Teaching mathematics to English language learners: A comparative study of issues faced by teachers in New Zealand and the United States

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Abstract

New Zealand and the United States are both ethnically and linguistically diverse. With this diversity comes high numbers of English language learners in school classrooms. This is a challenge for teachers of mathematics, both mathematics specialist teachers, and those who teach mathematics as part of a wider primary/elementary curriculum, because mathematics is bound by language and culture, leading to challenges when teaching mathematics to English language learners. Understanding the issues teachers face when teaching English language learners mathematics enables these issues to be addressed.

This study sought to understand the issues teachers face when teaching mathematics to English language learners. A comparative, qualitative study of ten teachers was undertaken; five teachers from New Zealand and five teachers from the United States. Each teacher participated in an individual, semi-structured interview over webcam.

There were issues that teachers in both countries faced. Culture and building parental relationships impacted all teachers. Teachers in both countries had issues with mathematical language and word problems. There were also concerns about the amount of training teachers' received and funding for English language learners. There were also issues unique to each country. In the United States, teachers were concerned with their own ability to speak Spanish, while in New Zealand teachers were concerned with the cultural appropriateness of the Numeracy Project.

Further research could be undertaken to gain a deeper understanding of the issues teachers face, especially because of the small sample size in this study. Understanding these issues can enable positive changes both in policy and at the school level to better support teachers in teaching mathematics to English language learners.

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Chapter One: Introduction

1.1 Introduction

Diversity is a hallmark of modern day classrooms in both New Zealand and the United States. With this diversity brings challenges. Teachers in mainstream mathematics classrooms are expected to meet the needs of students from a wide range of backgrounds, including English language learners (ELLs). To be successful in mathematics, there are many aspects of language and culture that ELLs and their teachers must navigate. The challenges ELLs face are reflected in their outcomes, where research indicates that commonly ELLs underperform in comparison with their peers from English speaking backgrounds (Franken & McComish, 2003; Martiniello, 2008; Organisation for Economic Cooperation and Development, 2013; Xi & Yeping, 2008). Understanding the issues that teachers face when teaching mathematics to ELLs enables these issues to be addressed, so teachers can better meet the needs of ELLs, leading to better outcomes.

In this chapter, my interest in the challenges teachers face in teaching mathematics to ELLs will be discussed and trends in the numbers of ELLs and in the achievement of ELLs in New Zealand and the United States will be explored. The reasons for using a comparative study will then be discussed and the purpose of the study will be explained. Finally, the structure of the thesis will be outlined.

1.2 Personal Interest in the Topic

My interest in the issues teachers face when teaching mathematics to ELLs stemmed from my dual interests in mathematics education and in teaching ELLs. My interest in mathematics education developed in my undergraduate teacher education when I learned about the Numeracy Project (New Zealand Ministry of Education, 2010) and became excited at the possibilities mathematics education held for learners. For the first time, I saw learning and teaching mathematics as a creative and engaging pursuit. As I taught mathematics in my own classrooms, the

passion I had for mathematics education continued to grow.

After teaching in New Zealand, I moved to Japan and taught English as a foreign language in public schools. Working exclusively with ELLs made me more aware of the difficulties they face when transitioning to English speaking school systems; they needed to navigate both language and cultural differences. At this time I also had the opportunity to observe in a number of primary mathematics classes. Watching the different ways in which mathematics was taught, reflecting Japanese culture, made me appreciate the different ways of teaching and learning mathematics that exist between cultures.

It was during this time in Japan that I also began my postgraduate work. I chose to do papers in my two major areas of interest, bilingual/multilingual education and mathematics education, and saw a link between the two that I felt warranted further exploration. Mathematics education relies on language. Therefore, if ELLs have not obtained a high enough degree of language proficiency, they are likely to be at a disadvantage.

1.3 Trends in English Language Learner Numbers

Both New Zealand and the United States have high numbers of ELLs. New Zealand is very diverse, and it is estimated that around 23% of school-aged students are from non-English speaking backgrounds (Edwards, 2012). The Auckland region has an especially high proportion of foreign-born residents. In 2013, 39% of the Auckland population were foreign born, compared with 18% in the rest of New Zealand (Statistics New Zealand, 2014). Of these, over 60% came from regions where languages other than English are commonly spoken: Asia, Europe outside of the United Kingdom, the Pacific Islands, Africa and the Middle East. Furthermore, immigrants in Auckland tended to be younger than immigrants to the rest of the country, with Auckland having twice the proportion of immigrants under the age of fifteen as other regions (Statistics New Zealand, 2014). With a higher proportion of foreign-born residents, and a larger proportion of these under the age of fifteen, schools in Auckland probably have higher numbers of ELLs than elsewhere in New Zealand.

In the United States it is estimated that around 10.5% of students are ELLs (National Council of Teachers of English, 2008). This proportion is not evenly spread across the whole country, however, with some states and districts having much higher numbers of ELLs. For example, estimates are 15% in Texas, 19% in Nevada and 29% in California (United States Department of Education, 2014). Some specific school districts also have much higher numbers. For example, in 2009, around 60% of students in the Santa Ana School District in California were identified as ELLs (Russo, 2009). Furthermore, in the US the number of students who are not fully proficient in English may be greater than the number indicated above, as once students have been transitioned out of ESL and Bilingual programmes into mainstream programmes they are no longer considered ELLs, even if they have not yet achieved full, age-level academic proficiency in English (Elfers et al., 2009). Also, the number of ELLs in the United States is rapidly increasing. It is estimated that by 2025, 20-25% of all students will be ELLs (Elfers et al., 2009). This is a major demographic shift in the educational landscape in the United States, and has strong implications for teachers in mainstream classes.

There is evidence that in both countries there is an achievement gap between ELLs and students from an English speaking background (Franken & McComish, 2003; Fry, 2008; Martiniello, 2008; Organisation for Economic Cooperation and Development, 2013). In New Zealand, ELLs have historically tended to not perform as well as their peers from English speaking backgrounds in the Trends in International Mathematics and Science Study (TIMSS) examinations (Franken & McComish, 2003).

More recently, however, there have been contexts where this is not the case. For example, in the 2011 TIMSS examinations, Year nine New Zealand students who always spoke English at home had the same average score as those who spoke English sometimes (TIMMS, 2011). This was opposite to the majority of participating countries, where second language learners tended to have lower scores. There was no comparison, however, between students who always spoke English at home and those who never did, due to insufficient data being available for those who never did, meaning that the information gathered may not reflect fully whether there is a disparity between those from English speaking

backgrounds and those from non-English speaking backgrounds. These trends were further explored and, on average, no difference was found between the scores of schools with high numbers of ELLs and those with low numbers (Caygill, Kirkham & Marshall, 2013).

In the 2012 Programme for International Student Assessment (PISA) study, however, students from non-English speaking backgrounds tended to score lower in mathematics (Organisation for Economic Cooperation and Development, 2013). This was true both before and after adjusting for student socio-economic background, although the disparity was greater before adjusting for student socio-economic status.

In the United States there is also a gap in mathematics outcomes between students who are ELLs and students from English speaking backgrounds, including in comparison with students from other minority demographics. In a study of states with high proportions of ELLs, it was found that ELLs often score lower in mathematics proficiency exams than African American students, another minority demographic that historically scored lower than their peers (Fry, 2008). Fry (2008) gives the example of Texas, where 44% of African American eighth graders were considered proficient in mathematics, compared with 22% of ELLs. There are also examples of achievement gaps from states that do not have such a large number of ELLs, such as Massachusetts, where it was found that in the mathematics test in the National Assessment of Educational Progress, 68% of students who were from English speaking backgrounds were deemed not proficient in mathematics, compared with 92% of ELLs (Martiniello, 2008).

There are large numbers of ELLs in schools in both New Zealand and the United States. An achievement gap exists between ELLs and learners from English speaking backgrounds in the United States, and in at least some contexts in New Zealand. It is therefore essential that teachers are prepared and supported to best meet the needs of these large numbers of learners. Historically, there has been a strong focus on methods of teaching ELLs, but less focus on the teachers themselves. As Elfers et al (2009) mention, "[t]here has been considerable research around program models and their effectiveness, but limited examination of the role of classroom teachers on the education of ELL students and the support

they receive to work with them" (11). It is therefore important that more research is done, focussing on the teachers themselves. Looking at the issues teachers face enables a deeper understanding of the needs teachers have, and therefore enables key parties to provide the support and training necessary to meet those needs.

1.4 Rationale for Comparative Study

As an expatriate New Zealander, living in the United States, I have a strong relationship with both countries. I am currently registered/certified to teach primary/elementary both in New Zealand and in the State of Ohio. I find the issues that are faced as a teacher in both systems can parallel each other but that there are also strong and unique issues faced by teachers in each system. As a result, exploring issues surrounding education in both countries was appealing. As both countries have sizeable ELL populations, a comparative study was an appropriate way of gaining further insight into the issues teachers face in the two countries.

Comparative studies in education are becoming especially prominent as the world becomes more globalised (Nóvoa & Yariv-Mashal, 2003). In their current format, comparative studies are frequently used as a tool to evaluate education systems against each other. International comparison is considered important politically, as it reflects the current need for countries to compete economically in a global market. By focusing on major international testing and the pursuit of accountability, however, the other benefits of doing international comparative studies can be minimised.

There are two main advantages of comparative studies that pertain to this research. Firstly, by comparing different systems, and the perspectives and experiences within them, the knowledge gained can work to strengthen understanding in both systems. Policies and the ways in which teachers are supported, resourced and able to effectively teach ELLs are able to be examined. There are benefits to examining ways of teaching and policies between systems, as a means of reflection and deepening understanding, as well as sharing ideas. It is important to be cautious, however, of the phenomenon of "policy borrowing," discussed by Phillips (2006), where policies and practices are seen as directly

translatable into other contexts. As all education is contextual, one cannot assume that what works in one system will work in another. This does not negate the value of learning about different policies and practices, however, as there can be benefits in examining other systems with an awareness of cultural and historical contexts, and recognising policies and practices which are translatable (Torney-Purta, 1990). When using comparison in educational research, it is important to use comparative study as a way to learn and reflect, not a way to directly ascertain a universal best practice.

