learning approach versus explicit explanations as well as the use of guided scaffolding. Guided scaffolding utilizes step-by-step procedures to increase student independence in learning. At least three teachers adopted inquiry-based and discovery learning for Lenny, but no teacher attempted to employ a discovery learning strategy for Marcella. For example, these teachers began the lesson with an exploratory challenge, as Teacher #3 stated: "For this student [Lenny] I would use the upside-down mathematics approach where I would present the class with an open-ended question based on fractions." Interestingly however, the same teacher chose teacher-led explicit instruction for Marcella: "I would introduce multiplying fractions. I would present Marcella with the rule on multiplying fractions using an example." Aside from the three exceptions that adopted discovery-oriented instruction for Lenny, there was a pattern that teachers chose to explicitly explain and model mathematical concepts rather than encourage learners to discover them.

## Discussion

While we analyzed how the participating teachers designed a mathematics lesson when instructional cases were given for Lenny (non-EL) and for Marcella (EL) in their instructional support, approaches, and procedures, we discovered a few salient themes drawn from the emerging patterns. They include different quality of instruction and teachers' different expectations for ELs versus non-ELs as well as language support that has little connection with mathematical discourse and culture for ELs. In this section, we will discuss our findings around themes while comparing them with previously published studies.

*Quality and Expectation From an Equity Perspective*

*Participation in learning*. Collaborative learning has its own merits in that students often feel safe and confident in group settings and improve engagement and eventually understanding (Nebesniak & Heaton, 2010). However, the patterns of participation and engagement, which were based on teachers' expectations, paints Marcella as a passive learner. For example, some teachers viewed Lenny (non-EL) as an active learner and contributor to class, as he could serve as a tutor to other students. In contrast, they perceived Marcella (EL) as needing assistance. It is of note that Marcella has the grade-level mathematics and literacy skills in her first language. However, her limited English skills put her in a passive learning role, reducing her participation and power. ELs' mathematical contributions are not considered, and their passive role is cemented as a receiver of help (Turner et al., 2012). Although our study did not specifically investigate how Marcella's gender interplays with her being an EL, teachers may inadvertently underestimate female students' abilities under the assumption that they may not be good at mathematics (see Amador, 2018; Clark et al., 2014).

*Quality of mathematics instruction*. There were very little in-depth explanations of mathematics strategies for teaching fractions with conceptual models, unlike Moschkovich's (2015) view of mathematical academic literacy that encompasses proficiency, practice, and discourse. Although teachers adopted instructional strategies such as an anchor chart, fraction strips, and modeling, their lessons focused more on resources rather than how to use the resources to teach the mathematics concepts. For example, Teacher # 16 had a higher expectation for Lenny: "Since he is at grade level, giving him challenging word problems or higher order thinking problems, will challenge him into developing higher skills in that content area." Although the same teacher acknowledged Marcella's strong first language literacy skills and average mathematics skills, her instructional strategy was to use translation until Marcella became comfortable. Very similarly, another teacher, Teacher #20, showed she had high expectations for Lenny and stated, "I would challenge Lenny by asking him to represent his answer on a line plot and also in some type of picture or chart." These examples imply that the participants' quality of mathematics instruction suffered from different expectations of what Lenny and what Marcella can do. This finding confirms Abedi and Herman's (2010) study that reported that ELs had lower levels of learning opportunities compared to non-ELs, which, in turn, negatively influenced their performance. Teachers often adapt and modify lessons for students with special needs, including ELs. The problem, however, is that they tend to choose something "easier" for them and "provide fewer opportunities for students to connect ideas and build knowledge—thereby impeding, not supporting, learning" (Van de Walle et al., 2019, p. 26). Our findings are consistent with previous research that has found limited meaningful learning opportunities for ELs.

### *Language-Heavy Support From an Intersection Perspective*

From a perspective that mathematics education for ELs intersects with culture and language (Aguirre & del Rosario Zavala, 2013; Van de Walle et al., 2019), we found that most teachers employed translation-based and simplified language support for Marcella. Language proficiency of ELs is different from mathematical knowledge and discourse (Turkan & de Jong, 2018). Multiple ways to scaffold mathematics discourse include using questioning, repetition, elaboration, think-aloud, and consistent incorporation of mathematical discourse using modeling and elicitation rather than simple vocabulary instruction or translation (Banse et al., 2017; Hansen-Thomas, 2009). Song and Coppersmith's (2020) study also found that teachers who had completed a professional development training on how to support ELs still did not engage ELs with mathematical discourse in their classroom applications.

What these studies commonly point out is that simple translation or English language proficiency itself fails to view the complexity of mathematical discourse that could be taught within the mathematical conceptual understandings. Yet, the teachers of this study often chose simple translations and labeling to support ELs and how mathematical concepts, culture, and language are interlinked in mathematical problem solving was little considered.

Another compelling finding was the lack of cultural support and presence in mathematics problems and instruction. To our surprise, none of the participants raised questions about the word problem, the context of which was a dinner party, or the fraction example being based on a pound of roast beef. This word problem is not relevant to students' cultural backgrounds or interests. Furthermore, non-U.S. countries use metric-systems that do not include pounds or ounces. However, no teachers pointed out these discrepancies.

## Conclusion

This study investigated how a group of teachers in a TESOL graduate program developed strategies and tasks in response to two learner profiles—EL and non-EL. Teachers more actively reasoned why they chose certain instructional strategies in the case of Marcella and cared about providing language support in their lesson designs. However, from the equity perspective that concerns equal meaningful learning opportunities for ELs, their lessons fell short of creating these opportunities. Furthermore, their heavy language support with little mathematical conceptual development or cultural integration proved that the teachers did not have a full understanding of the intricate interconnections between mathematics, language, and culture despite their exposure to ESL training and experience working with ELs.

