Language as a Barrier of Teaching Mathematics to English Language Learners

by
Josephine Sechrist

A THESIS

submitted to

Oregon State University

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in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Mathematics
(Honors Scholar)

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Presented May 23, 2016
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AN ABSTRACT OF THE THESIS OF

Josephine Sechrist for the degree of Honors Baccalaureate of Science in Mathematics and Honors Baccalaureate of Arts in International Studies presented on May 23, 2016
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Mary Beisiegel

In recent years, there has been a steady increase in the number of English Language Learners (ELL) in the United States. According to the Education Commission of the States, ELLs have significantly lower achievement levels than their non-ELL peers. Further, numerous research studies report that teacher education programs lack ELL specific training, resulting in a documented 57% of current teachers who believe they need more training to be effective working with ELLs. In this study, we hoped to gain perspective from mathematics teachers about the current climate that ELLs face in mathematics classrooms. The participants were contacted via email, eventually resulting in a total of nine interviews with relevant information. These were then transcribed and then analyzed with thematic analysis. These interviews showed that language was a significant barrier in teaching mathematics to ELLs. Furthermore, the participants reported the lack of effective resources for their ELL students, which resulted in the necessity for these teachers to create their own intervention methods. Many of these methods were supported by the literature, but overall, this study shows the need for improved teacher education programs in an effort to give ELLs a more equitable experience in mathematics classrooms.

Key Words: English Language Learners, ELL, learning, teaching, mathematics

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I understand that my project will become part of the permanent collection of Oregon State University, Honors College. My signature below authorizes release of my project to any reader upon request.

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Chapter 1: Introduction

In this study, I will mainly address the issues mathematics teachers face when teaching English Language Learners (ELLs) in their classrooms. This research project was motivated by the rising number of ELLs in the U.S. and their right to an effective education. One essential way to do this is by creating "equity-enhancing policies," (Singh, para. 1) which are "pivotal for universalizing access to education without discrimination or exclusion" (Singh, para. 1). This need is present not only in the U.S., but also in countries like Spain, which has, in recent years, become second to the U.S. in number of immigrants received annually (Gibson & Carrasco, 2009, p. 250).

Studying the similarities between Spain and the U.S. was particularly important to me as I spent the summer of 2015 studying abroad in Granada and Oviedo as part of my degree in international studies. My passion is for mathematics education, but growing up with an immigrant mother has also motivated my study of ELLs and my desire to help this population that is often unfairly seen as a burden in U.S. and Spanish schools today (Borgioli, 2014, p. 189).

To better understand the experiences of teachers and students in this region of the U.S., I developed a research study involving interviews with mathematics teachers. The methods behind these interviews and the following thematic analysis (Braun & Clark, 2006) of the collected data will be described in Chapter 3. I will then present the findings of these interviews in Chapter 4 through the use of participant statements and my own analysis of these comments. In Chapter 5, I will make connections between the preexisting literature and the data I collected, while also presenting the conclusions we can draw from the interviews. I will also reflect on the way this study

has impacted me as a future hopeful teacher, analyze the limitations of this study, and propose ideas for future research.

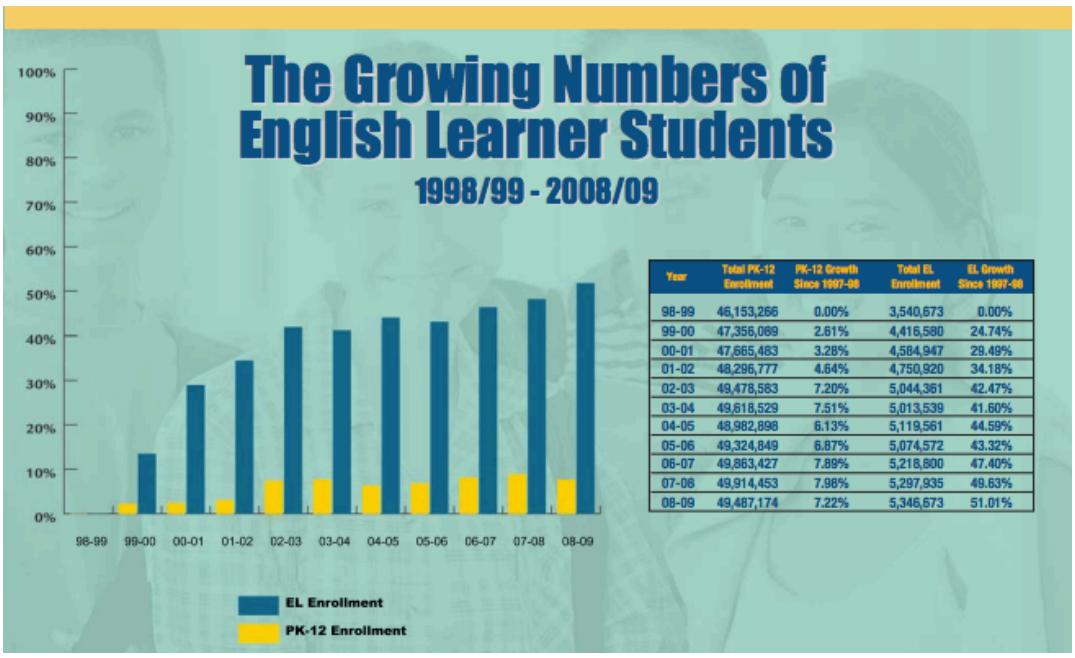
Chapter 2: Literature Review

In this chapter, I will explore the research surrounding the rising number of ELLs in the U.S. and abroad, and the lack of teacher education in effective ways to help these students. I will additionally explore the connections to Spain and ELLs abroad, and present the important ideas connecting language to mathematics and some researched methods that help ELLs in their learning of mathematics.

2.1 English Language Learner Population and Achievement Information

In recent years, there has been a steady increase in the number of ELLs in the United States. According to the U.S. Department of Education's (DOE) National Center for Education Statistics (NCES) (n.d.), in the 2002-03 academic year, nationally, there was an 8.7% ELL population, totaling to approximately 4.1 million students, and in the 2012-13 academic year, that number had risen to 9.2% ELL population and a estimated 4.4 million students (para 1). This trend extends back to 1998 and is displayed in the Figure 1.

This population is concentrated more in the western United States with Oregon and Washington both ranked among eighteen states with ELL enrollment percentages between 6.0 and 9.9 (U.S. DOE NCES, n.d., para. 2,3). The percentage of ELL students in U.S. classrooms is displayed in Figure 2.



Year	Total PK-12 Enrollment	PK-12 Growth Since 1997-98	Total EL Enrollment	EL Growth Since 1997-98
98-99	46,153,266	0.00%	3,540,673	0.00%
99-00	47,356,089	2.61%	4,416,580	24.74%
00-01	47,665,483	3.28%	4,584,947	29.49%
01-02	48,296,777	4.64%	4,750,920	34.18%
02-03	49,478,583	7.20%	5,044,361	42.47%
03-04	49,618,529	7.51%	5,013,539	41.60%
04-05	48,982,898	6.13%	5,119,561	44.59%
05-06	49,324,849	6.87%	5,074,572	43.32%
06-07	49,863,427	7.89%	5,218,800	47.40%
07-08	49,914,453	7.98%	5,297,935	49.63%
08-09	49,487,174	7.22%	5,346,673	51.01%

Figure 1: The Growing Number of English Learner Students Source: National Clearinghouse for English Language Acquisition, Growing Limited English Proficiency (LEP), "The Growing Number of English Learner Students," 1996-2009

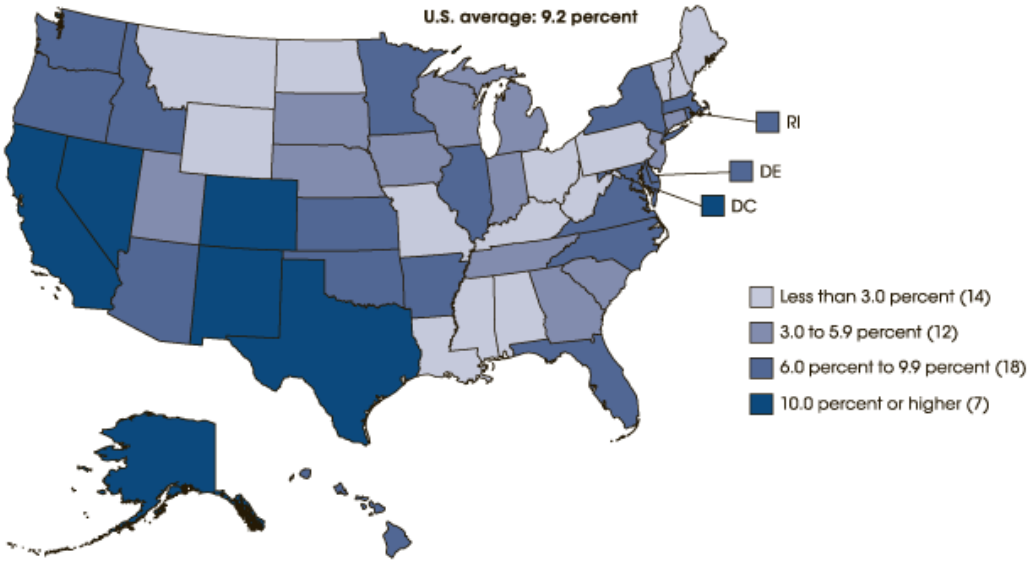


Figure 2: Percentage of ELL Students in Public Schools Across the U.S. Source: U.S. Department of Education, National Center for Education Studies, Common Core of Data (CCD) , "Local Education Agency Universe Survey," 2012-2013

This data shows the continual increase in ELL growth in the U.S. and demands our attention. According to the Education Commission of the States (ECS, 2013), "ELLs' academic performance significantly lags that of their non-ELL peers" (p. 2), which is reflected by national report cards across the country. Worse still, it has been reported that students who remain in ELL programs for longer amounts of time score worse on annual standardized tests than those who are phased out, resulting in typical grade point averages below a 2.0 and high drop-out rates (ECS, 2013, p. 2). These students can be found in a variety of classrooms including bilingual or structured immersion classrooms, however an increasing amount are being placed in mainstream classrooms, leaving content-specific teachers the responsibility of teaching students who are still struggling to learn English (Ballantyne, Sanderman, & Levy, 2008, p.9).

2.2 Teacher preparedness in teaching ELLs

The mainstreaming of ELL students leaves secondary teachers in a difficult position. Ballantyne and colleagues (2008) report that only 29.5% of teachers who have ELLs in their classrooms have had adequate training to teach these students well, and further, that 57% believe they need more training to provide effective teaching methods for ELL students (p. 9). Many of these teachers did not acquire undergraduate or graduate degrees focused on the teaching of this specific population. Just twenty states require that new teachers have some form of ELL training, and of this twenty, only four (Arizona, California, Florida, and New York) require a separate certification or specified coursework for ELL education (Ballantyne et al., 2008, p.9).

Teachers recognize that they are underprepared and unfortunately, when schools and districts place teachers in this position, they still do not provide adequate training opportunities. According to the U.S. Department of Education (2013), only 26.8% of public school teachers had participated in some form of professional development centered on teaching ELLs or students with limited English proficiency (p. 19). Further, Ballantyne et al. (2008) report that, "of teachers who had at least three ELLs in their classroom, 62% reported attending training related to ELLs within the past five years. However, the median amount of training was 4 hours" (p.10), which is likely not sufficient to meet teachers' needs. Based on these findings, one can conclude that there are not enough teachers who are adequately trained in teaching ELLs to match the growing population.

2.3 Connections to Spain and Immigrant Students

The United States is often described as a nation of immigrants, so the issue of ELLs specifically as the children of immigrant parents is not as surprising as one may initially think. In fact, according to a comparative study of the U.S. and Spain conducted at the Ohio State University, Gibson and Carrasco (2009) state that nearly one in four children (23%) in the U.S. today have an immigrant parent (p. 250). Spain has never been described in the likeness of the United States – a country built by immigrants. Yet, in recent years, Spain has become second to the U.S. in number of immigrants received annually (Gibson & Carrasco, 2009, p. 250). This has obviously extended to the number of immigrant children in Spanish schools, which has been on the rise since the beginning of the 2000's (refer to Figure 3), and is now over 15% in some autonomous countries (Zinovyeva, Felgueroso, & Vazquez, 2013, p. 26).