Secondly, with the changes in numbers of ELLs being a phenomenon in a large number of English speaking countries, understanding issues that are consistent between countries can further guide research. Reflection on the reasons why certain issues are consistent and certain issues are country-specific might provide understanding and insight. This is especially true when looking at New Zealand, as its size means that a lot of the research taken into consideration when exploring issues surrounding ELLs and mathematics tends to be from foreign sources.

Ultimately, comparative education can be and is used as a framework for educational analysis (Nóvoa & Yariv-Mashal, 2003). Phillips (2006) suggests that this analysis is especially advantageous as it brings together both theory and practice; it enables theories to be examined in practice in different contexts. By undertaking comparative research in this study, the issues in both countries were able to be analysed alongside each other, leading to more contextual analysis.

1.5 Purpose of Study

The purpose of this study was to investigate the issues teachers faced when teaching mathematics to ELLs. Having students who do not yet have a strong grasp on academic English makes the teacher's role more challenging because of the degree of language required in teaching and learning mathematics. Knowing what issues do arise when teachers are faced with teaching mathematics to ELLs is the first step in addressing them. By addressing these issues, teachers will be more able to effectively teach English language learners, narrowing the gap between them and their peers from English speaking backgrounds.

Because of this, I sought to find out what these issues are. The key research question I sought to address was:

> *What are the issues faced by teachers in New Zealand and the United States when teaching mathematics to English language learners?*

1.6 Definition of an English Language Learner

The definition of an English language learner can vary. In New Zealand, ESOL funding is based on the proficiency of students under the English language learner progressions. To be eligible to be considered an English language learner for funding, a student must be from a migrant or refugee background, or have parents from a migrant or refugee background, and meet specific criteria under the English language learner progressions (New Zealand Ministry of Education, 2014). In the United States, there is great flexibility under No Child Left Behind as to who is an English language learner, meaning that the definition can vary widely between different districts and schools (National Council of Teachers of English, 2008). Because of the differences in who is formally identified as an English language learner across regions, I did not think it was appropriate to exclusively identify English language learners as students who receive funded ESL or ESOL services. Not including learners from non-English speaking backgrounds who are not in formal programmes could potentially ignore whether this in and of itself causes issues.

Because there is no consistent definition of an English language learner, I chose to define English language learners as students who, as identified by their teachers, were from non-English speaking backgrounds and did not speak English as a home language. They therefore learned English as a second language.

This aligns with Xi and Yeping's (2008) description of English language learners as students "who come from places where English is not spoken at all or where limited English is spoken" (p.90). Using a broad definition left room for those students who do not receive funding or services, but are still from non-English speaking backgrounds and learn English in the school setting.

1.7 Overview of Thesis

This thesis is divided into six main chapters. This first chapter introduces the reader to the thesis, outlining my interest in this topic, the purpose of this thesis, and why a comparative study is appropriate.

Chapter two addresses the surrounding literature. Whilst little study has been done specifically on the issues teachers face when teaching mathematics to ELLs, chapter two addresses issues surrounding mathematics and language, and looks at issues teachers face when teaching ELLs and when teaching mathematics.

Chapter three introduces the methodology of the study, justifying why interviewing was an appropriate method and discussing the ethical considerations taken into account. Chapter four gives the results of the research, identifying the key themes participants shared. Chapter five explores these results and the identified themes further, in light of relevant research. Chapter six draws final conclusions from this research, and implications, limitations and areas for further research are discussed.

Chapter Two: Literature Review

2.1 Introduction

A hallmark of modern day classrooms in both New Zealand and the United States is diversity. This diversity enriches classroom environments, but with it comes challenges. One of these challenges is working with ELLs. Teaching mathematics to ELLs brings a new and unique set of issues. Teachers must balance the increasingly complex nature of mathematics teaching, where linguistic demands have increased to enable deeper understanding, and the cultural and linguistic challenges an ELL brings.

Identifying the issues teachers face enables better support structures to be established, leading to better teaching. Not only is it important that teachers understand the barriers that exist in relation to language and culture and mathematics, but it is also important that teachers receive the support, training and resources they need to be able to teach effectively.

This chapter will review the literature that addresses mathematics and ELLs and the challenges teachers face when teaching mathematics to ELLs. Issues pertaining to language, culture and mathematics will be examined, followed by the specific issues teachers face. Whilst there is little research specifically pertaining to issues teachers face in teaching mathematics to ELLs, there is a body of research that addresses the two elements of this; issues faced in teaching ELLs and issues faced in teaching mathematics.

2.2 Language and Mathematics

A challenge for any teacher working in a linguistically diverse classroom environment in New Zealand or the United States is meeting the needs of all students. There are a number of factors that need to be taken into account when teaching mathematics to ELLs. It is often theorised that in many ways mathematics can be considered a language, separate from English. Mathematics is a language that deals with abstract concepts, related to both time and space, enabling them to be understood and discussed (Metsisto, 2005). Children face

challenges when learning to read mathematics, as there are requirements for decoding, comprehension and fluency that are similar to those needed to read in English, but this is further complicated by the introduction of numerals and other symbols (Adams, 2003). To effectively read mathematics, students must be able to understand the meaning of mathematical symbols (Adams, 2003). For all students to succeed in mathematics, they must be able to read and communicate in this language. It is essential that teachers understand that all students, including ELLs, are grappling with not only learning to be literate in English, but are also learning how to understand and use the language that is mathematics.

In this section, language and mathematics will be discussed. Mathematical registers, issues surrounding word problems, code switching and academic language proficiency will be considered.

2.2.1 Mathematical registers. A mathematical register is the specific style of language used for communication within mathematics. When mathematics is discussed and expressed in English, the English used is distinctive and different to the English used in ordinary conversation. The language used in mathematical registers is very specific. For an ELL to be competent in mathematics, they need to understand not only the ordinary English that they speak in everyday conversation with their teacher and peers, but also mathematical English (Xi & Yeping, 2008). A mathematical register is made up of the vocabulary used in mathematics, the linguistic structure used when communicating mathematically, and the conveyed meaning of the specific mathematical vocabulary and structure (Chapman, 1993). There are multiple registers that a learner must contend with, depending on the situation and context applying to the mathematics in question. In reference to the multiple registers found within mathematics, Kenney (2005) uses the example of school mathematics and street mathematics. The formal, more rigid form of mathematics that is done in school differs from the way mathematics is used and discussed in everyday situations. Awareness of this is important for teachers; they need to ensure that students can communicate mathematically both inside and outside of the classroom.

For a student from an English speaking background, mathematical registers can pose a challenge, as they are a new form of language that must be learned and

mastered. For the ELL, this is even more challenging. Not only must an ELL try to learn in English whilst concurrently learning to speak English, they must also be working within the English mathematical registers without yet having mastery of ordinary English. Furthermore, it is common for a lot of processing to occur as an ELL works within both English and their home language. ELLs must be able to understand the English mathematical register they are working in, then translate it into ordinary English. They must then it from ordinary English into their own language, before translating it into one of the mathematical registers used in their home language. They must then go through this process in reverse in order to express their thinking or answer in the appropriate English mathematical register (Lager, 2006). This linguistic complexity further demonstrates the need for mathematics teachers to have the tools and training to effectively work with ELLs, so they are able to support these learners to competently work within the different registers that are used in mathematics.

Vocabulary is an important aspect of mathematical English registers. There are many words that differ in meaning between mathematical and ordinary English registers. An example is the word 'table', which differs in meaning in its mathematical usage and its everyday usage (Kotsopoulos, 2007). There can be further challenges when words have multiple mathematical meanings, some of which further differ from ordinary English registers. One example of a word that has multiple mathematical meanings is 'square', where 'square' is used geometrically to refer to a shape, and is also used commonly in the term 'square root,' or in a number 'squared' (Rubenstein & Thompson, 2002).

When words are introduced from the ordinary English register, with a different assigned meaning in mathematics, interference can occur (Kotsopoulos , 2007). Language interference happens when in the process of learning one language, the use of another language is transferred across (Skiba, 1997). In this context it refers to the idea that students will be trying to place the everyday English meanings of words within the mathematics register, even though the meanings are not correct. If students are unable to navigate the mathematical register, and thus minimise interference, it can be a hindrance to their learning. According to Kotsopoulos (2007), this interference can exist in a variety of contexts. Teachers will often speak in mixed registers, with mathematical and everyday English intertwined.

Students, in talking to each other, can also be a source of interference, as they will frequently discuss mathematics using everyday English. Furthermore, the mathematical English registers can cause interference when words are assigned multiple meanings in mathematics. All of these, if left unchecked, can interfere with a student's mathematical English development.

As well as this, there are words shared with other disciplines that have technical meanings that differ between these disciplines. Rubenstein & Thompson (2002) give the example of the word ‘divide’. In mathematics, to divide is a mathematical operation, meaning to split into equal groups. In geography, however, divide is used in terms of the Continental Divide, meaning the ridge that separates Eastern and Western North America. Furthermore, divide can be used in other contexts, such as to describe a disagreement between two groups of people with opposing viewpoints, or as a way to create some sort a boundary between two things or areas (Oxford English Dictionary Online, ND).

There are also issues surrounding homonyms with mathematical language and ordinary English. An example of this is pi and pie (Rubenstein & Thompson, 2002). Although these are distinctly different words, they still present a challenge to learners trying to grapple with English vocabulary and the vocabulary used in mathematical registers.