## Limitations and Implications

This study has a few limitations. The number of participants is small with convenient sampling, which makes the findings difficult to generalize or translate into other contexts. In addition, the teachers were not instructed to design an actual lesson plan but to respond to the case with instructional strategies and tasks. This might have hampered their lesson development. Despite the merits of the case approach that could be used in a methods course to approximate the actual teaching contexts, there might be discrepancies between what teachers plan to do and what they actually do in a real classroom.

In spite of these limitations, our study shed light on a few critical issues that teacher education programs of mathematics education and ESL education should consider. As our findings show, teachers tended to have different expectations for ELs as passive learners and mistake lack of language proficiency for lack of mathematical understanding. This prevented genuine engagement opportunities. Simple translations and providing native language support are not enough for ELs to improve mathematical discourse. High expectations and quality mathematics instruction should be ensured while educating traditionally marginalized students. Conspicuously, the lack of cultural integration into mathematics problems points to the need for culturally responsive teaching, which further promotes equity of learning. Specifically, pre- and in-service teachers need self-reflection, asking themselves how their lessons help their students connect mathematics with real-world situations in their lives. Deliberate planning for mathematics problems entailing social issues could also cultivate students' awareness of social justice while learning mathematics. Finally, what it means to create equal opportunities to learn mathematics and what it means to teach social justice through mathematics instruction for teachers of ELs warrants further investigation.

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## Appendix A

***You want to teach a math lesson on multiplication with fractions to 5th graders.***

| **Standards: Grade 5, Number and Operations - Fractions** |
| --- |
| Apply and extend previous understandings of multiplication to multiply a fraction by a whole number. a. Understand a fraction a/b as a multiple of 1/b. For example, use a visual fraction model to represent 5/4 as the product 5 × (1/4), recording the conclusion by the equation 5/4 = 5 × (1/4) or 5/4 = 1/4 + 1/4 + 1/4 + 1/4 + 1/4 |

**Please design a main body of the lesson such as instructional strategies and tasks that serve students like <u>Lenny</u> and <u>Marcella.</u>**

***<u>Case 2: 5 X 1/4 = ?</u>***

Possible Story Problem: If each person at a party will eat 1/4 of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?

1. <u>Lenny</u> is a 5th grade student who is performing at grade level in mathematics.

2. The English Language Learner, <u>Marcella</u>, is originally from the Dominican Republic. The student is from a middle-class background. She arrived in the U.S. three weeks prior to enrolling in the 5th grade. She has had formal schooling in her native country and has developed strong literacy skills in her first language, Spanish. Marcella appears to have average mathematics skills, but her English is at a Kindergarten level.

**Please respond to the following questions as best as you can.**

1. I am certified in____________.
2. I have taught for____________years altogether.
3. I have had English learners in my classes. ___Yes____years<br>___No
4. I have taken (workshops, undergraduate courses, graduate courses) to learn about instructional strategies for English learners (circle all that apply).
5. Please feel free to make any comments or your thoughts on this task.

Thank you for your participation!

**Appendix B**

Instructional Scenario

You want to teach a math lesson on multiplication with fractions to 5th graders. Please design a main body of the lesson such as instructional strategies and tasks that serve students like Lenny and Marcella.

Standards: Grade 5, Number and Operations - Fractions

Apply and extend previous understandings of multiplication to multiply a fraction by a whole number. a. Understand a fraction a/b as a multiple of 1/b. For example, use a visual fraction model to represent 5/4 as the product 5 × ( 1/4), recording the conclusion by the equation 5/4 = 5 × ( 1/4) or 5/4 = 1/4 + 1/4 + 1/4 + 1/4 + 1/4

5 X 1/4 = ?

Possible Story Problem: If each person at a party will eat 1/4 of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?

1. Lenny is a 5th grade student who is performing at grade level in mathematics. Please design a main body of the lesson such as instructional strategies and tasks that serve students like Lenny.

I would teach Lenny this concept by showing several examples on the board, and then allow him to use a reference sheet with the math formula to assist him with independent work. His independent work would be similar fractions examples for which he would complete on his own. Some of these problems would include word problems, and Lenny would be asked to explain his work and thinking with words at the end of the word problem. I would challenge Lenny by asking him to represent his answer on a line plot and also in some type of picture or chart.

2. The English Language Learner, Marcella, is originally from the Dominican Republic. The student is from a middle class background. She arrived in the U.S. three weeks prior to enrolling in the 5th grade. She has had formal schooling in her native country and has developed strong literacy skills in her first language, Spanish. Marina appears to have average mathematics skills, but her English is at a Kindergarten level. Please design a main body of the lesson such as instructional strategies and tasks that serve students like Marcella.

I would show Marcella several examples of these fractions problems on the board. I would provide Marcella with a fractions vocabulary list with common words translated in Spanish since she has strong Spanish literacy skills. She could refer to this sheet during the lesson to help her understand the discussion and teaching. I would have directions written on the board in Spanish and English before giving Marcella the independent math activity. I would make sure that her worksheet was differentiated with sentence starts and a word bank for her to use when describing her math work for the words problems. I would also translate the word problems into Spanish to support her in understanding what is expected of her within the problem. Since Marcella seems to be an average math learner, I would ask her to complete similar examples to the rest of the class, but focus on differentiating for her language needs. I would also have her work with a partner that speaks Spanish as well as English if I had a bilingual student in my class who could assist with translating and partake in math discussion with her.

Feel free to share any thoughts and opinions.

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