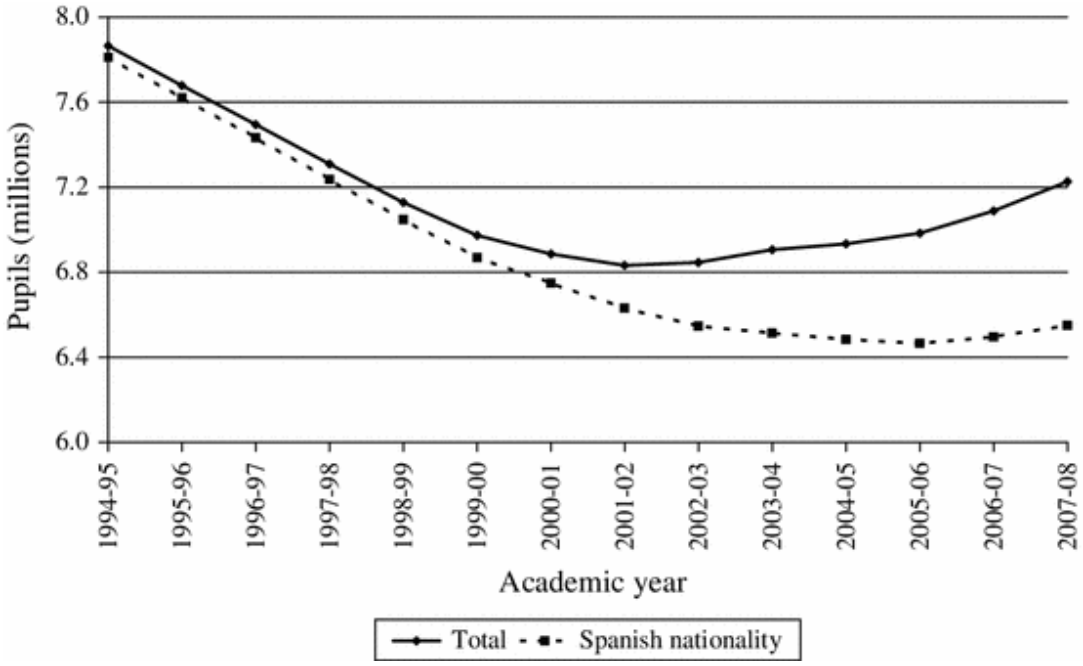


Figure 3: Native Spanish Students vs. Total number of students in Spain Source: Zinovyeva, N., Felguroso, F., & Vazquez, P. "Immigration and Student Achievement in Spain: Evidence from PISA SERIEs," 2013

Much like in the United States, there is a significant gap between student achievement among those of immigrant origin and those of native birth (Zinovyeva et al., 2013, p. 26). Gibson and Carrasco (2009) compare the achievement deficit in each of these countries, reporting that a recent study of 18 schools in Catalonia displayed high school dropout rates of 12% among native students, but 30% among non-Spanish nationality students (p. 252). Further, in California, only 60% of Latino (the nationality of students with the most severe disparities) students graduate from high school compared to 77% of white students, and among those who do graduate, only 20% of Latinos have completed the coursework for admission to a four-year college, compared to 38% of white students (Gibson & Carrasco, 2009, p.252).

It appears that these disparities can be largely attributed to three issues: (1) lack of teacher education or confidence in teaching ELLs and immigrant students, (2)

improper or unfair low placement, and (3) an unwelcoming atmosphere in schools, which is galvanized by the negative perception of these students (Borgioli, 2008; Gibson & Carrasco, 2009; Gorgorió, Planas, & Vilella, 2002; Zinovyeya et al., 2013).

The lack of teacher education in ELL and immigrant teaching methods extends to both Spain and the U.S. In Spain, these programs are rare (Gorgorió et al., 2002, p. 29), and most teachers receive no "specialized preparation related to cultural and linguistic diversity… and they find themselves poorly prepared to meet the needs of their increasingly diverse student populations" (Gibson & Carrasco, 2009, p. 253). Furthermore, though the education systems in both the U.S. and Spain claim to have "high academic standards and equality of opportunity, both end up producing unequal results for their largest immigrant populations" (Gibson & Carrasco, 2009, p.252).

In Spain, recently arrived immigrant youth often end up segregated from their peers for much of the day in "newcomer classes" for an entire year, after which they are most often placed in lower level or remedial classes (Gibson & Carrasco, 2009, p. 253). This same idea of ELL and immigrant student exclusion is present in the U.S. as "far too many children of immigrants end up segregated in English Language Development (ELD) tracks with inadequate curriculum materials" (Gibson & Carrasco, 2009, p. 253).

In both countries, there appears to be a negative connotation associated with ELL and immigrant students. Specifically in the U.S, there is a deficit model focus, where a lack of academic achievement is attributed to "flaws… within the students, their families, or their culture" (Borgioli, 2014, p. 189). Gibson and Carracso (2009) also emphasize this idea, and they continue to state that a large part of this deficit

view is due to the "English-only" culture that also neglects to celebrate or reward bilingualism (p. 253). Seeing students' linguistic differences as their biggest hurdle to learning in turn leads policy makers and teachers to push for these students to adapt to the new language as quickly as possible, often at the expense of the students learning of mathematics (Civil, 2012, p. 136).

In Spain, the attitude is similar. Marta Civil (2012) reports that, "teachers…underscore the issue of language as being a problem and do not seem to recognize the potential for richer learning grounded in different problem solving approaches and experiences that immigrant students may bring with them" (p.130). This attitude is extended into the classroom experiences of the immigrant and ELL students, who "often end up feeling silenced and alienated in school because actual practices can be elitist or tokenistic" (Gibson & Carrasco, 2009, p. 254). Overall, both systems have explicit objectives stating that the learning of ELL and immigrant populations is a priority, but both fall short of their potential, leaving these students lagging in their education.

2.4 Language

The core difference between ELLs and native English speaking students is their primary language choice. This can present an obvious obstacle to ELLs' learning of all subjects when integrated into U.S. schools where the primary language of education is English. This language barrier is an essential part of the problems many ELLs face in the entirety of their education, and particularly in their learning of mathematics.

2.4.1 The Integration of Math and Language

Though it is easy to understand that learning in one's non-native language could pose challenges, many people incorrectly assume that mathematics is "culture free," making it the ideal subject to teach ELLs (Garrison & Mora, 1999, p. 35). This assumption that mathematics is less difficult for ELLs because it is a topic "based on a language of numbers" has led to mathematics as one of the least researched disciplines in regards to ELL learning (Janzen, 2008, p. 1017). Unfortunately, this flawed idea is held by not only the general populace, but by some mathematics teachers as well, which could lead to an inability to fully recognize the needs of their students. Even those who are immersed in the art of teaching can be misguided in the belief that mathematics is a subject devoid of culture (Civil, 2012, p. 131).

This belief is, in fact, incorrect, as research has been pointing to the interrelated nature of language and mathematics since at least the mid 1980's (Schleppegrell, 2007, p. 139). The truth of the above statement aligns with Garrison and Mora's (1999) description of mathematics as a "highly compressed form of communication in which a single symbol may represent several words or relationships" (p. 36). This expresses that mathematics is based in highly complex linguistic communication methods through the use of symbols. Because of this, the teaching of mathematics relies heavily on the oral explanations of concepts from the teacher (Janzen, 2008, p. 1017). This idea is emphasized in a number of research papers that are focused on the teaching of mathematics to ELLs including works by Dr. Schleppegrell (2007) and Drs. Garrison and Mora (1999). These studies further reiterate the fact that oral communication is an integral part of mathematics teaching,

making it difficult for ELLs who may struggle with the understanding of English when mathematics is communicated verbally. This presentation of mathematics does nothing to help ELLs with their understanding of the subject as according to Garrison and Mora (1999): "research has shown that low achievement in mathematics of Latino ELLs can be attributed to low levels of English proficiency" (p. 35).

2.4.2 The Difficulties ELLs face in Mathematics Because of Language

For ELLs, the barrier created between their native language and English can prevent them from creating even a basic understanding of everyday language that is used for the foundational understanding of mathematics (Janzen, 2008, p. 1017). Furthermore, much of the technical mathematic language, which is an essential part of their holistic learning of the subject, is only available to them in the context of school, and "not through regular conversational interaction" (Janzen, 2008, p. 1017). This limits ELLs' exposure to important mathematical discourse and, in turn, makes the development of their mathematical fluency much more difficult.

The English language contributes to ELLs' difficulties in mathematics classrooms. There are a number of "everyday" words that have specific meanings in the realm of mathematics, which can be a difficult concept for ELLs' to grasp (Schleppegrell, 2007, p. 140). Garrison and Mora (1999) provide a relevant example to the issues that can be caused by this specific trait of mathematics:

> Since most English Language Learners first encounter the word *odd* as meaning unusual or different, when they hear a number referred to as odd, they may assume that something about the number is incorrect. The point of the teacher's presentation is often lost while students

> grapple to make sense of both new vocabulary and words with multiple meanings (p. 36).

A student's lack of exposure to the word "odd" in the context of mathematics directly results in his or her inability to focus on the remainder of the lesson and is likely to have happened to a number of ELLs when working with other "everyday" words with different meanings in the realm of mathematics.

Another way that English can serve as a barrier for ELLs is in their own connections between the new language and their native one. A majority of these students have likely been taught mathematics in their native language; with the increasingly popular trend of simply mainstreaming ELLs, many of these students are not allowed the time they need to build connections between the mathematical concepts they understand in their primary language and the new English words describing those same ideas (Gorgorió et al., 2002, p. 23). It is essential that schools be adapted to allow students this time and that teachers are educated in methods to help these students develop a "bridge from the meanings of their initial situation to those of the present one" (Gorgorió et al., 2002, p. 23). Without these critical connections, ELLs may have a difficult time understanding if they are on the same page of mathematical knowledge as their peers; and if the students themselves are unable to identify their current level of knowledge in the realm of mathematical content, it is even more difficult for teachers and administrators to accurately determine where they should be placed. This makes it difficult to know whether students are being placed in mathematics classrooms based on their actual

mathematical knowledge, or based on their level of proficiency in the new language of instruction (Civil, 2012, p. 136).

2.4.3 The Difficulties of Teaching Mathematics Because of Language

As mentioned in the previous section, it may be difficult for ELLs to determine their mathematical knowledge in the new environment due to the potential language barrier many face. Because of this, teachers may also struggle in determining the needs of the ELLs as it is likely difficult for them to understand the ELLs' level of mathematical understanding. Furthermore, Schleppegrell (2007) explains the possibility that "even when they [ELLs] arrive at the right answers, students may not be building the internal understanding that comes through using appropriate technical language to construct the mathematical meanings" (p. 148). This adds another dimension of difficulty to teachers' ability to gauge the level of understanding of their ELL students.

The burden of mathematics teachers may be lessened if they happen to speak or understand their ELL students' language of origin. However, it is important to recognize that "knowing a language means more than knowing technical terms, and a having a bilingual translation is not sufficient for scaffolding the development of mathematics language in a second language" (Schleppegrell, 2007, p. 154). Further, a bilingual Spanish teacher would need to have learned mathematics in Spanish to be able to accurately convey the deeper conceptual meanings associated with the mathematics (Schleppegrell, 2007, p. 154). Thus, though understanding languages other than English may give teachers an additional method to communicate with their ELLs (if they happen to speak the same language), it may still not be enough to give

the student all of the necessary parts of mathematical understanding that they will need.