Furthermore, to be able to perform competently, students must understand the highly technical language used specifically in mathematics (Brown, Cady & Taylor, 2005). This language is not used in everyday English, and therefore the vocabulary is less likely to be familiar or understood by ELLs. For example, a student is highly unlikely to encounter the words 'parallelogram' and 'multiplication' in their everyday life, thus meaning that they are not reinforced (Haylock & Thangata, 2007). The technical language and vocabulary of mathematics is not only essential for students to be able to understand and access the mathematics they are currently learning, but has an influence on their future mathematical development. When students do not have an understanding of the more specialised forms of mathematical language, they cannot access the higher level concepts, as these concepts involve a large degree of technical, specialist language (Jingzi & Normandia, 2007).

Mathematics also involves a high degree of precision with regard to vocabulary. An example of precise terminology, given by Adams (2003) is the word ‘square’, referring to the shape. Initially, a student may simply understand and define a square as a shape with equal sides, but this definition by necessity must get more complex as the required understanding of polygons advances. To be able to do higher levels of mathematics, students need to understand that not only is a square a shape with equal sides, but that it is in fact a polygon with four equal sides and right angles. Not understanding the technical and precise definition of the word ‘square’ hinders a student's development in mathematics.

Less precise, ‘everyday’ use of terms can also complicate understanding. Haylock & Thangata (2007) give the example of ‘cube,’ where in everyday life a sugar cube is an approximation of a cube, but is unlikely to be an exact cube in the mathematical sense. Whilst this can help students have some idea and understanding of what a cube is, it doesn't necessarily convey the term precisely. Furthermore, Haylock & Thangata (2007) give examples of common, everyday phrases like ‘a fraction of the cost,’ which imply an imprecise and possibly wrong meaning. When something is described as ‘a fraction of the cost’ in everyday English, the word ‘fraction’ implies a small part of the whole. In mathematical English however, this is not always true. A fraction can refer to a large proportion of the whole, or can even be larger than the whole in the case of an improper fraction.

Furthermore, what is implied in an ordinary English register may not have the same meaning in mathematical registers, because mathematical registers require a much higher degree of precision in language; that which is implied in ordinary English registers may no longer be implied when working within mathematical registers. Boero, Doeul & Ferrari (2008) give the example of ‘less than’ as opposed to ‘less than or equal to’. In ordinary English, ‘less than’ usually implies ‘less than or equal to’, whereas in mathematical English it does not; ‘less than or equal to’ must be used.

Also, without the necessary technical mathematical vocabulary needed, students’ communication in mathematics is hindered. This is especially a problem with

regard to their written communication. When a student is hindered in their ability to write in mathematics due to their lack of vocabulary, it can hinder understanding, as writing is linked with understanding (Jingzi & Normandia, 2007). This further highlights the need for mathematics teachers to view themselves as not only mathematics teachers, but also teachers of English (Brown, Cady & Taylor, 2005).

Prepositions can make a difference in the meaning of a statement in mathematics, and if learners don't have a strong understanding of what prepositions mean in a mathematical context, it can pose a challenge to their understanding. Examples of this, given by Haylock & Thangata (2007), include the difference between dividing *x* into *y*, and dividing *x* by *y*, and the difference between reducing *x* by *y* versus reducing *x* to *y*.

Understanding prepositions in mathematics is a challenge that all students must face, but there is an extra degree of challenge for English language learners, as they don't necessarily have the underlying understanding of prepositions to begin with. In a series of studies on New Zealand high school and university aged students with a home language of Mandarin, it was found that in English medium tests, students struggled to understand the prepositions in the questions, leading to lower scores (Neville-Barton & Barton, 2005). This can be a challenge for teachers, as they need to have a constant awareness of the small details of the language they use, to ensure understanding for all learners.

Another challenge with using mathematical language faced by all students, but especially English language learners, is the fact that in mathematical English there are often multiple ways of saying things. This can be in the choice of word used, for example the use of ‘one quarter’ or ‘one fourth’ (Rubenstein & Thompson, 2002). It can also be in the phrasing used to describe operations, for example ‘five take away three’ versus ‘take three from five’ or ‘five minus three’ (Ballantyne & Rivera, 2014). This means that English language learners who already have grasped these concepts and can state them in their home language need to learn not a singular translation, but multiple words for the same concept.

Having to work in and communicate in mathematical registers, which involve differences in language and structure to ordinary English, provides extra

difficulties for English language learners. English language learners tend to learn to communicate in ordinary English, and in social contexts, many years before they are able to understand and use technical, academic language (Slavit & Ernst-Slavit, 2007). Therefore, even if an English language learner is competent in using the ordinary English register, the use of the mathematical register provides extra difficulties for English language learners. Awareness of this is important for teachers of English language learners; understanding that even if a student can easily converse in English, that doesn't necessarily mean they have the level of English required to effectively communicate in mathematics. This has the potential to be challenging for teachers because it adds extra challenge in determining the level a student is at, or ascertaining how much support a student needs to be able to learn mathematics in and through English.

2.2.2 Word problems. As well as considering the linguistic challenges of mathematical language and registers, it is also important to look at other ways language and mathematics are linked in the classroom, such as in word problems.

Word problems often cause challenges for ELLs due to their linguistic complexity (Martiniello, 2008). According to Martiniello (2008), English language learners especially struggle when presented with word problems that are complex. These problems involve such syntactic features as multiple clauses and long noun phrases. Furthermore, there are complexities with vocabulary in word problems that hinder English language learners, including unfamiliar words, and words with multiple meanings (Martiniello, 2008). The findings of Barbu and Beal (2010) support this. In a study of middle school aged English language learners, they found that when the linguistic complexity of a problem increased, English language learners were less successful in solving them. This stood true even if the operations were identical to a word problem written with simpler English, where the learners had more success. Making a student read and grapple with English vocabulary or syntax they are unfamiliar with before being able to attempt the mathematical problem can be a hindrance.

Not only can the language itself cause difficulties, but unfamiliar contexts in word problems can also cause issues. Brown, Cady & Taylor (2009) give the example of a young Mexican girl in an American classroom being given a word problem

involving hanging streamers for a party. The girl was unaware of the word ‘streamer’, although she was familiar with stream. As a result, this child tapped into her prior knowledge, knowing that a stream was a moving body of water and assuming that a streamer was related to a stream. She then spent a lot of time figuring out how streams could be measured and quantified in a room. If the context had been accessible to this student, these issues could have been avoided and she would have been able to focus on her mathematics, not trying to understand the written English.

Such issues do not negate the value of word problems; instead they highlight the need to give problems that are appropriate and designed for the student. Using word problems in the classroom has a number of benefits for all students. They enable students to gain a deeper understanding of the concepts being taught. To be used most effectively, word problems should be designed to enable students to make sense and meaning of a problem, as opposed to simply being presented with word problems as a way to demonstrate mastery and understanding of a computational property (Moscardini, 2010).

Word problems can be made more accessible to ELLs. Providing non-linguistic cues, such as diagrams and drawings, can make more complex language accessible (Brown, Cady & Taylor, 2009). It is essential that teachers are able to make appropriate modifications to the word problems they use, making such problems and their benefits to ELLs’ understanding more accessible.

For teachers this can present a challenge. The tools and resources teachers have available to them do not necessarily have accessible English for an ELL. Teachers have the challenge of providing ELLs with word problems that have authentic and relevant contexts, whilst not diluting the mathematics required.

2.2.3 Code switching. One important element in learning mathematics as an ELL is code switching. Code switching occurs when a student is actively and simultaneously working in two or more languages. It enables students to clarify their understanding and better express their arguments and ideas in mathematics (Zazkis & Zazkis, 2011). When students code switch in mathematics, their understanding of mathematics is enhanced (Anthony and Walshaw, 2007).

Code switching occurs not only between languages, but also between registers, with students moving between both ordinary English and mathematical English within the mathematical classroom (Zazkis & Zazkis, 2011). Within the classroom this switch is unavoidable; the everyday English register is used in communication both between teacher and students and between students (Boero, Douek & Ferrari, 2008). This can challenge ELLs, as it requires them to switch between registers that they have not yet mastered (Lager, 2006).

Code switching in mathematics is common and complex, often being done for different reasons, depending on the type of problem and the context in which it is done. In a qualitative case study of 16 Persian children in Years 4 and 5 in Australia, who undertook a mathematics test in English, it was found that most code-switched at some point (Parvanehnezhad & Clarkson, 2008). Code switching was more common in word or open-ended questions as the mathematics itself became more difficult, yet more common in the easier questions in symbolic format. They proposed that this is because children will code switch for different reasons, depending on the type of problem. Word and open-ended problems are more linguistically complex and use more context. Students may struggle to understand these in English and instead switch to Persian to enable understanding of the problem itself. On the other hand, when presented with symbolic questions, such as '38 x 6 =', students might automatically read them in their home language, and perform computations using Persian without explicitly thinking about it.

A common misconception teachers hold is that code switching has negative implications for students, and that students should be required to work exclusively within English, the language of instruction. This assumption that code switching negatively impacts learning is frequently a reflection of wider societal attitudes (Walker, Shafer, & Iiams, 2004). Attitudes toward the use of home language in the classroom, and beliefs about whether classes should be entirely conducted in English and students should be required to only speak in English, vary in both the US and New Zealand.

Research indicates that in New Zealand education contexts, allowing the use of a student's home language is often, but not always, seen favourably. In a 2004 study of teacher educators in New Zealand, examining their attitudes toward bilingualism, it was found that over 67% favoured bilingualism in the classroom over English-only environments (Smith, 2004). When asked about the use of an English-only environment, as opposed to encouraging teachers to use students' home languages in the classroom in private ESOL schools in Auckland, 50% of teachers and managers responded favourably to having an English-only environment, whilst the other 50% responded with a desire to have an environment that fosters and encourages bilingual interactions (Martin, 2004). The New Zealand Ministry of Education, through the English Language Learning Progressions (ELLPs) documents, encourages teachers to allow and encourage students to continue to learn in and through their first language (L1) and advocates for bilingual education. Code switching, or interlanguage use, is considered to be a normal part of second language learning (New Zealand Ministry of Education, 2008). Because New Zealand teachers have a lot of autonomy, however, this doesn't necessarily mean that individual teachers will encourage the development of a student's home language, or encourage code switching. In a study of teachers who spoke only English and bilingual teachers in a New Zealand early childhood setting (Ball, 2010) there were mixed attitudes from centre managers and associate teachers toward the use of a second language with the children. Some encouraged the use of the teacher or preservice teacher's use of the students' home language, whilst others heavily discouraged it and desired the students to also speak only English amongst themselves.