2.4.4 Methods that Teachers Can and Should Use to Help ELLs with Language Problems in Mathematics Classrooms

The first step that teachers must take to become better resources for their ELLs is to recognize that mathematics and language truly are integrated if they do not think so already. Without the realization and internalization of this fact, teachers will be unable to even address the fact that a problem exists (Janzen, 2008, p. 1017). Upon the comprehension of this issue, teachers can then "move away from simplified views of language and interpreting language as vocabulary, single words, grammar, or a list of definitions," as this attitude can result in teachers missing ELLs' participation in mathematical practices (Moschkovich, 2013, p. 50). Thus, it is necessary for teachers to recognize the complexity of language, especially in relation to mathematics (Moschkovich, 2013, p. 51) so that they can then attempt to develop the necessary techniques "that will assist students in connecting everyday language with the language of math" (Janzen, 2008, p. 1017). With this newfound understanding, teachers can expand their conceptions of their role as a math teacher to include the necessary part as a "language teacher and cultural facilitator" as well (Borgioli, 2008, p. 189).

Another important concept for teachers to recognize is the fact that because mathematics relies so heavily on language, this can pose a large barrier for the ELLs in learning the necessary materials. Within this context, teachers must acknowledge and understand the issues each student has with the language and consider how

linguistically complex the current unit is before actually diving into teaching. These things need to be kept in mind for the teachers to be able to provide a well-structured and informative lesson that the ELLs will actually benefit from (Garrison & Mora, 1999, p. 36). Along these same lines, it is also essential that teachers spend time thinking about the structure of each lesson and consider how they, as educators, "can best support students to learn vocabulary as they actively engage in mathematical reasoning about important mathematical topics" (Moschkovich, 2013, p. 46-47).

The last essential realization and decision that mathematics teachers must make to be able to support ELLs in learning mathematics involves an attitude shift. The current outlook toward ELLs in both the U.S. and Spanish Language Learners (SLL) in Spain (as explained earlier in section 2.3) is a deficit model (Borgioli, 2014, p. 189). This is unfair to not only ELLs, but also to their English-speaking peers. Teachers must recognize and emphasize that the linguistic and cultural differences that ELLs bring to the classroom provide opportunity rather than adversity. This attitude shift along with the recognition of ELLs' struggles can then serve as the beginning of a classroom shift toward a more equitable atmosphere for ELLs.

What is equitable teaching? Dr. Judit Moschkovich (2013) defines equitable classrooms as:

> Those that (a) support mathematical reasoning, conceptual understanding, and discourse—because we know such mathematical practices lead to learning important mathematics, and (b) broaden participation for students who are learning English—because we know that participation is connected to opportunities to learn (p. 45-46).

Other research studies go on to explain the necessity that these classrooms provide a respectful and non-threatening atmosphere that allows all students, including ELLs, to feel that their contributions are valued and honored (Borgioli, 2008, p. 188; Moschkovich, 2013, p.46).

In equitable classrooms, ELL and native English speaking students will feel comfortable when contributing their ideas, which in turn can foster a community where mathematical discourse is common and encouraged. This is the goal of all mathematics classrooms as "a focus on language is critical for student learning in the classroom" (Janzen, 2008, p. 1017). Furthermore, it is important that in this discourse, teachers support students' (and especially ELLs') use of mathematically technical terms in their efforts to "talk their way through problems or make verbal explanations of their reasoning" (Janzen, 2008, p. 1021).

In addition to a particular focus on mathematical language in discussion within the classroom, teachers should provide structure allowing ELL and non-ELL students to interact verbally with one another. This emphasis on reciprocal teaching and group work was expressed in the research studies of Garrison & Mora (1999), Schleppegrel (2007), and Janzen (2008). Garrison and Mora (1999) specifically emphasized that group work can provide ELLs with a less intimidating setting where they can reason through their understanding of the mathematics, and that these opportunities can allow the students time to develop their listening and speaking skills in the new language of instruction (p. 42). On the other hand, though Schleppegrel (2007) agrees that group work is helpful for ELLs, she also cautions that, "Interaction with peers alone will not lead to the development of the mathematics register.

Students working in groups are not always able to express their ideas clearly or understand each others' explanations" (p. 148). Thus, teacher interaction throughout the entirety of these activities is necessary in monitoring the development of accurate mathematical discourse among all students.

Instruction of ELLs can also be enhanced through the use of technology, visual representations, and connections to tangible objects. In Janzen's (2008) investigative paper on teaching ELLs in each of the content areas, her section devoted to mathematics references a research study including of the use of a specific technology program: The Geometer's sketchpad. This program gave students immediate feedback on the correctness of their answers, and Janzen found that ELLs performed better in the experimental group as opposed to the control group (traditional textbook-based instruction) (p. 1020). Along these same lines, Dr. Moschkovich (2013) explains that successful instruction should "draw on multiple resources available in classrooms (objects, drawings, graphs, and gestures)" (p. 50). This idea of using the various resources that are available also extends to Garrison and Mora's (1999) report that relating vocabulary to tangible objects can make words easier to remember as "students can see and touch the objects they represent while repeatedly hearing and saying the new words" (p. 41)

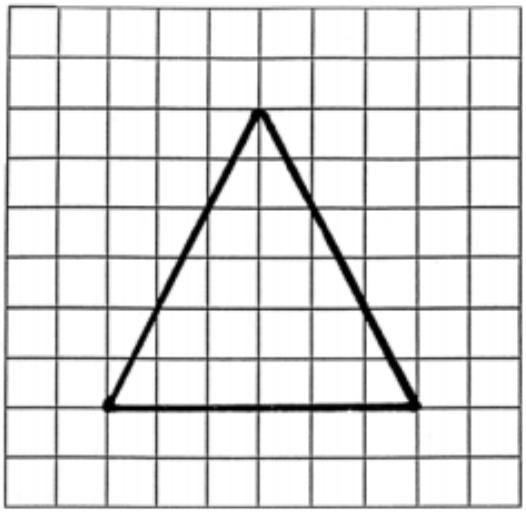
Another essential way to allow ELLs the opportunity to break into the mathematics that is presented in the classroom is for teachers to make connections to all students', but especially to ELLs', lives. This comes naturally for teachers when they begin to accept and emphasize the fact that ELLs enrich classroom dynamics rather than take away from them. With this attitude, teachers are then more likely to

make a concentrated effort to incorporate multicultural contexts (Civil, 2012, p. 131) and to create connections between "student's knowledge or interests" (Janzen, 2008, p. 1021) and the mathematics. These connections are helpful in not only fostering a higher level of engagement among students, but also in creating "higher level cognitive demand tasks that are comprehensible to ELLs" (Borgioli, 2008, p. 187).

The last and possibly most important researched method for helping ELLs in mathematics classrooms is allowing and encouraging the use of the students' native language as it "can help them in their learning of mathematics" (Civil, 2012, p. 135). This idea has been emphasized by a myriad of people and can be presented in a number of ways. Borgioli (2008) mentions the effectiveness of a word and picture wall for mathematical concepts and definitions using English and the various native languages of the ELLs in each class (p. 189). Another method is the preview-review technique as described by Garrison and Mora (1999) where students are first exposed to a new concept in their native language, and then later, the concepts are reinforced in the second language by focusing on "the new labels and vocabulary used to describe the previously established concepts" (p. 37).

Garrison and Mora (1999) continue to extend this method of allowing native language work to written explanation of mathematical understanding. Their article suggests that teachers allow students to write their logic behind a particular problem in their native language, and then if the teacher has no experience with that particular language, students can take additional time to attempt to translate their thinking into English. Though this may seem counter productive, it is actually easier for the student as their initial work was solely focused on the mathematical understanding, and in the

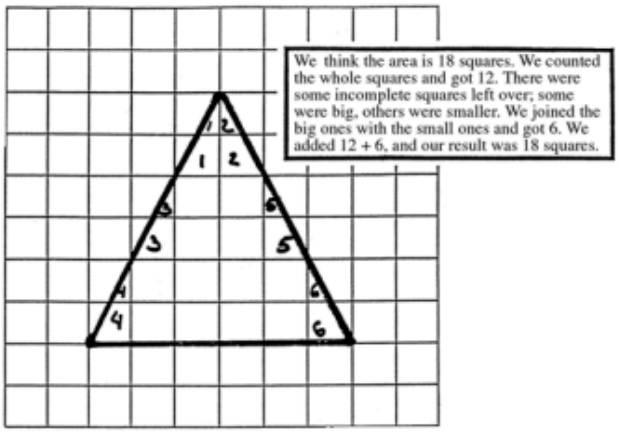
second part, they only need to focus on the language (Garrison & Mora, 1999, p. 43). Garrison and Mora provide a specific example of student work and explanation and the vast differences between her justification in her second language of English, and her native language: Spanish (see Figures 4 and 5). This provides an incredible illustration of the fact that ELLs can "answer more completely in their primary language" (Garrison & Mora, 1999, p.43).



because we count the squares.

Fig. 5.1. Janet's incomplete response in English gives little information about her understanding of the concept of the area of a triangle.

Figure 4: Student's Incomplete Explanation in English Source: Garrison and Mora, 1999, p. 43



Nosotras pensamos que el area es 18 cuadrados. Nosotras contamos los cuadros que estab enteros y eran 12. Sobraron algunos cuadros incompletos. Unos estaban mas grandes y otros mas chicos. Juntamos los grandes y chico y salieron 6. Sumamos 12 + 6 y nuestro resultado fue 18 cuadrados.

Fig. 5.2. Janet's response in Spanish gives a greater insight into her grasp of the concept of the area of a triangle.

Figure 5: Student's Detailed Explanation in Spanish Source: Garrison and Mora, 1999, p. 44

2.5 My Research Questions

Based on this background knowledge, I wanted to explore the current attitudes that mathematics teachers have toward their ELLs in their classrooms. I also wanted to understand the participants' level of dedication to ensuring that ELLs have an equitable experience in their math classrooms and whether they felt they had access to resources to help those students. Furthermore, I hoped to explore the methods these teachers used to help their ELLs and find whether they thought it necessary to target the issue of language in particular. Based on this, my research questions are:

1. What resources are currently available to teachers that are specifically targeted toward helping ELLs?
2. How are these resources implemented?
3. What other resources could be helpful in these kinds of environments?
4. How do these teachers help their ELL students learn mathematics?

In the next chapter, I will describe the methods I employed to answer these research questions.

Chapter 3: Methods

In this section I will explain the procedure I followed to collect my data, which includes the development of interview questions, the recruitment process, and the methodology of the actual interviews. I will additionally outline the data analysis process that took place after formal data collection and transcription were both completed.

3.1 Recruitment Procedures

My goal was to recruit between 10 and 15 participants. To find potential participants, I accessed the teacher directories of four local school districts through their public websites. Once I found each list of faculty members, I simply copied and pasted the email address, first name, and last name of all those who were indicated as mathematics educators onto a master list of potential participants. This list included 28 different middle schools and a total of 203 emails sent to teachers. After exhausting these four school districts, I used my list to send the pre-approved recruitment email to each teacher (See Appendix A).

Following the process approved by the OSU Institutional Review Board (IRB), I waited two weeks, and then sent a follow up email to the same list of teachers (See Appendix B). In the time between sending the first and second emails, I only received one positive response from the 203 teachers I contacted. After sending the follow up email, I received three responses kindly declining participation and two positive responses reflecting interest in my study. The lack of responses led me to appeal my original request. The search was expanded to middle *and* high school teachers in the same area, adding 17 schools and 154 potential participants, but unfortunately still did

not yield a high enough interest. I appealed to the IRB for a second time and expanded the scope to include public middle and high schools in three larger school districts. This expansion included 656 new teachers from 43 middle schools and 23 high schools. I additionally rewrote my initial emails to be more personable and included information about myself as a hopeful future educator (See Appendix C). These new emails and expanded scope resulted in a much higher response rate including 19 positive responses and 8 responses kindly declining to participate. After waiting the required two weeks, I sent my last round of follow up emails (See Appendix D) and received 12 more positive responses and 12 kind dismissals. This increase in response allowed me to proceed with the scheduling of interviews either on the phone, or in person with each teacher who responded positively.

Table 1: Participant Information

Pseudonym	Education	ESOL [1]	Language background	School/ Classroom Diversity
Sarah	Bachelor's degree in educational leadership, Master of Arts in teaching endorsement: secondary mathematics	No endorsement, has a certificate	High school French, some Chinese and Sign language	59.5% Free and Reduced Lunch, 10.9% Transitional Bilingual, 24.7% Hispanic, 3.4% Asian, 5.5% African American, 56.8% white
Matt	Bachelor's degree in finance economics, Master's degree in education	Yes	Four years of high school Spanish	80% Hispanic and Latino, 5% White, 5% African American, 10% mixture of Native American, Pacific Islander, and Asian. 100% Free and reduced lunch

[1] ESOL refers to English Speakers of Other Languages. This title is used by the state of Oregon to describe its endorsement program for public school content specific teachers.

Table 1 continued

Kevin	Bachelor's degree in teaching with certifications in music and mathematics.	No	Spanish at college level. Self described as "proficient"	60% Hispanic and Latino, Large number of ELL students
Anthony	Bachelor's degrees in math and history. Master's degree in teaching with an emphasis in math	No	Two years of high school Spanish	School population between 2400 and 2500. 75% of students speak Spanish at home, 80-90% of students in poverty.
Jeff	Bachelor's degrees in English and education	No	Some Spanish in high school and college. Self described as "not proficient"	34% Hispanic and Latino, 37% White, Roughly 20% African American, and 15% Asian or Pacific Islander. About 35% ELL and 97% free and reduced lunch
Carrie	Bachelor's degree in math, Master's in teaching	No	Spanish through high school, exchange program in Mexico	Class 1: 1 White, One Hispanic, remainder African American. 11 absences of 24. Class 2: One Russian, two white, three Hispanic, remainder African American
Melissa	Bachelor's degree in sociology criminology, Master's degree in teaching, working on Ph. D. in education leadership with an emphasis in science education	No	High school Spanish. Working proficiency	School: 72% free and reduced lunch, 20% ELL. Classroom: 70% ELL, all but one free and reduced lunch, all but one suspended

Table 1 continued

Greg	Bachelor's degree in Math	No	None	30% Hispanic and Latino, 70% White
Jack	Bachelor's degree in math, Master's degree in Education Endorsement: secondary math	No	Small background in Hebrew ad French	Largest student body: 33% Latino, followed by White, African American, Pacific Islander, Native American. Diverse Linguistically

3.2 Interview Procedure (Or Data Collection)

Each interview included a one-on-one conversation between the participant and myself either over the phone or in person. The participant decided on the meeting place, time, and method via email communication for the sake of their convenience. Each interview was set to last no more than 90 minutes. Before the interview officially began I read the IRB approved consent form (see Appendix E) to the participant and obtained verbal confirmation that they understood the scope of my study. After obtaining their consent, I began audio recording and asked the interview questions in Appendix F and additional clarifying questions if necessary. The interview lengths ranged from as short as 12 minutes and 53 seconds to as long as one hour, 26 minutes, and 45 seconds. At the conclusion of each interview I stopped the recording and thanked each participant for his or her time.

3.3 Thematic Analysis

I followed the examination process of thematic analysis as outlined by Braun and Clarke (2006). This particular approach focuses on the identification, analysis, and report of various patterns within a dataset and is advantageous to use because of

its flexible nature (Braun & Clarke, 2006, p. 6). Before beginning the formal analysis process, Braun and Clarke recommend that explicit decisions be made about the focus of the analysis. I decided to follow their definition of an inductive approach: "Inductive analysis is… a process of coding the data without trying to fit it into a pre-existing coding frame, or the researcher's analytic preconceptions" (Braun & Clarke, 2006, p. 12). I chose to pursue this approach rather than the deductive because I wanted to let the data speak for itself. To me, deductive analysis would bring too much of my own bias into the process. I preferred to keep my preconceptions from interfering with the true meaning that each interviewee was trying to convey. Further, I chose to pursue the study of latent rather than semantic themes in an effort to "examine the *underlying* ideas, assumptions, and conceptualization" (Braun & Clarke, 2006, p. 13) of the interviews. Semantic themes emphasize a focus on only the surface meaning that the data presents. The interviews I conducted were rich in their potential to be analyzed at a deeper level, which is why I decided to focus on latent themes. Once these critical selections were made, I proceeded with the six phases that are explained below. These phases are addressed in the following five sections.

3.3.1 Familiarizing yourself with the data

After conducting all of the interviews, I reviewed the notes I took during each conversation to begin the familiarization process. I realized that some of the interviews I conducted did not provide much of a perspective about ELLs and thus decided to code each interview based on its relevance to my topic. Some of the educators I interviewed had very little experience working with ELLs or were unwilling to share much about their experiences, while others were eager to give

specific examples and spoke at length about their work with this student population. This distinction was easy to make and resulted in the following scheme with four different options: green, light green, yellow, and red. Green reflected those interviews that would be most important to my research and red, the least. After discussing this coding scheme and the specific interview notes with my mentor, we decided to transcribe only the green and light green interviews. These nine separate audio files were sent to Vanan Transcription services and transcribed professionally non-verbatim (excluding pauses, ums, and uhs).

After the transcriptions were completed, the true familiarization process began. I de-identified each transcribed interview by constructing pseudonyms for each participant and removing any names or places mentioned by the interviewee. I also read through each transcript a second time while also listening to the interviews to ensure that the transcriptions matched the audio recordings.

3.3.2 Generating initial codes

Continuing in the familiarization process, I began my third read through with a few initial codes in mind. I began with five colors and while reading, highlighted any parts of the transcripts that seemed to resonate with the color code.

- Green: Perceptions of ELLs
- Pink: ELL participation
- Yellow: Emotions/ response to being an ELL
- Blue: school support or lack of
- Red: Idea that methods for helping ELLs is actually beneficial to all students
- Dark Yellow: Struggles

Through this process, I realized that my data was not organized well enough to find these themes in an effective manner. To help organize the data, I created an excel spreadsheet with the participant ID numbers and pseudonyms listed across the top as the column headings and the questions listed along the left side as the row headings (refer to Table 2). At this time, I had the idea to create an additional sheet dedicated to descriptive information about each participant, labeled "participant info". This included each participant's education, experience, whether or not they had an ESOL endorsement (or its equivalent), their language background, background working with ELLs, classroom diversity, and school diversity. These details can be seen in table 1, which describes the participants.

Table 2: Participant Responses

	Participant number and Pseudonym			
Question:	149: "Sarah"	286: "Matt	…	900: "Jack"
Please explain your background in Education and Mathematics?	Response in transcribed words- same for all other blank boxes.		…	
Why did you decide to become a middle or high school math teacher?			…	
…			…	
Are there any other thoughts about your teaching that you would like to share?			…	

3.3.3 Searching for themes

My thesis mentor and I met to discuss the questions included in my interview. We decided together that there were seven key questions that would give us the most information about the participants' attitudes toward ELLs. These questions also gave us the best insight into their strategies and methods as a teacher.

- If the diversity has changed over time, have the classroom dynamics changed in any way? If so, how have they changed?
- What have you learned teaching mathematics to English Language Learners?
- What are the most important things to keep in mind when teaching algebra to English Language Learners?
- When students struggle with mathematics, how do you help them? What are some of your techniques? How did you learn those techniques?
- If your students struggle with mathematics, what would you say their biggest struggle is? Why do you think they struggle with that (topic)?
- Have you noticed whether your ELL students work on mathematics differently from the non-ELL students? If so, what have you noticed?

I created a separate sheet for each of these questions and included not only the participant's answers to one of the seven questions above, but also included their answer to the question "Please explain your background with English Language Learners." My thesis mentor and I thought that the participants' answers to this question might help in my understanding of the reason behind their answers to the focus questions. After reading through the answers to these key questions, I summarized the ideas each participant reflected in notes on each sheet and began making connections among answers to different questions and across different

participants. At this point, some key themes became apparent and I created even more excel sheets- one for each potential theme:

- Technology in the classroom
- Classroom norms[2]
- Teachers' perceptions of ELLs' attitudes
- Idea that ELL struggles are equivalent to non-ELL struggles

I then read through the participants' answers to the key questions and began pulling extracts that were relevant to the themes making sure to organize by participant and to mark which question was being answered. After reading through the seven questions, I did a quick scan of my initial sheet that included the entire conversations and made sure I had not missed any pertinent information. At this point, I again checked in with my thesis mentor and clarified one theme that we had been misunderstanding. I had included more than was necessary in the "classroom norms" theme and decided to create another potential theme entitled "life norms of ELLs" that included more personal struggles that ELLs face outside of the classroom. At this point in the analysis process, I had five themes.

3.3.4 Reviewing themes

After making this small clarification, I went through the excel sheet and began to highlight the participants' statements I found to be most relevant to the theme.
I then created a new excel workbook strictly dedicated to these five themes and broke each theme into various subthemes, including quotes as evidence for each one. The subthemes for each theme were as follows:

- Technology in the classroom: *lack of technology, useful technology*
- Classroom norms: *working in native language, reciprocal teaching/working together, vocabulary/language emphasis, deliberate scaffolding, visuals, language and cultural barriers, ELL confusion/lack of understanding, ELL preparation, extra help*
- Teachers' perceptions of ELLs' attitudes: *work ethic/attitude toward school, reciprocal teaching, vocabulary, ELLs' background knowledge, parental involvement/support*
- Idea that ELL struggles are equivalent to non-ELL struggles: no subthemes
- Life norms of ELLs: *school specific, life in general*

Once I sorted each category into its respective subthemes, I sent this excel sheet to my mentor and met with her to hear some feedback. We decided together that there were two broader ideas running through the five themes presented above and each theme's various subthemes. These included **Teacher Interventions** and the **Issue of Language**.

At this point, I thought we had decided on the two final themes; however, after spending time finding evidence of each theme and trying to come up with new subtheme ideas within this new framework, I began to get confused. The two themes were so interwoven that I could not seem to separate them into two concrete and independent ideas. I found various quotes for each theme and began reflecting on them, then met with my mentor for her input again.

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[2] By 'classroom norms' I mean things that ELLs experience on a daily basis in their mathematics classrooms. This could include anything as basic as the provision of a warm up every day, to something as complex as ELL interactions in the classroom.

3.3.5 Defining and naming themes

The struggle with the "finalized" two themes led to a productive discussion about the nuances of each theme. My mentor and I debated for quite some time and thought more on our own to consider the two themes. We came back together and realized that there really was only one overarching theme of **ELLs and Language**, with subthemes: *resources, intervention methods, and the broader effect of the language barrier on ELLs.* These themes and subthemes were finally representative of the data and communicated the most important ideas presented by my research participants.

3.4 Producing the Report

The final step in thematic analysis is to produce the report. In the following chapter I will write at length about the theme of ELLs and Language with a particular focus on whether or not teachers are provided with resources to help ELLs, if they are, how effective those resources are, the necessity for the participants to create interventions targeted at helping ELLs, what those intervention methods are, and the greater impact of the language barrier on ELLs learning mathematics and on their school experiences. I will provide evidence for each of these ideas through the provision of quotes from my interviews with Sarah, Kevin, Anthony, Jeff, Carrie, Melissa, Jack, Greg, and Matt.

Chapter 4: Findings

In this chapter I will present the pertinent findings of the transcribed interviews within the one major theme and three subthemes illuminated through thematic analysis. After creating an initial sorting method including a wide variety of potential themes, through further reading and inspection, I found one overarching theme that I confirmed with my thesis mentor who also read through the participants' statements. The most important theme that emerged from the thematic analysis was *ELLs and Language* presenting relevant information about ELLs' experiences with language in and out of mathematics classrooms. There are multiple subthemes within this larger categorization that will be described in further detail later in the chapter. I will provide evidence of the theme and subthemes with quotes from my transcribed interviews and will additionally deconstruct the comments made by each teacher.