In the United States, attitudes towards code switching are also varied, with strong social and political support existing for English-only policies. An example of this is the political group, English for the Children, who advocate for English-only policies to replace bilingual education throughout the United States (English for the Children, 1997). Furthermore, the passing of legislation passed by referendum, that removes bilingual education in favour of English-only education in California, Arizona and Massachusetts, is indicative of wider social views against bilingualism in education in regions of the United States (Walker, Shafer & Iiams, 2004). Conversely, there is concern about the implications of English-only

education from the National Education Association, one of the major teachers' unions in the United States, as discussed by Weber (2006) in their magazine.

There are variations in teacher attitudes in the United States toward the use of a student's L1 in the classroom. In a study by Walker, Shafer & Iiams (2004) of teacher attitudes toward ELLs in an area with an historically low but rapidly increasing ELL population, it was found that 61% of teachers responded either favourably (15%) or neutrally (46%) to the idea that students learn English best when prohibited from using L1. There were also examples of principals putting a blanket ban on the use of any language but English throughout entire schools.

Insisting students and teachers use only English in the classroom is detrimental because it prevents students from utilising their home language to be able to understand, clarify and express their ideas (Zakis, 2000). Furthermore, it can mean that students miss out on a valuable resource. When a teacher is able to speak the home language of students, and employ code-switching strategically within the classroom, student achievement and learning is enhanced, as the student's home language is able to be used as a resource (Setati, Adler, Reed & Bapoo, 2002). This might be more difficult in a New Zealand classroom because of the high linguistic diversity found in New Zealand (Royal Society of New Zealand, 2013). In the United States, however, around 80% of ELLs are from Spanish-speaking backgrounds (Goldenberg, 2008). If the teacher is able to speak or learn Spanish, it is likely that their lessons will be enhanced. Simply enabling students to work in their own language can be beneficial: students who are allowed to access and work in their home language are able to develop their English mathematical vocabulary faster (Xi & Yeping, 2008). Not only does this benefit their mathematics in English, it also benefits their overall mathematical understanding, in comparison with their monolingual peers.

Dealing with multiple languages in the classroom is potentially challenging for teachers. Not only is it a challenge to find resources in the student's home language, but there is also the challenge of ascertaining a child's mathematical understanding when there is a language barrier. To only allow answers in English limits what a student is able to communicate. When a teacher does not speak the language of every ELL in his or her class, he or she is not able to understand

student responses in anything but English. Without outside assistance, this limits the ability for a student to answer in anything but English.

2.2.4 Academic language proficiency. A common, potentially detrimental misconception is that if a child is able to communicate fluently in English on the same level as their peers, then they are able to undertake academic work at a similar level. Cummings (2008) discussed the inaccuracy of this. He identified two forms of language competency: basic interpersonal communication skills and cognitive academic linguistic skills. Basic interpersonal communication skills are those children use in age-appropriate social situations. A child with strong basic interpersonal communication skills can converse with their peers, and interact fluently or near-fluently in their social and classroom conversations. Cognitive academic language proficiency, however, refers to the skills needed in academic situations. It is common for a child to be able to communicate in social situations whilst still not having the English skills to undertake more challenging academic work.

This can be for a number of reasons. One is the vocabulary. Mathematics has its own highly specialised vocabulary (section 2.2.1). If a student is unable to understand the technical vocabulary used in mathematics and doesn't have appropriate support, they are likely to face difficulty in mathematics, regardless of whether they can fluently converse about everyday things in English. Furthermore, academic language tends to be more decontextualised (Schleppegrell, 2012). Because so much of developing language understanding can rely on context, decontextualised language has the potential to further hinder ELLs**.** Having an understanding of the different forms of English proficiency can help a teacher to better support their ELLs.

Many teachers and policymakers believe language is developed a lot faster than it really is, and expect students to have no further issues after a certain amount of time. For example, in Arizona policies are in place that only offer ELL support for a student for up to one year. The assumption is that a student should be fluent or near-fluent in a language after a year of immersion (MacSwan and Pray, 2005). When the teacher lacks understanding of different types of language proficiency, it is easy to assume that a student will become fluent an a rather short timeframe, as

the timeframe students need to develop good interpersonal communication skills is much shorter than the time required to develop strong academic language proficiency (Cummins, 2008; MacSwan & Pray, 2005).

Language and mathematics are linked. Language enables students to communicate mathematically, and understand mathematical concepts. When learning mathematics through English, ELLs are faced with the challenges of understanding mathematical registers, comprehending word problems and switching between their home language and English. As a result, when teaching ELLs, mathematics teachers must not only be looking to teach mathematics in and of itself, but must also become teachers of language, and have a deep appreciation of the influence of culture on mathematical understanding. As Brown, Cady & Taylor (2009) discuss, "Since the language of mathematics is not universal and mathematics contexts are culturally bound, mathematics teachers must be aware of their role as a language teacher when working with English language learners." (534).

2.3 Culture and Mathematics

Culture is a complex concept, and it shapes the way students interact and learn. For this thesis, culture is defined as the norms, values, patterns of behaviour and attitudes one develops through socialisation in the communities one lives in and belongs to (Center for Advanced Research on Language Acquisition, 2015).

There is a perception that mathematics is culturally neutral, or that it is universal across cultures. There is some degree of universality within mathematics. A large number of countries and cultures have taken on the Arabic system of mathematical notation, meaning that there is some universality in being able to read and operate using the same mathematical symbols (Garrison & Mona, 1999). Adoniou & Yi (2014) suggest that there can be a mutual understanding of arithmetical operations amongst many, but not all, cultures. There is a degree of universality present especially when considering mathematics as a language, as there is some universality in the symbols and mathematical syntax used. Wagner (2009) discusses the universality of mathematics as a language, "Humans across cultures can understand each other's mathematics because we share common

experiences of patterns in the world and of trying to make sense of these patterns. We can understand each other. Understanding is an aspect of language." Making sense of patterns and the world around us is a universal idea. The universality that does exist within mathematics (for example equations that are consistent across many cultures), is important in the modern world. The consistency and intercultural understandability of a lot of mathematics enables developments to be made in areas such as science and technology, as well as areas such as business and finance, which are important internationally and require a large degree of intercultural communication (Leshem & Markovitz, 2013). This does not mean, however, that all mathematics is universal.

Mathematics is country- and context-specific, and has evolved differently across the years in a number of cultures. It is strongly tied to language as well, and often language barriers within mathematics can cause difficulty. For example, Japan and Korea use the unit of a man, or 10000, as a base for large numbers (Xi and Yeping, 2008). As a result, it can be difficult for a student to work within place values in English, with a base unit of 1000 for large numbers, even though the mathematics they are working on may look the same on paper. Holding to misconceptions surrounding universality can hinder a teacher's ability to effectively teach mathematics, as they are unaware and unable to provide for the linguistic and cultural needs of their students.

One cannot separate mathematics from culture (Ascher, 1991). The common misconception that mathematics is culturally neutral can have detrimental effects on student learning, as it means the students' cultural capital is being ignored and their needs are not being met (Haren, Holliday & Sharif, 2010).

The link between culture and mathematics is deeper than simply using familiar contexts. A number of other elements must also be acknowledged. The reasons why certain mathematical concepts exist in cultures and the beliefs underpinning them can differ. For example, the way patterns are created and analysed within cultures may differ wildly, regardless of the fact that the outcome might be somewhat similar. An example given by Ascher (1991) is strip patterns. These exist in both Maori and Inca cultures, but the style, purpose and links to other aspects of culture of these patterns differ considerably. All cultures have

mathematics in some form, but the way that it looks and the focus on what is important can differ, based on the values of a particular culture. At the same time, because of the spread of a small number of dominant cultures, a lot of mathematics around the world is now wrapped up in Western cultural assumptions and ideas (Ascher, 1991). François (2010) discusses the implications of this in classroom practice; in diverse classrooms students come from a range of cultures that determine how they see mathematics. Understanding and acknowledging this enables teachers to be responsive to their students in teaching mathematics.

Language and culture are strongly intertwined. This is very relevant for the ELL, as it means that the development that they have previously had of mathematical concepts and ideas within their own culture is not always directly translatable to classroom mathematics in a Western, English speaking classroom. An example is that not all languages have a base ten counting system. For example, speakers of the Northern Pame language in Mexico use a base 8 counting system (Avelino, 2005). These differences demonstrate the type of difficulties that ELLs can face. These issues have the potential to be further exacerbated if the teacher does not understand the linguistic nature of mathematics.

Every student enters a classroom with a degree of cultural capital. This cultural capital can either be utilised by the teacher to best meet the needs of the student, or ignored and diminished, thus further harming a student's motivation and creating a barrier to learning and achievement (Averill, Anderson, Easton, Te Maro, Smith & Hynds, 2009). Assuming mathematics is culturally neutral minimises the cultural and linguistic background and knowledge the student brings to the table (Haren, Holliday & Sharif, 2010). Recognising the cultural nature of mathematics, however, and understanding the importance of a child's cultural capital can enable a teacher to best utilise the child's home language and culture to develop their mathematical understanding.