4.1 ELLs and Language

Within this overarching theme, there were three subthemes that emerged as relevant through the participants' statements. These included *Teachers' Use of Resources, Intervention Methods, and The Broader Effect of the Language Barrier on ELLs.* In my original coding scheme, the initial idea was to analyze the classroom norms that ELLs experience daily in the schoolrooms of the interviewed teachers. Upon further inspection, I realized that, stretching across many of the interviews, was the necessity for these teachers to create their own interventions and support systems for ELLs mostly due to the barrier created by language. It became commonplace for teachers in my study to supplement their teaching of mathematics with a variety of access points for ELLs because many would be left behind without them. The lack of

district and school support is noteworthy and requires these teachers to create resources for their ELL students, which in turn has an effect on theses students' ability to learn mathematics. These intervention methods and the greater issue of the language barrier are having a palpable impact on ELL students, particularly in their classroom placement. Thus, the reason for these interventions, the ways these teachers help their ELL students, and the effect of all of these factors on ELLs' ability to learn mathematics and overall experiences in school became the three subthemes that are supported by my data.

4.1.1 Teachers' Use of Resources

When presented with the question: "When students struggle with mathematics, how do you help them? What are some of your techniques? How did you learn those techniques?" many teachers responded by talking about their experiences with district provided resources, specifically for ELLs, or the lack thereof.

One teacher, Kevin, had access to the most useful resource, which he explained in response to the question above:

> They gave me a bilingual IA [instructional assistant]. Ideally just written translation is not what I would love to have going on because it's some delay and it's noise that's happening while I'm trying to explain things, but in that case, if I don't have somebody translating, then they're just sitting there getting absolutely nothing…No, they were repeating basically … in Spanish. But the instructions that I was giving, it was a verbal translation.

Though Kevin's explanation is slightly confusing, the district-provided resource he had access to at the time of the interview was a bilingual IA. In his classroom, it seems that the IA was seated with the students whose first language is Spanish, and while Kevin was teaching, the IA's job was to verbally repeat everything to the students in their native language. This is a resource that none of the other interviewed teachers had access to, and though it seemed more effective than the students "just sitting there getting absolutely nothing," Kevin's comments reflected his qualms with the process. In regards to this same situation he later stated, "It was hard to have to work around that situation, but I really didn't see another option for those kids in that classroom." Kevin saw the verbal translation as a distraction, but as necessary to support the ELLs learning of math. Though the resource may have been helpful, it is also possible to have taken away from the experiences of the non-ELL students in Kevin's classroom. Furthermore, although Kevin had access to the best resource among all of the interviewed teachers, he still found it necessary to supplement his teaching with other interventions to help his ELL students. This will be explained later in the chapter.

In contrast, Carrie was the research participant among those I interviewed with the least amount of ELL support. One of her comments referenced promises made and not kept:

> In [city A] public schools, one way students meet their graduation requirements is by doing work samples. Work samples are word problems, students are supposed to be able to do them in their native

> language and we do not have Somali or Spanish ones-- the district is supposed to do that.

Carrie's district claimed to support ELLs through the provision of work samples in their first language, but appears to have neglected to follow through with this resource. This lack of follow-through extended even further in Carrie's experience in the realm of written translation for her student from Somalia. Carrie commented,

> There's a guy in the district who is supposed to be our contact person for Somali students, he hasn't got back to me so I'm going to try calling him …because I need someone to translate or I need to have a good tool to translate because we got final exams coming up.

The interviews were conducted in the spring. Assuming that this student began the school year in the fall, this would indicate that this "Somali contact" had not responded to Carrie in six to eight months of her instruction of this child. The promise of ELL aid and apparent lack of help is troublesome. Carrie and other teachers in her district were not provided with adequate support at the time of the interview, and likely still to this day, making it difficult to imagine that these children can be successful in learning mathematics.

Carrie continued to explain the situation with this student, which brought an even more alarming situation to light, "I think there's one other student who speaks Somali but… nobody can communicate with him." Carrie obviously cannot speak Somali, and her ability to do so was not a part of her job description as a math teacher; however, this student's inability to communicate with anyone throughout his day at school is worrisome. Without adequate resources, this student might feel

isolated at school and this isolation is likely to have an impact on his ability to learn and enjoy his education.

In a less extreme case, Anthony explained his experience with district-provided written translation:

> One of the things I tried at first getting all the stuff translated because if I had it electronically, I send it to a person and they translate it and send it back. But when I start, I notice with some of my kids, I had a lot of kids, they're a group of kids who are straight out of Mexico from the summer. They're coming straight here with whatever English they pick up in Mexico and over the summer, the translation I don't know if it was too formal, the translation or just the vocabulary, they got to where they didn't really like translated stuff so I was having better luck with when I paired the kids, trying to get one of my ESL[3] students whose really good a math and I would get them to translate back and forth for each other.

The district provided a potential resource with the translation of electronic materials, but the formality of those translations proved to be ineffective for the students. If the students cannot understand the translations that are provided, this resource is more likely a barrier than a tool in Anthony's classroom. Additionally, the effort to obtain such a resource would be significant.

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[3] In this context, ESL is equivalent to ELL and stands for English as Second Language Learners, which refers to a student who is not completely proficient in English. However, it is important to note that in different contexts, ESL refers to the curriculum used to help ELL student learn in specific content areas.

For example, to gain access to the translations, Anthony had to communicate with the district to give them his electronic files far in advance of the actual activity, then wait for those files to be translated, and eventually present those materials to his students who would immediately realize that the formality of the language made it difficult to understand. Anthony's comments show that even if district support is provided, it is not a guarantee that the resource will actually prove useful to ELLs.

4.1.2 Intervention Methods

Though the provision of translations can be seen as helpful, in practice, Anthony had more success with the creation of his own interventions, one of which was pairing two students who spoke the same first language and allowing them to work together in their native language. This support method was employed by a variety of the interviewed teachers including Sarah, Anthony, Melissa, and Kevin.

Melissa explicitly mentioned this intervention method when presented with the question: Has the diversity of your classrooms changed since you became a teacher? If so, how has it changed? Melissa began to explain the large district shift that took place in her time as a mathematics teacher at this particular school:

> When I started at the school, we had a very small ELL population, like under 10%. Then the district made some shifts and the ELL students used to go to one middle school, and they were all shifted to our school. We went from around six to 10%. I forget what our percentage is now. I'm not sure what our percentage is. I don't remember but I think we had maybe 20 ELLs when I started and we have, I think it's over 150 now. Those are just the kids who are designated ELL. That's

> not including the fact that we have so many dual language kids or multiple language kids.

According to the district website, if Melissa began teaching 13 years ago as she stated earlier in her interview, at that time, the middle school she taught at was designated as 0% Transitional Bilingual, 0% Migrant, 0% Special Education, and 37.3% Free and Reduced Lunch . In contrast, in the 2014-2015-academic year, that same school reported: 10.9% Transitional Bilingual, 0.2% Migrant, 9.1% Special Education, and 59.5% Free and Reduced Lunch. Melissa's impression of the district shift is reflected in these reports and she later explained that these changes had a tangible affect on her teaching methods. Melissa was next asked: If the diversity has changed over time, have the classroom dynamics changed in any way? If so, how have they changed? In her response she stated:

> We now have the dual language program, which is either Spanish where half the day is in Spanish and half the day is in English. We have that. We have a lot more language diversity in the classrooms. It is very common for two ELL kids to want to sit together and the teacher gives the lesson in English but as they work on the assignment, they're working on it in their native language which there wasn't a lot of that when I first started here.

The addition of so many ELLs led to the new classroom norm of these students working in their native language. Though Melissa ends her contributions about work in native language at that comment, it is apparent

from her statement that the ELLs benefit, or at least enjoy working together in their native language.

Sarah also mentioned this particular intervention method, but included more about the specifics behind the approach and its importance:

> I'm actually doing the reviews that we've done or done a vocabulary review where they make like an ABC book, and this one boy said, 'Well can I do to Spanish terms? Can I define it English and then define in Spanish?' and so I said, 'Okay, that's cool.' It probably helped them understanding a lot more.

Sarah's focus was on the learning of her ELL students. She encouraged them to work in the manner that she thought would foster a better understanding of mathematics and was willing to be flexible when her students asked to work in ways that would help them learn. Sarah took this idea even further in her review activities where the work in various languages was brought back to the entire classroom:

> When we were doing review activity, I would have one group do a poster and I have them do it in Spanish, and I had another group do it in the Russian, Ukrainian, and then another do it in English. Then I have them all three, like the same content post it on my wall in all three languages.

This incorporation of the native languages of all of her students is insightful and supportive. In doing this, Sarah has created a classroom environment where her students can share their backgrounds with the native English speaking students in a productive and mathematically focused way.

Later, she explained the importance of emphasizing this intervention method in her and other teachers' classrooms: "it is fine with me if they speak in Spanish to get help with the math. I had a girl last year that that really helped her a lot. Maybe that's something that needs to really be said specifically … by teachers." This idea of not only allowing, but also encouraging the work in one's native language is extremely beneficial to ELLs and non-ELLs. The ELLs are getting the opportunity to internalize the math that they are learning by exploring the English and (in this example) Spanish words, while the non-ELLs are being exposed to another language and culture.

More generally, Sarah stated, "sometimes talking about it in their language helps them. If one person, the person with the better English or the better understanding can explain it in another language." She saw that the use of one's native language can, in a way, remove the language as a barrier to the learning of mathematics. The only drawback of this idea is that Sarah was then reliant on the other student's understanding of the math. Jack echoed these concerns when asked about the most important things to keep in mind when teaching algebra to ELLs:

> They need to be checked in regularly because there are ideas or instructions that … will be misinterpreted if they are not checked in with regularly. The reason is, often when a student doesn't understand, some of them turn to their peers to help, but if the only peers who are helping also have difficulties with language, the same difficulties, then everybody is misunderstanding it and they hear the wrong direction. A group of students might be doing something completely wrong... And

> I've experienced that personally, that's heartbreaking, to see people waste their time. The thing I've learned is just to make sure I'm checking in as much as I can.

Jack's statement that "everybody is misunderstanding" seems a little harsh to ELLs. It is more accurate to say that each situation depends on the individual's level of English and mathematical understanding. However, overall his point is fair. Relying on students who struggle with a language to explain a mathematical concept, which is being taught to them in their non-native language (English), is somewhat risky. Thus, though working in one's non native language is a good practice and can be helpful to the ELLs as reported by Melissa, Kevin, Anthony, and Sarah, it is important to continuously check in with the group of students to ensure that those who are explaining the ideas to their peers actually have a sound understanding of the mathematical concepts.

Another intervention method that is closely related to the encouragement of native language talk between students of similar backgrounds is the idea of reciprocal teaching and group work. Sarah, Anthony, Kevin, and Melissa all made explicit references to using this method to help ELLs in particular, while Jeff and Greg mention group work as an essential part of teaching math to all of their students. Jack lies somewhere in between these two ideas and made weaker references to group work being beneficial to both ELL and non-ELL students.

In general, most participants conveyed that student-to-student interaction is beneficial for the learning of all students, and also for ELLs in particular. Kevin

expressed this idea after being asked about his methods for helping students when they struggle with math:

> Typically one of the helpful things about grouping is that you'll allow students to explain things to each other in a way that might be difficult from what even I explain it. I do my best trying to explain things to multiple perspectives, but for whatever reason, a student explaining it to another student can potentially be a lot more effective than me explaining to a student the second or third time no matter how many ways I'm just come at it from a different angle. Having student to student talk and having reciprocal teaching between students …is really effective, especially if you have two students with the same language background … and you can use more students to help teach another student the same thing.

Kevin, along with several of the other teachers I interviewed, saw the value of learning from one's peers. Students often think similarly to one another, so it is natural that they would be able to understand each other at a different level than the level at which they can understand their teacher.

Sarah is another participant who promoted the use of reciprocal teaching amongst students: "I also try, also ask the students to explain to each other how they -- how do you solve this problem and I'll get them to explain it to each other." However, she took this idea a step further in her later comments by stating:

> Well, I always try to get information from the kid, from the students about how to explain the math, like when someone understands

> something then I will… ask them to explain this in the class but then I will remember what they say and I will use that.

Sarah not only encouraged her students to explain ideas to one another and to the entire class, but she also remembered their wording and reuses these ideas to teach the mathematics in her later classes. This idea is notable – Sarah was learning from her students and finding new ways to present information from her own students.

In addition to the generalized idea of the benefits of group work, Anthony provided an excellent example of the power of peer mentorship among ELLs:

> We're starting actually a new algebra program next year where our kids are going to a different site. And some of these kids that are straight out of Mexico last summer are going to be our student aids/mentor/translators in our new algebra program just because there's really good students who came a long way in a year and they're going to be good role model for our next group of kids that come straight from Mexico next summer to say, "Hey, this is where you can be at in a year if you're willing to work hard." It's been interesting to see how the kids that are straight from Mexico, how well they work together and help each other to be successful because it would've been really easy for a good chunk of them just to say, all the other kids flunk, so no big deal.

This extension of reciprocal teaching into mentorship is special. This program provides the new students with not only an important ally in helping them understand mathematics, but also with a role model who was in their position just one year before.

This will give the new students an irreplaceable opportunity to have a resource who believes in them and who wants to see them succeed.

An alternative intervention used by teachers that seemed to be less helpful to ELLs was the use and integration of technology. This method appears to be a last resort for the two research participants who mention its use. In a less extreme case, Jack stated, "Sometimes I tell them to look it up if I've tried everything. They seem to be really struggling, I tell them, 'Google it, Google the idea.'" It is difficult to know how students in Jack's classes are affected by this method; however, it is not comforting to know that his last attempt after "trying everything" is reliant on a Google search. Jack did not provide any insight into the resources provided by his school or district, or if there was a lack of this kind of support. In this case, it is difficult to tell if the use of this technology is a result of unhelpful or a lack of district support; however, it is fair to say that a reliance on the Internet is likely not the best way for students, ELL or not, to learn mathematics.

Carrie, the teacher struggling to help her Somali student explained a similar intervention method using technology and the Internet:

> I have him watch YouTube videos so I'll just pull up a YouTube video on how to solve an equation in Somali. Sometimes, when I'm desperate for him to understand something I'll just -- to have him get out his headphones and he'll watch a video and he'd just copy the examples when I give him a problem just like that and he does it correctly and I'm like 'good.'

Earlier, Carrie mentioned that no one could communicate with this student, resulting in his primary venue of education as YouTube. The lack of district support has made Carrie anxious for a way to help her student learn, and has resulted in her reliance on potentially inadequate Internet resources. This is further extended into her translation method:

> I translate their text on Google Translate. I don't know how good of a job it's doing. I think the Spanish is fine but the Somali sometimes when these translation tools translate like he'll type Somali for me to read something. It's never worked. I can't understand.

The end of Carrie's quote is slightly confusing, but what I understood when interviewing her was that, in her mind, the Somali translation was not likely to be very effective because every time her student typed something into Google translate in his native language, the resulting English translation was not understandable. She later mentioned that using Google translate was a daily occurrence with this student, making me wonder how much this child was actually able to learn. Carrie did not know if the translations she provided made sense to the student, and further, she had no way of checking his status of understanding because he could not communicate back to her. The use of these technological "tools" appears to be unhelpful with the Somali student.

Another more supplemental intervention tool is to use visual aids in the presentation of mathematics to ELLs. Jeff, Matt, Carrie, Jack, and Sarah all mentioned its use and provide visual aids through various techniques. Matt indicated the use of this particular method in response to the question about the most important

things to keep in mind when teaching English Language Learners by stating, "For me I use picture examples, so my visuals. There's fancy that, you know the pedagogy says use regalia. Use regalia, real life examples… And definitely for English Language Learners I would say use visuals." He did not provide specific examples, but does emphasize that the use of visuals is an important way to help these students.

More specifically, Sarah mentioned the relationship between visuals and vocabulary in their note taking method:

> Vocabulary is definitely important … for everybody, but definitely for those students, so emphasizing that… I really like the math notebooks as it gives them -- we do vocabulary for every lesson, it may introduce new vocabulary. We highlight it in different colors and we give an example of it, so that they can go back and they can look and review those words.

Sarah used this color-coding technique to emphasize the importance of mathematical language to her students and especially to her ELLs. This particular response was given after Sarah had been asked the same question: What are the most important things to keep in mind when teaching algebra to English Language Learners? This reflects the potential that her vocabulary presentation method was likely chosen with ELLs in mind.

After being asked the same question, Kevin extended this idea even further and included more explicit visual aids when presenting vocabulary ideas for even the second or third time:

> If I'm going to mention something that we went over the day before or if it was a week ago, then definitely I'm going to have to be very specific and very explicit with all of the vocabulary. I'm going to have to make sure that I have diagrams and pictures that I can also refer to. Because we spent a lot of time on it a few days ago, does not necessarily mean, especially for the ELL kids, that they're going to have the context to immediately put that back into the context that I assume that it goes with.

Kevin realized that his ELLs may struggle to contextualize the vocabulary if they are not being continuously exposed to it. His awareness in this situation is encouraging and shows his active engagement with his ELL students.

Two other participants who explained their use of visuals in an effort to help ELLs include Carrie and Jeff. These two teachers are important to make note of in regards to this particular topic because their responses appear to be slightly conflicting. Up until now, the examples of visuals have been in an effort to emphasize the importance of mathematical language in the classroom; however, some of the statements made by Carrie and Jeff almost seem to indicate that they are trying to replace language with visual cues. Jeff began by explaining his deliberate decision five years prior to change his teaching methods. When his school gained access to new technology, he decided to rewrite all of his lessons electronically onto PowerPoint presentations. He then explained his methodology related to visuals in more detail:

> Now that I've had a couple of years to refine a lot of ways, now I to try to find ways to take out the words that I would say out loud and try to find visual cues for those kind of things that are consisted of phrases consists like acronyms whether that be consistent graphics that mean certain things, consistent animations that I create that mean certain things or indicate like the next process or some sort of protocol in our classroom just to make it a lot less auditory maybe.

In this statement, it seems that Jeff has attempted to create visual cues and graphics that allow ELLs more access points to the materials, but in doing so that he may be avoiding auditory references to mathematical language. This idea is dangerous because though understanding the language may be difficult for ELLs, it is important for them to begin to develop that technical vocabulary they can build a solid foundation for further understanding of mathematics terms. Jeff continued his interview with the following:

> I don't want to say I take the language out of it because I really do try to incorporate as much discussion and interaction as possible, but to take the need to hear the words I say, that's the only way to get the math information. That's certainly a challenging way to approach learning math for students who don't know a lot about the language. I'm providing that chance to native English speakers, while also having a really comprehensive visual explanation of how to solve something, or some problem to be analyzed, provide other chance, another way to access the content, that's not just auditory.

Though his statement is slightly difficult to interpret, it appears that Jeff is saying that it is challenging for ELLs to understand math concepts if the only way for those students to access the information is through auditory communication. Because of this, as stated above, he has attempted to create a teaching method centered on the provision of numerous visual aids that ELLs may be able to understand better than his auditory explanations. Parts of Jeff's interview seem to indicate that his methods are intended to supplement his teaching of ELLs and to help break the language barrier that students are facing. However, other sections indicate that though his intentions are good, his methods may be resulting in a lack of actual exposure to mathematical language, which is unhelpful to ELLs. Overall, his explanations are difficult to interpret because of his conflicting statements, but this provides more evidence that teachers of ELLs struggle to find ways to help these students and need access to more resources or more education about research driven methods that have been proven to be successful.

This same idea is reflected in Carrie's response to the most important things to keep in mind when teaching ELLs:

> Well, I try to state things in as simple terms as possible. Using common language or using, comparing then contrasting. So saying it's like this, and speaking slowly and making sure that the environment is conducive to learning because they're hanging on my every word. They're trying to put together the pieces of this puzzle that I have no patience for disrupting that. It's hard, and also just making sure they understand the directions first so what's expected, what they need to

> do and then doing a lot of modeling. Drawing a lot of pictures and labeling them and going over the vocab.

Carrie's initial idea of stating things in "as simple terms as possible" is vague but potentially problematic. From her language choice, it is difficult to understand what she means by "simple terms." If she were trying to say that she is not using mathematical language when explaining mathematical concepts to students, then this would be detrimental to the development of their mathematical vocabulary, which would possibly hinder the students' progress in the next mathematics class. Her later comments are extremely encouraging. Her reference to "drawing a lot of pictures and labeling them and going over the vocab" reflects a helpful way to supplement her teaching methods with visual aids for ELLs' benefit. Overall though, both Carrie and Jeff's comments on the use of visual aids includes some vague language. This confusion in their communication reflects the fact that they struggle to find effective ways to help ELLs and emphasizes the importance of ELL training for all teachers, but especially to math teachers.

4.1.3 The Broader Effect of the Language barrier on ELLs

Another important issue that became apparent through the use of thematic analysis was the problems that ELLs are facing because of their difficulty in understanding the new language of instruction. One particular part of this is that the ELLs themselves may struggle to connect the mathematical concepts they have learned in the past with the same concepts that are being presented in English because of the language barrier. This point is illustrated perfectly by Kevin in his response to the question asking about important things to keep in mind when teaching ELLs:

"things that I would expect students at the high school level to be able to be familiar with, I can't make that assumption with our ELL students. They might know what it means but they might not know the English word for it." There is a significant difference being brought to our attention here: some students are struggling to understand mathematics concepts, while others are simply not connecting a mathematical idea to the specific English term for it. It seems that the districts of the teachers I interviewed unfortunately do not address this issue. Kevin explained this notion in his own personal experiences:

> I have some ELL kids that will come in from Mexico or from somewhere else and they'll be really sharp with their adding, subtracting, multiplying, dividing and their multiplication skills, they just need a vocabulary in a way that they can understand it. Then we also have kids that have transferred in with very little English that had very little math. It just depends but with the one size fits all Algebra for everybody that a lot of districts have, we're saying that if you come in with less than Algebra we're going to put you in Algebra and try to get caught up on all the things that you're missing, which is tough.

Here, Kevin is showing his understanding that all ELL students enter school at different levels of knowledge in the English language and in mathematics. From his comment about the "one size fits all algebra," it seems that the district may not be recognizing this important fact. Teachers need resources to help them understand the problems their pupils are facing and where those issues are rooted – in language or in mathematics.

This issue negatively affects not only the students, but also the teachers. Carrie reflects this idea in her responses about being unable to adequately translate for her Spanish students who have had less practice with English:

> He [student A] translates for me and when I can't figure out the words because I've studied Spanish a lot but it's been probably 10 years since I have been in an intensive Spanish program, that was a while ago when I did something like that and so forth. But I really, I really need to get up to speed on my Spanish.

It seems that Carrie feels it is her responsibility to improve or revive her Spanish skills to better serve her Spanish-speaking students, which may stem from feelings of inadequacy. This is unfair and not part of her job – she does not deserve to be feeling inadequate because, as a mathematics teacher, she cannot translate the mathematics into Spanish. Further, this idea can be extended to other math teachers who have no language background- it is possible that they could be feeling even worse for having no access to those skills whatsoever.

Additionally, this detachment between comprehending the true struggle that ELLs are facing can have a significant negative impact on the students themselves. If teachers are failing to understand that students are only struggling with the language, and not with the mathematical concepts, then it is possible for those students to be placed in lower math classes than perhaps they should be in. Melissa gives a powerful example of this very situation in her response involving the things she has learned teaching ELLs, but first explains that the classes she mainly teaches are "math lab" classes, which she described in this way:

> It is a block class. So most classes are 42 minutes but the block class is 84 minutes so it's a whole period of math. You're teaching at grade level but you're also going back and filling in the holes and the gaps that they have, because most of these kids are at least two years below grade level, but they are still required to learn the seventh grade content.

Melissa also shared the unfortunate impact of the disconnect between language and mathematics for a particular student who was consequently placed in a lower math class than her skill reflected.