2.4 Resources and Funding

Effective resources can help in teaching mathematics to ELLs. In New Zealand, there are resources available to support numeracy learning on the Ministry of Education run website, NZ Maths (www.nzmaths.co.nz). These resources include

some of the *Accelerating Learning in Mathematics* resources, such as resources two and three, which outline good pedagogy when teaching mathematics to ELLs, and resource four, which gives direct strategies using four different mathematics activities. Furthermore, some of the activities available on NZ Maths offer specific guidance and adaptations for working with ELLs, such as the activity *Dynamic Displays*, where teachers are given an activity to encourage ELLs to be able to make comparisons with adjectives (New Zealand Ministry of Education, 2010).

There are other resources available to New Zealand teachers too, although they are not necessarily mathematics specific. The New Zealand Ministry of Education website, ESOL Online (http://esolonline.tki.org.nz/), offers teachers strategies, readings and other forms of support for teaching ELLs. Even though the majority of the resources and sites are geared toward literacy, a lot of these principles transfer to mathematics. In recognising the dual role mathematics teachers have with ELLs as mathematics and language teachers, language resources are very relevant. Some of the language-based resources specifically address mathematics, for example the activity *Matching Exercises* (New Zealand Ministry of Education, 2012). Furthermore, the English Language Learner Progressions (ELLPs) enable teachers to identify where a learner is at, and how to further develop their abilities (New Zealand Ministry of Education, 2008). When a teacher understands how to develop a student's English skills, the student's mathematical language skills will also be developed, enabling a higher degree of mathematical understanding.

In the United States, school funding varies between states and districts, meaning that different levels of resourcing will be available depending on how much money is available and on the state or district spending priorities. These differences disproportionately disadvantage students from low socioeconomic backgrounds because property taxes are frequently used to fund schools. Students from low socioeconomic backgrounds are likely to attend schools that lack quality technological resources. (Lhamon, 2014). Because of this inequality in funding, it is difficult to know what resources are likely to be available to teachers. It can be assumed, however, that a large number of students from non-English speaking backgrounds attend schools where the resources available are lacking, because resources are so often tied to the socioeconomic status of the area of the school,

and the majority of immigrant students in the United States come from economically disadvantaged backgrounds (National Education Association, 2008).

In studies from the United States by Elfers et al. (2009) and Gandara, Maxwell-Jolly & Driscoll (2005), lack of appropriate resources was identified as an issue teachers faced when teaching ELLs. Elfers et al. (2009) noted that teachers identified a need for grade-level appropriate and content appropriate resources. Teachers described the need to create materials to fill gaps in the curriculum for ELLs, and some stated that they needed more resources to enable them to adapt or change existing curriculum. There were some cases where teachers, without the appropriate training or materials, tried an easier, or "watered-down", version of the materials and curriculum. This, as expected, didn't meet the needs of their ELL students.

2.5 Standardised Testing

In the United States, a challenge that all public and charter school teachers of mathematics face, which strongly influences their practice, is high-stakes testing (Dickey, 1997). The No Child Left Behind programme, which requires regular state-wide assessment, was introduced in 2001 (Duncan, 2011). Since then, there have been some changes, including waivers to offer individual states more flexibility (Duncan, 2011), but the United States education system still has a lot of standardised testing.

Whilst New Zealand does not currently have the United States style high-stakes standardised testing for accountability purposes, there are still testing challenges teachers face. Students in years 11 to 13 must be prepared for NCEA internal assessment and external examinations (New Zealand Qualifications Authority, n.d.). Furthermore, there are a number of standardized tests commonly used in schools, such as the Mathematics Progressive Achievement Tests, taken annually by students in Years 3-10 (New Zealand Council for Educational Research, n.d.).

The large-scale testing both countries have in place not only has an effect on teacher practice in general, but also has an influence on ELLs. Often the testing

requirements for mathematics rely heavily on language; students must be able to understand the English used in the testing to be able to answer the questions. In New Zealand NCEA exams there are a large number of word problems, as can be seen in sample papers and exemplars available through the New Zealand Qualifications Authority website (New Zealand Qualifications Authority, n.d.). Similarly, in state tests required under No Child Left Behind, a large number of the questions involve word problems (Pearce, Bruun, Skinner, & Lopez-Mohler, 2013). Whilst it is recognised that because of the language difficulties ELLs face, reading tests are inappropriate and therefore ELLs are exempt, there is no such recognition for mathematics. This means that all learners, including ELLs at all levels of language proficiency, must participate in this standardised testing (Wright & Li, 2008). This, according to Wright and Li (2008) is based on a false premise that mathematics provides minimal added difficulty for ELLs. Word problems tend to be problematic for ELLs and lead to lower test scores. For a number of students this is a challenge, as it effectively turns a mathematical assessment into a literacy assessment; students are being tested on their English reading ability as opposed to their mathematical ability, thus hindering the validity of these assessments (Kaesehagen, Klenowski, Funnell, Tobias, 2012).

Whether to give all students the same test without accommodations or to give modified versions of tests can create tension for those who must interpret the tests. On the one hand, a test conducted without any accommodations for ELLs can lack validity because the language barrier may prevent the student from understanding what is being asked of them, thus making the test a poor indicator of their ability in the subject being tested. On the other hand, when accommodations are given for students from non-English speaking backgrounds in standardized tests, it can be difficult to ensure that the tests are still standardised and that the results are the equivalent to what they would get if English was their home language (Mahon, 2006). Wright and Li (2008) talk about the potential of simplified English tests, but find these can still be problematic because to be able to test in English, there will always be some English requirement, thus meaning there is still potential difficulty for ELLs.

There has been very limited research on the implications of giving tests with simplified English to ELLs, or giving tests in their home languages, and whether

these do, in fact, enhance validity. In a study of US kindergarten and first grade students, Robinson (2010) found that Spanish speaking students performed significantly better in mathematics when they were able to sit the test in Spanish. This has important implications for these children, as it enables them to have their academic needs more accurately met; they aren't held back due to language barriers. In New Zealand, five studies by Bill-Barton & Barton (2005) on Mandarin-speaking students being assessed in English or Mandarin for mathematics found that across the board, students were at a 10-15% disadvantage when taking the tests in English. Four of these tests involved Year 12 and 13 students from four different New Zealand secondary schools, and the other was conducted using students from Auckland University. In their California study of eighth grade students, Abedi and Lord (2001) found that the gap in mathematics achievement between ELLs and students from English speaking backgrounds widened when students were assessed using word problems from the National Assessment of Educational Progress mathematics exams. When the word problems were rewritten in such a way that the content was the same, but the grammar, syntax and vocabulary used were simpler, the gap was reduced.

This does not mean that improvements when tests are offered in home languages are universal, however, especially when language shift, where a community has started moving from speaking one language to another, is occurring. In a Mexican study of Mayan children aged five and six by Solano-Flores, Backhoff, Contreras-Niño and Vázquez-Muñoz (2015), it was found that there was little improvement on their mathematics scores, regardless of whether they sat the test in Spanish, a Mayan translation of the Spanish or in a test in Mayan that used the same content and was developed from scratch. Part of this was due to a language shift, where the populations were moving to speak Spanish and therefore the Mayan language was not valued in education. This has implications for students from indigenous and language minority backgrounds. For children from indigenous backgrounds where language shift is occurring, ensuring assessment validity is more complex than simply offering a test in the child’s home language.

The fact that there are often discrepancies between the test scores of students when tested in English and in their home language or in simplified English, indicates that a student's score in an English-medium mathematics test is likely to

not be an accurate measure of their mathematical ability. This may make it difficult for teachers to effectively assess or plan for their ELLs. Furthermore, when language shift is occurring in a community, often students struggle in both their home language and the dominant language, leading to add difficulty in accurately assessing these learners.

2.6 Issues Faced in Teaching English Language Learners

It is essential that teachers of mathematics have sufficient training, resources and support to effectively teach ELLs. Gaining an understanding of the issues teachers face can help tailor efforts to support, resource and train them so they are equipped to teach mathematics as effectively as possible in these circumstances.

With the change in educational landscape in both countries, the role of the teacher has evolved as the number of ELLs has increased. In the United States there is a mismatch in the rate that the numbers of ELLs have grown, and the rate at which teachers are given support and training to be able to meet the needs of these students (Elfers et al., 2009). Many teachers say they do not have the strategies they need to effectively work with ELLs, and a number of teachers acknowledge that they lack the training and experience to meet student needs (Elfers et al., 2009).

Whilst there is little literature on the specific issues teachers face when teaching mathematics to ELLs, there are studies examining the issues that teachers of all subjects in mainstream classrooms face when teaching ELLs. A large study by Gandara, Maxwell-Jolly & Driscoll (2005), of teachers throughout California, found that there were some issues that teachers commonly faced. These included challenges in communication with students' families and communities; teaching content taking extra time because of extra language requirements; frustration with having to try to teach students with a wide variety of linguistic needs and levels at the same time; and a lack of teaching and assessment tools that were appropriate for ELLs.

In a Washington study by Elfers et al. (2009) it was also found that teachers struggled in communicating with the families of ELLs, and that teachers had a

lack of tools and resources to appropriately teach and assess ELLs. Other issues included having a lack of one-to-one assistance for ELLs, and having ELLs put in their classes before they had the necessary academic ability in English to be able to keep up with the class work.

2.6.1. Training. Gandara, Maxwell-Jolly & Driscoll (2005) found that teachers who had had greater preparation in teaching ELLs tended to have greater confidence, which translated to better outcomes for students. There are other benefits to teachers having strong preparation. According to Elfers et al. (2009), "when teachers lack complete, accurate information about certain groups of children they become more susceptible to misinformation, which can lead to the development of negative stereotypes" (16). These stereotypes can lead to detrimental situations for ELLs. For example, they can lead to the teacher blaming the learner for having difficulty if they are not aware of the needs of the student. Conversely, however, when teachers have sufficient training, they are likely to view ELLs in a positive light, and better meet their needs (Elfers et al., 2009).