> One thing I learned is, one year I had a girl in my class, who she had tested -- everybody's tested before they're put into the lab class and she was in the lab class. She could do any equation I gave her. I could show it to her and she got it. Word problems, she couldn't do. By the third, fourth week in the class, and since the beginning of the year, I'm like, "She doesn't belong in this class," it's not about her math ability, it's about the language ability. Here, she was put in a class with a group of kids who were two years below her and I had made the request that she be retested doing an equation test without any word problems and sure enough, she did not belong in that class. And we got an interpreter to come in and have conference with the parents and I said, "Look, she knows how to do the math, she doesn't have enough English skills to understand the word problems and that's what getting her scores down." Because when I went back and I analyzed her

> original placement test, the only questions she got wrong, were the word problems. It wasn't that she couldn't do the word problems, she didn't understand the language.

This is a notable instance when a student was placed in a mathematics class far below her capabilities simply because of her struggles with the language. Melissa realized that this student was capable of higher-level mathematics, and thus proposed to the administration that she be placed one year ahead (in 8th grade mathematics). This idea was rejected, which Melissa said was "understandable," and she then proposed that the student stay in her "math lab" class instead, allowing the student an extra period of mathematics, but that she, the teacher, would provide the student with 8th grade material. This idea was accepted, but then put Melissa into the difficult situation of providing two separate curriculums to students in the same class. This situation shows that even if teachers understand what issues these ELLs are facing as Melissa did, there is still a possibility that the district or school administration will hold that child back. Further, this shows the immense burden that can be placed on mathematics teachers who have their students' best interests in mind. However, it is important to note that this is just one example and further research would need to be conducted to adequately represent policies of this school or district.

Sarah found herself in a similar situation as Melissa, with a student from Russia who was able to do well in the mathematics, but was placed in Sarah's class because of language issues. In this case, Sarah was initially hesitant to advance the student because of the language barrier, but after the first quarter of the school year, she noticed that the student had been consistently performing well on the mathematics.

At this point, Sarah was still cautious about advancing the student, but approved the change after realizing that there were other Russian-speaking ELLs in the higher level class who could help her student with language issues. Two months later, the student was still performing well, consistently getting A's on assignments and tests, which affirmed Sarah's decision to allow the student to move up to a higher level of mathematics. This verification by the teacher illustrates Sarah's dedication to ensuring that the student be well prepared before advancing into a higher level of mathematics. Her caution demonstrates her care, but also her need for better tools in determining whether a student is ready to progress or not.

Another notable situation similar to the one exemplified above is the potential for ELLs to be incorrectly placed into special education. Greg spoke about this issue more broadly:

> One of the weird things is because ELL student gets -- they, I mean, you've probably researched this but they get put in special ed a lot of times when it really has nothing to do with their ability to do things. It just has to do with the language barrier so then they end up getting accommodations that they don't really need… It's a screwed up system.

Even worse than simply being placed in lower-level mathematics classes, some students are being incorrectly placed into special education. If needed, it is important that ELLs have access to the amenities provided by special education classrooms; however if their struggle were with the language and not with any mental or intellectual disabilities, this would be misguided and unhelpful. Further, it would be

placing more stress on the special education teachers by having one more student than necessary in an environment where one-on-one interactions are incredibly important.

In another equally alarming example, Sarah explained that one of her English speaking students was sent from a Spanish immersion program, which included mathematics in Spanish, back into a full English curriculum:

> I had a girl last year and I was just teaching pre-algebra…She had been in the Spanish-Immersion Program all throughout, and when they were doing that math was taught in Spanish and so she really struggled with understanding the vocabulary in English and that sort of thing.

This student had no transitional period between being taught mathematics in Spanish to being taught in English. She was expected to make the switch without any resources to help her make the connections between the Spanish and English mathematical dialogue, which interestingly, was still difficult for her even though her native language is English. Without an intermediate period of transition, it is likely that the student was overwhelmed with the stark contrast between the two languages. This provides a glimpse into the difficulties that mainstreamed ELLs face when transitioning from mathematics in their native language to mathematics in English. If this is difficult for a native English speaker to do after an immersion program, it is likely to cause even more issues for ELL students who are being taught in the new language of instruction.

4.2 Conclusion

In this chapter I explored the theme of ELLs and language and its subthemes including: teachers' use of resources, intervention methods, and the broader effect of

the language barrier on ELLs. In these themes, I see that teachers work hard to accommodate ELLs in a system that does not always seem to be prepared to work with ELLs' needs. Furthermore, that this system lacks the ability to distinguish between ELLs struggling with mathematics or language, leading to a possibility of their incorrect placement into lower level or even special education classes. In the following chapter, I will connect my findings to those in the field of mathematics education and address the implications of my study. I will also explore the ways this study has impacted me as a hopeful future teacher, address the limitations of this study, and discuss potential future research opportunities knowing what this study has shown.

Chapter 5: Conclusion

In this section I will relate my findings back to the literature initially introduced in Chapter 2 and comment on whether the research I conducted aligns with previous research findings. I will also explain the new information presented by my research study, analyze the limitations of my project, and lastly, present some ideas for potential future research.

5.1 Discussion and Implication of Findings

One central idea presented by the literature surrounding ELLs and mathematics is that teachers are not currently given enough opportunities to learn the best methods for helping these students before they enter the profession. Ballantyne and colleagues (2008) present statistical data representing the number of teachers who feel they need more ELL training. This is cause for more research and questioning of the currently established programs surrounding ELLs and mathematics. In my study, no comments were made about these teachers' graduate and undergraduate programs, however it is notable that only one of the nine people actually had an endorsement to teach ELLs, even though all of them had ELLs in their classrooms. My data also goes a step further to show that in these teachers' experiences, there is an significant lack of district and school support, and where support does exist, it has not been seen as useful. Thus, it is not only that teachers may not be well prepared to teach ELLs before entering the profession, but also that if this is the case, they may not be fortunate enough to work at a school that provides effective support, if any support at all.

Another essential part of my research is the impact of this lack of resources on the teachers. Carrie's comments about the need to improve her Spanish skills reflect her feelings of inadequacy and her need to provide more to her students. This is unfair to her as a teacher – speaking Spanish was not part of her job description as a mathematics teacher. Teachers need opportunities to be better educated about teaching this specific group of students, and once they are provided with this information, we can expect more of them. Borgioli (2008) comments that teachers need to expand their idea of their role as a mathematics teacher to include work on literacy and cultural open-mindedness; however, this is not possible or fair to ask for as these teachers were never prepared to do so. The shift would require significant time and other resources, which, based on these teachers' experiences, the districts and/or schools do not have.

With the current state of teacher education programs and the lack of professional development focused on teaching mathematics to ELLs (U.S. Department of Education NCES, 2013, p.19), teachers are being forced to create their own intervention methods. The teachers I interviewed are a testament to this new expected part of mathematics teachers' lives, and luckily, though most of these participants were not given much to work with, they have, for the most part, implemented interventions that are supported by the research. Melissa, Kevin, Anthony, and Sarah all mentioned the use of native language work for their ELL students, which authors like Moschkovich (2013), Civil (2012), and Garrison and Mora (1999) all emphasize in helping these students internalize mathematical concepts. One of Sarah's examples of this is her review activity, which included

students creating posters in their native language. This is a method strongly supported by Borgioli (2008) and his explanation of using a "word wall." Borgioli's research shows that presenting the native language work of ELLs to the entire classroom helps in creating a more equitable environment. Sarah explicitly mentioned that her students' posters were shared with the class, which, according to Borgioli (2008), would prompt a change in attitude toward ELLs from a deficit model to a more positive contribution model.

Though encouraging native language work was the most emphasized method of helping ELLs presented in the literature, reciprocal teaching followed closely and was supported by Garrison and Mora, Schleppegrel, and Janzen. Additionally, this intervention method was the most widespread among my participants. Sarah, Anthony, Kevin, and Melissa all explicitly mentioned group work for helping ELLs in particular, while Jeff and Greg made less explicit, but still significant references to using this method to help all of their students.

In the literature, this intervention method is emphasized because it allows ELLs to practice interacting in English and further, it allows them to do so in all forms of communication: reading, writing, speaking, and listening. Interestingly, the teachers' reasons behind implementing this method were completely different. The general consensus of the teachers I interviewed was that allowing students to work together was beneficial because students learn from one another in different ways than they do from their teacher. This is made possible by the students' ability to think in similar ways to one another and their ability to communicate more directly.

The participants' lack of any mention of the language component in reciprocal teaching is now very interesting to me. It is unfair to say that these teachers were unaware of the linguistic benefits for their ELLs in promoting their use of English and mathematical terms during group work, but it is significant that not one of them mentioned it. It is likely that this was not their main reason for implementing the reciprocal teaching method, and that instead, they were focused on the students' ability to communicate new ideas to one another; however, this may be indicative that teaching this specific part of the literature to teachers could be extremely beneficial for ELLs. If teachers are implementing group work as an essential part of the structure of their classes and keep in mind that they should be focusing on the students' use of correct mathematical language, ELLs will have another chance to make those essential connections between their native language and the new language of instruction.

A less studied intervention that has been used by the participants of this research study is technology, specifically, the use of YouTube and Google Translate. Carrie spoke about using this method in an attempt to communicate with her student whose native language was Somali. Jack also mentioned its use when telling his students to refer to Google after he had "tried everything." There was not much literature devoted to either of these specific forms of technology, as the only explicit mention of technology was by Janzen (2008) in reference to a very specific computer program called "The Geometer's Sketchpad." From this, we can see that ELL interaction with Internet aids (such as Google and YouTube) is an under-researched area. Though the comments made by Carrie and Jack are useful in allowing us a

better understanding of their ELLs' experiences, it is not enough to draw concrete conclusions about all ELLs or all mathematics teachers.

The last, and, to me, most controversial, intervention method presented by the interviewed teachers was the use of visual aids to help ELLs. The presented literature mentions the importance of making connections to ELLs' lives and of drawing on the various resources available in the classroom: "objects, drawings, graphs, and gestures" (Moschkovich, 2013, p.50). Carrie and Jeff both seemed to present mixed messages when referencing their use of visual aids in the classroom. It appears that both of them have good intentions and are attempting to allow ELLs another way to access the new concepts that are being taught in English, but some of their language when talking about their methodology is worrisome. Carrie mentions the use of "simple terms" while Jeff's comments seem to indicate that he may be avoiding the use of auditory references to mathematics in an effort to (in his mind) make the understanding easier for his ELLs. The literature explicitly denounces these ideas, instead emphasizing that exposing ELLs to more mathematical language is essential to their learning, and further, that if teachers are to use visuals, they should be supplemental to the use of verbal communication, not used as a replacement. To me, the conflicting ideas presented by Carrie and Jeff warrant further research into their backgrounds with ELLs and on a greater scale, into teacher education programs as they should be educating these future teachers about the effective and ineffective ways to present materials to ELLs.

The participants in this research study all reported various intervention methods for their ELL students, indicating their understanding that these students

struggle with mathematics. Further, it is clear to see through their comments that they acknowledge the need for explicit intervention methods to help their ELL students. Overall, most of the interventions used by these participants are supported by the literature, and those that are not simply indicate that more research is necessary and perhaps that teacher education programs, district policy, and professional development programs should all be evaluated for their effectiveness in educating teachers about the best ways to help this particular demographic of students.

The last, and perhaps most important, part of my findings was focused on the broader effect of the language barrier on ELLs. The literature focuses on the struggles that students may have in creating connections between the mathematics they have been taught in their native language, and the "new" concepts that may actually be old ones, in the new language of instruction (Gorgorió et al., 2002). This in turn makes it difficult for teachers and administrators to recognize where students are in their level of understanding, which is supported by the comments made by teachers in my research study. Melissa gives a specific example about an ELL who was incorrectly placed into her lower level math class. The student knew the math concepts, but struggled with the language, which resulted in her low test score that consequently placed her in a math class that was not challenging enough for her. Melissa was able to recognize this as the student's teacher, but it took the administration months to make the necessary change. Further, Greg made a connection between ELLs and special education, stating that the "screwed up system" has often mistakenly assessed language issues as equivalent to special education issues. This is a significant finding

of my research and goes even further than the presented literature to show how ELLs are being affected by unproductive school policies.

5.2 Personal Reflection

As an undergraduate mathematics major with plans to pursue a secondary teacher education program at Stanford in the coming summer, this research study has been immensely rewarding and helpful in my understanding of the life of a mathematics teacher. I have been given the opportunity to look into the lives of fifteen math educators in the Pacific Northwest, many of whom actually told me not to become a teacher. These sarcastic comments have not deterred me from my passions, but rather, have increased my desire to eventually pursue a Ph.D. in mathematics education after spending time as a teacher in public schools. Participating in this research study has exposed me to the possibility of spending more time pursuing mathematics education research, which would allow me to help students in new, but equally important way.

Another essential part of this experience has been my own education and understanding of the difficulties mathematics educators face. I will begin my own teacher education program in the next month, and will likely have a job at a middle or high school in the following year. Knowing this, I am excited to take my masters program head on and absorb as much information as I can. Further, now that I have seen the struggles of my participants in creating their own intervention methods, I will be looking for all the places and ways that my teacher education program prepares me to work with this important student population.

5.3 Limitations

This research study was conducted on a volunteer basis, which adds a clear sampling bias to the collected data. In this particular type of bias, it is important to realize that, “often, voluntary response samples oversample people who have strong opinions and under sample people who don't care much about the topic of the survey” (Smith, 2012, para. 9). Thus, it is likely that the participants of my research study had strong opinions about helping ELLs or about the resources that were or were not provided by their schools and districts.

Another significant limitation of this study is that the teachers I interviewed came from a variety of school districts across the Pacific Northwest, making it difficult to make generalizations about one district or school. One teacher’s opinions and contributions are not representative of an entire school, and thus, the information given needs to be evaluated as each teacher’s own personal beliefs.

5.4 Potential for Further Research

After conducting this research, it is clear that more research needs to be done in the area of teacher education programs. The literature and my findings indicate the fact that most teachers are unprepared to work with ELLs, even though their population has been growing for the past decade. It is becoming increasingly likely for math teachers to have mainstreamed ELLs in their classrooms who they need to be able to help. Teacher education programs need to be evaluated for their provision of intervention methods to help these students and a focus on helping teachers understand the difficulties ELLs face in the classroom. This needs to be done in an effort to create more equitable classrooms across the United States.

Another potential area for further research is technology and its ability to help ELLs in their understanding of mathematics. I could not find literature related to the use of Google and YouTube, but from the comments made by Carrie and Jack, it is possible that these two parts of the Internet may be a potential resource for teachers in helping ELLs.

Lastly, the literature presented a compelling argument demonstrating the parallels between ELLs in the U.S. and immigrant students in Spain. Keeping this in mind, conducting a study similar to this one in Spain to examine the underlying issues SLLs face in mathematics classrooms would be incredibly interesting. Further, many immigrant students in Spain have been reported to come from Latin America, so it could be possible that issues of culture are more prominent for immigrant students in particular, thus an examination of these differences could present important information for the Spanish education system.

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Appendices

Appendix A

Understanding Mathematics Educators' Experience with English Language Learners
Department of Mathematics
Oregon State University

Dear [Teacher]:

My name is Josey Sechrist and I am conducting a study titled *Understanding Mathematics Educators' Experience with English Language Learners*. This research study will give insight into middle school mathematics classrooms to the field of mathematics education. From this insight people could design in-service and pre-service mathematics teacher education programs that will prepare mathematics teachers for these experiences.

Participation in this study will include one interview, which will last no more than 90 minutes. The interview will be audio recorded for analysis purposes.

Your confidentiality will be protected by de-identifying any information that you provide during the interview. For example, you will be assigned a research ID number and all of the recordings of the interview and transcripts thereof will be labeled solely with that research ID number. Your name will not, at any point, be directly associated with the data you provide. The interview will occur in a place of your choosing (one that will reasonably protect your identity).

I would also ask that you protect your own identification by not sharing with others in your district that you have or have not agreed to participate in this study.

Your participation in this study will not impact your standing in your district or people's perceptions of you.

If you would like to participate, please contact me via email at sechrisj@onid.oregonstate.edu or by phone at 360-609-0881. If you have any questions or concerns about this study, please contact Mary Beisiegel at mary.beisiegel@oregonstate.edu.

Best Regards,

Josey Sechrist

Appendix B

Understanding Mathematics Educators' Experience with English Language Learners
Department of Mathematics
Oregon State University

Dear [Teacher]:

Two weeks ago, I sent you an email requesting your participation in my study *Understanding Mathematics Educators' Experience with English Language Learners*. I am following up with you about your possible participation. As the email message described, your participation includes one interview, which will take no more than 90 minutes. The interview will be audio recorded for analysis purposes.

Your confidentiality will be protected by de-identifying any information that you provide during the interview. For example, you will be given a research ID number and all of the recordings of the interview and transcripts thereof will be labeled solely with that research ID number. Your name will not, at any point, be directly associated with the data you provide.

I would also ask that you protect your own identification by not sharing with others in your district that you have or have not agreed to participate in this study.

If you would like to participate, please contact me via email at sechrisj@onid.oregonstate.edu or by phone at 360-609-0881. If you have any questions or concerns about this study, please contact Mary Beisiegel mary.beisiegel@oregonstate.edu.

Best Regards,

Josey Sechrist

Appendix C

Understanding Mathematics Educators' Experience with English Language Learners
Department of Mathematics
Oregon State University

Dear [Teacher],

Hello! My name is Josey Sechrist; I am a third year student at Oregon State University majoring in mathematics and international studies. I also have a minor in Spanish and an option in secondary education. My hope is to one day become a high school math and Spanish teacher and to help improve the U.S. education system. I am also an OSU Honor's college student, and as such am required to complete an undergraduate thesis.

I am conducting a study titled *Understanding Mathematics Educators' Experience with English Language Learners*. This research study will give insight into middle and high school mathematics classrooms to the field of mathematics education. From this insight people could design in-service and pre-service mathematics teacher education programs that will prepare mathematics teachers for these experiences. This study will also be incredibly helpful for me personally as I am hoping to gain insight into the life I will have as a mathematics educator myself.

Participation in this study will include one interview, which will last no more than 90 minutes. If necessary, a shorter interview could also be done if your schedule does not permit this amount of time. The interview will be audio recorded for analysis purposes.

Your confidentiality will be protected by de-identifying any information that you provide during the interview. For example, you will be assigned a research ID number and all of the recordings of the interview and transcripts thereof will be labeled solely with that research ID number. Your name will not, at any point, be directly associated with the data you provide. The interview will occur in a place of your choosing (one that will reasonably protect your identity).

I would also ask that you protect your own identification by not sharing with others in your district that you have or have not agreed to participate in this study.

Your participation in this study will not impact your standing in your district or people's perceptions of you.

If you would like to participate, please contact me via email at

sechrisj@onid.oregonstate.edu or by phone at 360-609-0881. I can't tell you how much I would appreciate your time. I know the life of a teacher is incredibly busy, but if you could spare even 30 minutes to speak with me, it would help my study greatly! If you have any questions or concerns about this study, please contact Mary Beisiegel at mary.beisiegel@oregonstate.edu.

Best Regards,

Josey Sechrist

Appendix D

Understanding Mathematics Educators' Experience with English Language Learners
Department of Mathematics
Oregon State University

Dear [Teacher]:

Two weeks ago, I sent you an email requesting your participation in my study *Understanding Mathematics Educators' Experience with English Language Learners*. I am following up with you about your possible participation! As the email message described, your participation includes one interview, which will take no more than 90 minutes, and could easily be shortened for your convenience. The interview will be audio recorded for analysis purposes.

Your confidentiality will be protected by de-identifying any information that you provide during the interview. For example, you will be given a research ID number and all of the recordings of the interview and transcripts thereof will be labeled solely with that research ID number. Your name will not, at any point, be directly associated with the data you provide.

I would also ask that you protect your own identification by not sharing with others in your district that you have or have not agreed to participate in this study.

If you would like to participate, please contact me via email at sechrisj@onid.oregonstate.edu or by phone at 360-609-0881. I can't tell you how much I would appreciate your time as it will help me with my undergraduate thesis and also give me insight into how my life will likely be as a hopeful future educator. If you have any questions or concerns about this study, please contact Mary Beisiegel mary.beisiegel@oregonstate.edu.

Best Regards,

Josey Sechrist

Appendix E

Department of Mathematics
368 Kidder Hall
Corvallis, Oregon 97331
Telephone: (541) 737-8397
Email: mary.beisiegel@oregonstate.edu

EXPLANATION OF RESEARCH

Project Title:	Understanding Mathmatics Educators' Experience with English Language Learners
Principal Investigator:	Mary Beisiegel
Student Researcher:	Josey Sechrist
Co-Investigator(s):	N/A
Sponsor:	None
Version Date:	February 26, 2015

Purpose: You are being asked to take part in a research study. The purpose of this research study is to gain insights into mathematics educators' experiences with English Language Learners. This study is being conducted to fulfill the requirements of an honors thesis for Josey Sechrist.

Activities: The study activity consists of one interview that will last no more than 90 minutes. The interview will be audio recorded for analysis purposes.

Time: Your participation in this study will last about one and a half hours.

Risks: The possible risks and/or discomforts associated with being in the study include potential discomfort should some of the participants' experiences with English Language Learners not be positive experiences.

Benefit: This study is not designed to benefit participants directly. However, the benefits for participants could include a chance to talk about your experiences teaching mathematics to English Language Learners, which will provide participants with insights into their teaching.

Confidentiality:
It is possible that others could learn that you participated in this study but the information you provide will be kept confidential to the extent permitted by law.

Voluntary: Participation in this study is voluntary. If the participant would prefer not to answer a question they are free to do so.

Study contacts: If you have any questions about this research project, please contact: Mary Beisiegel by email at mary.beisiegel@oregonstate.edu. If you have questions about your rights or welfare as a participant, please contact the Oregon State University Institutional Review Board (IRB) Office, at (541) 737-8008 or by email at IRB@oregonstate.edu.

Appendix F

Questions to be asked in the Interviews include:

1. Please explain your background in education and mathematics.
    a. Why did you decide to become a middle or high school mathematics teacher?
2. Was there a reason you decided to earn your ESOL endorsement? If so, what was that reason?
3. When did you earn your ESOL endorsement in relation to when you began teaching?
4. Please explain your background with English Language Learners (ELLs).
5. Do you have any background in a foreign language, and if so, which one?
    a. Please explain the extent of your experience in this language.
6. How long have you been teaching mathematics?
7. How long have you been teaching algebra?
8. How long have you been working at this school?
9. Have you taught at other schools?
    a. Were you also ESOL endorsed at that/those school(s)?
        i. If so, how long did you use this endorsement?
10. Describe a typical day in your classroom.
    a. Normal lesson day – do you present material, have students work at their desks individually or in groups, do you have students share their ideas with the class, do you collect student work during class time?
    b. Review day
    c. Test day
11. Do your classrooms tend to be diverse?
12. Has the diversity of your classrooms changed since you became a teacher? If so, how has it changed?
13. If the diversity has changed over time, have the classroom dynamics changed in any way? If so, how have they changed?
14. Do you find that some students participate or contribute more than others? If so, how would you describe that (who and how are they participating or not participating)?
15. What have you learned teaching mathematics to English Language Learners?

16. What are the most important things to keep in mind when teaching algebra to English language learners?
17. When students struggle with mathematics, how do you help them? What are some of your techniques? How did you learn those techniques?
18. If your students struggle with mathematics, what would you say their biggest struggle is? Why do you think they struggle with that (topic)?
19. Have you noticed whether your ELL students work on mathematics differently from the non-ELL students? If so, what have you noticed?
20. If you could give some advice to a college student who wants to teach middle or high school mathematics and earn their ESOL endorsement, what would it be?
21. Are there any other thoughts about your teaching that you would like to share?

The following will be used as follow-ups for the above questions if the interviewer would like more information.

- Can you please elaborate more on that topic?
- Could you give an example of that situation?
- Why do you think that is?