The amount and quality of training and professional development in teaching ELLs can vary considerably. In their California study, Gandara, Maxwell-Jolly & Driscoll (2005) found that many teachers had little or no professional development in teaching ELLs, including 43% of teachers who taught classes that consisted of more than 50% ELLs. Richardson & Wilkinson (2007) found in a survey of Elementary teachers in Texas, 87% had had some form of professional development in teaching mathematics to ELLs, but only 56% of those who had undertaken professional development found it to be useful. In New Zealand, in a study of 18 secondary mainstream mathematics teachers, Edwards (2012) found that only eight had received any formal training in teaching ELLs.

When teachers of ELLs do have specific training, it leads to deliberate and notable changes in teacher practices. Teachers implement more ELL-friendly practices. When teachers have sufficient professional development and training, their planning for, and teaching of, ELLs becomes more intentional (Elfers et al, 2009). Furthermore, a review of research by Goldenberg & Coleman (2010), found that there tended to be a positive correlation between professional development for mainstream teachers on teaching ELLs and ELL achievement. Whether teachers

specifically consider lack of training to be an issue in teaching ELLs is an interesting question. The question arises as to whether lack of awareness of issues surrounding teaching mathematics to ELLs could lead to an unawareness of lack of training, particularly if the teacher believes in common misconceptions.

Elfers et al (2009) looked at different areas of support offered to teachers of ELLs in Washington State, a state that does not traditionally have a high number of ELLs, and the influence these had on the outcomes for ELLs. They found that the key areas of support that had strong influence were professional development opportunities, direct staff support, being part of a collegial community with the opportunity to collaborate with colleagues, and having access to materials and appropriate curriculum to teach ELLs. If a teacher has an issue with receiving appropriate support in any of these areas, it could have a detrimental influence on their ability to meet the learning needs of their ELL students.

Elfers et al (2009) mentioned that teacher collaboration was a way of offering teachers support and enhancing the teaching for ELLs. According to Goddard, Goddard & Tschannen-Moran (2007, cited in Elfers et al., 2009), when teachers are given opportunities to work collaboratively on curriculum, instruction and professional development in working with ELLs, there is a positive effect on student learning. Collaboration can also be effective when it occurs between teachers and other support staff, such as paraprofessionals/ teacher aides and subject coaches/resource persons. Collaboration allows teachers and other staff to work together to identify ways to solve teaching problems and meet specific student needs (Elfers, 2009).

2.6.2 Parental relationships. Gandara, Maxwell-Jolly & Driscoll (2005) investigated the issues teachers faced in teaching ELLs in California. Parental communication was the most commonly cited issue, and the ability to communicate well with parents was a priority for teachers. Building relationships with families and communities can be difficult when there is an obvious language barrier. Interestingly, however, when students are able to use their home language at school, and students' home languages are valued within schools, the relationships with families and communities are strengthened. This in turn can be used to enhance student learning (Elfers et al. 2009).

As well as the language barrier, there can be strong cultural barriers that also make it difficult to communicate and form relationships with parents. This is problematic, as forming strong relationships with parents, and having a strong cultural understanding, contributes to positive outcomes for cross-cultural learners (Eberly, Joshi & Konzel, 2007). Also, having strong parental involvement in schools, arguably a natural outcome of strong relationships, tends to have a positive effect on student outcomes, especially for students from family backgrounds with lower degrees of social capital, such as immigrant backgrounds (Sil, 2007). This cultural divide is further exacerbated by the fact that often teachers have biases, frequently unexamined, against other cultures and other ways of parenting, causing them to make false assumptions about parents (Eberly, Joshi & Konzell, 2007). These biases often are based on the assumption that the teacher's culture exemplifies the right and correct way, thus rejecting the cultural knowledge of parents. These biases may also imply that parents from certain countries don't care about their children's education (Shim, 2013).

In the US, the majority of ELLs come from Latin American backgrounds (Campos, Delgado & Huerta, 2011). As a result, teachers frequently need to form relationships and communicate with parents from Latino cultures. Within Latino culture, the role and expectations of the teacher are different from those in mainstream American culture: parents are less likely to contact the teacher if there is an issue, or to attend certain school events. This can also influence things that in Western culture are seen as signs of academic dedication, such as beliefs around the importance of homework completion. Whilst this is often falsely perceived by teachers as disinterest, it is more a reflection of a cultural attitude of respect and trust toward teachers; that teachers should be left to do their jobs without parental interference, as they are the experts and therefore know what they are doing. When there is trust and respect between teachers and parents, strong relationships are able to be formed (Eberly, Joshi & Konzel, 2007). Trusting that parents have their children's best interests at heart, understanding that assumptions about parents' interest can often be an outcome of ethnocentricity and not a true reflection of interest, and instead respecting cultural differences, have the potential for positive influence on student learning.

These issues are not isolated to the United States. Wherever there are students with parents from different cultural backgrounds, problems can arise because teachers are viewed differently within different cultures, and the nature of parent-teacher relationships and communication differs. An estimated 23% of New Zealand students are from non-English speaking backgrounds (Edwards, 2012). As language and culture are so strongly linked, this implies that most, if not all of these families have a cultural background that is not mainstream New Zealand culture. This means that students bring different perceptions of the teacher with them. For example, East and Southeast Asian cultures often reflect Confucian ideals in their education systems, where there is greater distance and formality between teacher and student (Feng, 1994). When students and parents bring different understandings of the role of the teacher, it is important the teacher is aware of this, to enable a strong relationship to be built.

2.6.3 Technological literacy. There were other areas where ELLs needed support and teachers faced challenges. One example of this, given by Elfers et al. (2009), was technological literacy. Because students are not necessarily exposed in their home country to the same degree of technology, nor expected to use it to the same degree in their home country classrooms, they can have difficulty when expected to work in the technology-heavy classrooms of the United States. One can infer that there would be a similar challenge in the technology-rich classrooms in New Zealand. Therefore, teachers face challenges in providing appropriate tasks for students that will extend their content knowledge and ability, without putting in a barrier of technology that the students are unable to use. A key example given was asking students to make a PowerPoint presentation. If students don't have the skills to do so, this is an extremely frustrating task that forms a barrier to student learning (Elfers et al., 2009).

2.7 Issues Faced in Teaching Mathematics

There are issues that face teachers of mathematics with regard to all students, not only ELLs. These issues can differ between primary and elementary teachers who teach all subjects, including mathematics, and subject specialist teachers who only teach mathematics at the secondary level in New Zealand and the middle and high school levels in the United States. These specialist mathematics teachers typically

have undergraduate qualifications in mathematics and have studied mathematics to a high level, whilst many elementary and primary school teachers have not, leading to different issues for teachers in the different levels.

2.7.1 Mathematics anxiety. One of the issues facing elementary and primary teachers of mathematics is their own mathematics anxiety and the effect this has on students. Elementary teachers tend to have a disproportionate amount of mathematics anxiety (McAnallen, 2010). Recent research indicates that 35-39% of elementary teachers currently experience some degree of mathematics anxiety (McAnallen, 2010).

Historically, mathematics anxiety has particularly been a problem for females, due to a lot of systematic assumptions of lower mathematical ability in women and bias against females in school curriculums (McAnallen, 2010). Although mathematics anxiety is less gendered now than it was historically, and patterns of students taking advanced mathematics courses are at fairly equal levels (McAnallen, 2010), there is, however, evidence to suggest that there is still a present disparity between the mathematics anxiety of female versus male preservice elementary teachers, with females more likely to experience mathematics anxiety (Malinsky, Ross, Pannells & McJunkin, 2006). Furthermore, many middle-aged and older primary and elementary teachers would still have been affected by the historical gender bias leading to stronger mathematics anxiety amongst females. This is especially problematic because traditionally teaching has been a strongly female-dominated field, and this is still the case in both the United States (United States Department of Education, 2014) and New Zealand (Education Counts, 2014).

Mathematics anxiety is due to a number of reasons, including bias as described above, parental and teacher attitudes, and mathematics education that is based on drills and procedure, as opposed to deeper conceptual understanding. Furthermore, pre-service elementary teachers tend, on average, to show higher degrees of mathematics anxiety than students of other majors, thus furthering the number of elementary teachers with mathematics anxiety (McAnallen, 2010).

This can cause difficulty for a number of reasons. When a teacher has mathematics anxiety, this can have a negative effect on their students (Johnson & vanderSandt, 2011) and it can undermine their ability to effectively teach their students in an appropriate manner. This has the potential to cause a lot of difficulty for ELLs, as teachers with mathematics anxiety are likely to struggle to be able to meet the unique needs of ELLs.

2.7.2 Mathematical and pedagogical content knowledge. Primary and elementary teachers also face issues in their training and education, and can often lack the content and pedagogical content knowledge required to teach mathematics effectively. Part of this is due to the fact that often people who are less mathematically inclined choose to enter elementary teaching, and hence lack sufficient mathematical understanding to effectively teach mathematics. A large proportion of pre-service elementary teachers identify mathematics as their weakest subject (McAnallen, 2010). There are different ways that have been proposed to remedy this, however, such as more time spent on developing mathematics understanding in pre-service teachers (McAnallen, 2010).

When teachers have low subject knowledge, the quality of instruction they provide suffers, impacting student learning (Ball, Thames & Phelps, 2008). To teach effectively, teachers must not only have strong content knowledge, but strong pedagogical content knowledge as well, which typically involves a deeper understanding than the simple content knowledge itself (Ball, Thames & Phelps, 2008). Pedagogical content knowledge is the knowledge of how to teach mathematics. It is necessary in order to be able to effectively teach the subject. Pedagogical content knowledge involves understanding and predicting student responses and misunderstandings, having a strong understanding of the curriculum and knowing relevant and effective techniques for teaching mathematics, so students can learn effectively (Aguirre, Zavara & Katanyoutanant, 2012).

If teachers lack both mathematical and pedagogical content knowledge, it will potentially have a negative influence on ELLs. According to Aguirre, Zavara & Katanyoutanant (2012), one aspect of pedagogical context knowledge is the knowledge of students' understandings, conceptions and the potential

misconceptions they may hold. As mathematics is not culturally neutral, is a language unto itself, and involves working within an unfamiliar register, the potential understandings and misunderstandings an ELL may have could differ from those of students from English speaking backgrounds. It could be therefore argued that effective pedagogical content knowledge involves having a strong understanding of the role that culture and language play in mathematics. Ballantyne, Sanderman & Levy (2008) suggest that an understanding of how to teach a subject to ELLs is itself an aspect of pedagogical content knowledge; that a teacher with strong pedagogical content knowledge will have specific knowledge of how to teach their content area, in this case mathematics, to ELLs. Specialised pedagogical content knowledge is required for teachers to be able to meet the concurrent linguistic and mathematical needs of their ELL students.

2.7.3 Conceptual understanding. Teachers at all levels are also faced with the challenge of teaching mathematics methods and concepts that may differ from the traditionally more rote-based way they were taught (Dickey, 1997). This requires many teachers to re-learn how they think about mathematics, to enable them to effectively teach students (Wisconsin Center for Educational Research, 2009). In both New Zealand and the United States, the way students are taught mathematics focusses on students understanding mathematical concepts, not only performing procedures (Common Core State Standards initiative, 2015; New Zealand Ministry of Education, 2010). This requires a lot more language use than rote methods do. The extra language requirements necessary to successfully and effectively teach students mathematics in a way that enables conceptual understanding is an extra challenge for teachers. This can be especially difficult when teaching ELLs, as it means that the linguistic requirements put on students are greatly increased. It is far more challenging for a student to have to explain their mathematical thinking than it is to simply complete a straightforward equation using an algorithm or specific procedure. A number of ELLs are not familiar with more conceptually based methods of mathematics teaching, and then have the added difficulty of having to explain their thinking in a foreign language (Slavit & Ernst Slavit, 2007)

2.7.4 Technology. The introduction and expected use of technology has further changed how mathematics is taught and learned, leading to more challenges for teachers of mathematics at all levels (Dickey, 1997). The extra challenges teachers are faced with make teaching all students more challenging, even without needing to adapt teaching to effectively teach ELLs. This is further exacerbated by the fact that the newer ways of doing mathematics tend to rely a lot more on explanation and language, thus adding more challenges for teaching ELLs (Slavit & Ernst-Slavit, 2007).

2.8 Gaps in research literature

There are three important gaps in the literature that warrant further exploration. The primary gap is the lack of research specifically on the issues teachers face in teaching mathematics to ELLs. Whilst there are studies on the issues teachers face in general when teaching ELLs, such as the studies referenced by Elfers et al. (2009) and Gandara, Maxwell-Jolly & Driscoll (2005), and one study looking at the professional development needs of teachers who teach mathematics to ELLs (Richardson & Wilkinson, 2007), there is no research specifically on the issues teachers face in teaching mathematics to ELLs.

Secondly, of these three studies, only the study by Elfers et al (2009) involved individual interviews. Gandara, Maxwell-Jolly & Driscoll (2005) undertook a large scale survey and Richardson & Wilkinson (2007) used focus groups. Whilst focus groups have a lot of parallels with individual interviews, there are benefits to using individual interviews over focus group interviews. Specifically, when focus groups are used, some participants can dominate conversation and others can shy away from sharing their perspectives (Menter et al., 2009).

Finally, none of these three studies are from New Zealand. Because of its unique education system and culture, it is important that there are studies that pertain specifically to New Zealand, instead of relying on the conclusions drawn in research conducted elsewhere.

2.9 Chapter Summary

The current body of research indicates that there are a number of issues teachers face when teaching mathematics to ELLs. Some of these issues have to do with the relationship between mathematics and language; teachers must consider mathematical registers, word problems, the use of code switching, and the development of academic English proficiency. Furthermore, teachers face challenges because of cultural differences: there are differences between cultures in the place of mathematics and different intercultural patterns of interaction. Resources can be an issue. Teachers need available resources which are at both an appropriate language level and an appropriate mathematical level for ELLs. Standardised testing is also an issue for both teachers and students. Complex language requirements affect the validity of tests in both New Zealand and the United States. When teaching ELLs, teachers face a number of issues, especially with training and in forming relationships with families. For teachers of mathematics, especially those who teach mathematics as part of a primary/elementary curriculum with multiple subjects, the teacher's own confidence, pedagogical content knowledge and interactions with technology can all cause issues.

There appears to be a dearth of research on the issues teachers face when teaching mathematics to ELLs. Exclusively relying on inference from separate research on the issues teachers face in teaching ELLs and those faced in teaching mathematics potentially leaves important issues unaddressed. Because there is limited research specifically addressing issues faced by teachers when teaching mathematics to ELLs, this study was designed to investigate these issues. In the next chapter, the research design of this study will be discussed.

Chapter three: Methodology

3.1 Introduction

This research, undertaken to explore the issues teachers face when teaching mathematics to ELLs, involved a qualitative study of ten teachers; five from New Zealand and five from the United States. It was conducted using semi-structured interviews over webcam. The research question addressed was:

> *What are the issues faced by teachers in New Zealand and the United States when teaching mathematics to English language learners?*

In the first section of this chapter, the literature surrounding the research methods used in this study will be examined. Next, the procedures used to gather data in this study will be outlined. This includes information on participants, recruitment of participants, an outline of the interview procedure itself and data collection and analysis. Lastly, ethical considerations will be addressed.

3.2 Research Literature

In this section, literature on the qualitative data and the use of interview will be examined.

3.2.1 Qualitative data. Qualitative research is a holistic form of research (Toma, 2006). It involves collecting descriptive data in natural settings, with a focus on gaining an understanding of participant perspectives (Bogden and Bilken, 1998, Toma, 2006) Qualitative research is especially valuable when it is used in the exploration of ideas and problems where little is already known (Cresswell, 2005).

There are many benefits to undertaking qualitative research. Qualitative research is especially valuable when an understanding of participant perspectives is desired. It is focussed on making meaning and gaining an understanding of the perspectives of participants (Toma, 2006). It involves a great deal of flexibility. This flexibility enables a greater depth of information to be gained (Mack, Woodsong, MacQueen, Guest and Namey, 2005).

Qualitative research not only enables the identification of trends and patterns within social contexts, but also enables exploration into the reasons behind these trends and patterns. It enables the researcher to investigate why patterns and trends exist within data involving people and social patterns (Opie, 2004)

There can be disadvantages to doing qualitative research. Qualitative research tends to be less generalisable than quantitative research. The data collected in one situation or in working with one group of people doesn't necessarily transfer to similar situations or people with similar characteristics (Bogden and Biklan, 1998).

Furthermore, qualitative research can be more strongly influenced by researcher bias (Bogden and Biklan, 2008). Qualitative research involves a lot of researcher interpretation of subjective data. When gaining and interpreting this data, researchers must take care to ensure that the voices and perspectives of the participants are accurately understood and communicated (section 3.4.1).

A qualitative study design was appropriate because the issues teacher face are a matter of individual perspective; what one teacher may consider an issue another may not, and what is important to one teacher may not be to others. To gain deep understanding, a range of open-ended questions was used to encourage detailed responses.

3.2.2 Use of interview. Interviews enable in-depth information about participants' perspectives to be gained (Opie, 2004). Interviews enable participants to express their opinions and perspectives in their own words, which can lead to further insights for the interviewer (Bogdan & Biklen, 1998). Using interviews in qualitative research allows a lot of flexibility (Menter, Elliot, Hulme, Lewen, & Lowden, 2011).

There are many advantages to using interviews. Interviews enable in-depth data to be collected that cannot otherwise be collected through observation (Cresswell, 2005). The data collected reflects participants' own views, using their own terminology, and enables participants to discuss things that are unforeseen to the

interviewer (Menter et al., 2011). Furthermore, questions are able to be asked that elicit clarification or further responses from a participant (Cresswell, 2005).

There are, however, some disadvantages to using an interview approach. The quality of an interview is highly dependent on the social dynamic between the interviewer and the participant. If the participant does not feel comfortable with the interviewer, they are not likely to give sensitive information (Menter et al, 2011). Furthermore, there is strong risk of interviewer bias, as they can steer the interview through question design (Cresswell, 2005). Both of these need to be considered when designing an interview-based study.

Interviews can range in their degree of structure and formality. Structured interviews involve a set of pre-planned questions that the interviewer does not deviate from, whilst unstructured interviews do not involve predetermined questions and the only objective is to understand the views of the participant. Semi-structured interviews involve a set of predetermined questions, but are flexible. Interviewers have the flexibility to deviate from the questions and ask follow up questions to participant responses as they see fit (Menter et al., 2011).

Using a semi-structured interview approach enables participant answers to be directly compared (Newton, 2011), whilst still permitting follow-up on specific responses from participants that prompt deeper exploration (Menter et al, 2011). There is also the advantage that the participant has the space to tell their stories, and share their opinions and ideas, which is not as possible in a highly structured interview format (Bogdan & Biklen, 1998).

3.3 Investigation

In this section, the selection of participants and site of interviews will be discussed, and an overview of the interview procedure, data collection and data analysis will be given.

3.3.1 Participants. To be able to do a comparative study, participants needed to be recruited from New Zealand and the United States. To avoid conflict

of interest, references from prior colleagues and friends were used, so that there was no prior relationship between interviewer and participant that could influence the validity of the interview data (section 3.4.1).

There was a deliberate choice to focus on teachers from both regions and states with a high number of ELLs, and regions and states with low numbers of ELLs. This was because of the potential for resources and support given to teachers in regions and states with a higher percentage of ELLs to be stronger than the resources and support available to teachers in regions and states with fewer ELLs.

All of the participants were teachers in mainstream classrooms. The aim was to recruit participants from diverse backgrounds, considering aspects such as grade level and sex. Unfortunately, only one High School teacher volunteered, so the results are skewed strongly toward elementary and primary school teachers.

Table one shows the demographics of the participants and the areas they teach in.

Table 1: *Participant Demographics*

Participant	Demographic category						
	Country	Years teaching	Sex	Proportion of English language learners	Socio-Economic background (learners)	Year or Grade level	School area
Andrew	USA	>4	M	<20%	Low	4th Grade	Urban
Brian	USA	≤ 4	M	>20%	Low	9th Grade	Urban
Cameron	USA	>4	M	>20%	Low	4th Grade	Small town
Dominic	NZ	≤ 4	M	<20%	High	Year 5/6	Urban
Emily	USA	>4	F	>20%	Low	4th Grade	Urban
Felicity	NZ	>4	F	<20%	Low	Year 4-7	Suburban
Gabrielle	NZ	≤ 4	F	<20%	High	Year 5/6	Small town
Helen	NZ	>4	F	<20%	High	Year 1/2	Urban
Isabel	USA	> 4	F	<20%	Low	5th Grade	Urban
Justine	NZ	≤ 4	F	<20%	Mixed	New Entrants/ Year 1	Suburban

3.3.2 Site of interviews. The interviews were conducted using video conferencing. According to Menter et al. (2011), interviewing over video conferencing platforms, such as Skype, tends to be similar in nature to face-to-face interviewing. Using video conferencing enabled the interviews to be conducted over a large geographical area at times that were convenient for participants, taking into consideration factors such as time zones. Participants were in their homes or workplaces when they participated, whilst I was in my private home office, where there was no risk of interruption. This was important to maintain confidentiality for the participants.

3.3.3 Overview of interview procedure. In this study, a semi-structured interview approach was used. This enabled the collection of in-depth data, in participants' own words. Using semi-structured interviews gave participants the

opportunity to elaborate and share information that they considered to be relevant or interesting (section 3.2.2).

This research involved undertaking semi-structured interviews with ten teachers, five from New Zealand and five from the United States. Each participant participated in one interview in June or July, 2014. The interviews ranged in time from 30 minutes to one hour and 40 minutes. Each participant submitted a consent form before participating (Appendix four). The right to withdraw at any time for any reason was reiterated at the beginning of the interview, with verbal consent being gained again. As stated above, the interviews had a semi-structured interview format; participants answered a set of predetermined questions and follow-up questions were asked as relevant. Please see Appendix 1 for the specific pre-planned questions.

3.3.4 Data collection. The data was collected in two ways during the interviews. I took notes as the interview progressed, and the interviews were also recorded using a computer-based audio recorder. These interviews were then transcribed into Microsoft Word documents.

3.3.5 Data Analysis. The qualitative research data was analysed through codification of the transcripts. Codification involves identifying general, broad themes, and then highlighting key points related to these themes in the transcripts through labels known as codes (Menter et al., 2011). Once the transcripts have been labelled with codes, these codes are grouped into larger categories, enabling analysis of the data.

After the interview data had been transcribed, the transcripts were read through so a general overview of the data could be gained. Initially, larger themes were identified, such as teacher confidence and support. Codes were then created for these themes, and applied within the different transcripts to identify patterns. As patterns emerged between codes, they were grouped into larger categories that were used as the basis of analysis (Appendix five).

The categories within the transcripts were then examined and the key points pertaining to the research question were identified and discussed. This involved a

focus on both the common issues that affected a large number of participants, and issues that only had an effect on a small number of participants but were considered highly relevant to the research.

3.4 Quality Criteria

When undertaking research, it is important to ensure that the data collected is of high quality. In this section, the validity and generalizability of the data collected will be discussed.

3.4.1 Validity. Validity involves ensuring that the data collected accurately "measures what it was intended to measure" (Lodico, Spaulding, & Voegtle, 2010, 27). Qualitative data tends to have a strong degree of internal validity. Internal **v**alidity, or credibility, involves ensuring that the data gained and interpretation of the data truly reflects participants' perspectives (Toma, 2006). Validity in interviews relies on how well the voice of the participant is reflected in the research, not the perspectives of the interviewer (Newton, 2010).

There are benefits and concerns with regard to validity in a semi-structured interview format. One of the risks to validity when doing a semi-structured interview is the interviewer's own bias being reflected in the questions, with the questions themselves leading the participants (Newton, 2010). Furthermore, this bias can be reflected in a rigid question design, where the interview only focuses on what the interviewer deems to be important, rather than what is important to the participant. To avoid this, the final questions were general, open-ended questions, where participants were asked what issues they faced and how they could see these issues being mitigated. As teachers, they are aware of what they face in and out of the classroom. In asking these questions, issues that weren't previously addressed in the interview were able to be identified by participants, ensuring that the real issues teachers faced were addressed, as opposed to simply whether they faced the researcher-identified issues. This helped to mitigate concerns about participants only being asked questions that reflected the researcher's assumptions about what issues participants faced.

There are multiple methods for ensuring validity and mitigating interviewer bias. Member checking is one of these methods, where participants' answers and the interpretations thereof are reflected back to the participants, in oral or written form, ensuring that what they expressed has been understood correctly (Cresswell, 2005). Member checking was used throughout the interviews to ensure validity. After each question, other than demographic questions, I reflected back to participants to ensure their meaning was understood. This process provides a level of confidence that the interpretation of results from the transcripts is correct.

Participants were selected through referral and were not personally known. This was a deliberate measure to ensure validity. If there is a personal relationship between participants and the interviewer, the chances are higher of participants not speaking freely, due to concerns over the relationship (Seidman, 2013). To mitigate these threats to validity, participants were chosen with whom there was no personal relationship.

3.4.2 Generalisability. Generalisability, or transferability, is the ability for findings to be applied not only to the sample group, but across similar situations (Toma, 2006). Due to the nature of qualitative research, generalisability is less important than the internal validity. This does not mean it is unimportant, however. It is important that studies can be related to other work, in order to gain a bigger picture of issues and enable design of policy or further research (Toma, 2006).

There are limits to the generalisability of this study, because the sample size was small, with only ten participants, and because of the open-ended nature of the questions and responses. While the small sample size cannot be completely mitigated, there was an effort made to maximise generalisability by deliberately seeking participants from a wide range of backgrounds, with a focus on gender, region, concentration of ELLs, level taught and teaching experience. With such a small sample size, it is difficult to determine generalisability when a small number of participants experience a specific issue. If a large proportion of participants share similar issues across such wide backgrounds, however, there is a stronger likelihood that this is an issue that is widespread and that the findings are more generalisable.

There was an effort to recruit participants from a range of age levels. Unfortunately, once volunteers started to come forward, nine of the ten taught in primary/elementary schools, thus potentially causing issues with sampling bias.

3.5 Ethical Considerations

There are a number of ethical considerations that were taken into account when preparing and undertaking this research. Prior to doing this study, I foresaw little harm to participants. Research is never completely harm-free, however, (Shaw & Barrett, 2006) and steps were taken to minimise the potential harm that could be done to or happen to participants as a result of participating in this study. These steps included gaining informed consent, ensuring confidentiality, and ensuring that data collected was stored safely.

3.5.1 Informed consent. Participants were given an information sheet and a letter outlining the research and the request for an interview (see Appendices 2 and 3). The procedure was outlined in the letter and they were aware they would be participating in an interview, over Skype, of around one to one and one half hours. Participants signed a consent form (see Appendix 4) and consent was obtained again prior to beginning the interviews. It was stressed to participants and written on the consent form that they had the right to withdraw at any point during the interview, and had the right to choose not to answer questions. The interviews were recorded for future reference. The participants were made aware of and gave consent for this.

3.5.2 Confidentiality. All participants' identities were kept in complete confidence. Pseudonyms were used to protect their identities and locations and specific circumstances were made deliberately vague. None of the participants' schools were identified in the research. No notes or recordings were kept with participant names attached. Nobody who referred a participant was told if the person they referred was participating or not.

3.5.3 Collection and storage of data. With participant consent, interviews were recorded in audio format. This data was stored in a password-protected

section of my computer. Nobody but me was able to access this material. Transcripts of the data were also stored in a similar manner. After five years, all data will be destroyed.

3.5.4 Further minimisation of harm. One source of potential harm for participants was if the information they shared in confidence was made available to any other parties. To prevent this I ensured that all data was stored in a secure and anonymous manner. It is not believed that professional reputations would be at risk as a result of participating in this study, nor because of any information shared in this study. It is still important, however, to maintain confidentiality.

There was also the potential for emotional distress as a result of taking part in the research. Whilst the nature of the questions was not particularly sensitive, and I saw no serious potential for emotional harm from answering them, it was still stressed to participants that participation was entirely voluntary, and they could choose not to answer any questions they felt uncomfortable with, could opt out of the interview at any time, and that all records of their involvement could be destroyed at any time they requested.

3.6 Chapter Summary

To be able to effectively gain an understanding of participant perspectives on the issues that they faced, I decided to undertake qualitative research, through interviews. By using a semi-structured interview format, participants were able to elaborate on their own thoughts and share their perspectives. As with all human-based research, there was some potential for harm to come to participants. Steps were taken to mitigate this potential harm, including gaining informed consent, keeping participant data confidential, storing data safely and ensuring that the questions in the interview were not likely to cause emotional distress.

Chapter Four: Results

4.1 Introduction

The study was undertaken to answer the question:

> *What are the issues faced by teachers in New Zealand and the United States when teaching mathematics to English language learners?*

The study involved semi-structured interviews with ten participants, five from New Zealand and five from the United States. Themes were identified from interview transcripts. These related to teacher confidence, mathematical language, assessment, support and resources, and culture. In this chapter, the perspectives of participants around these themes will be explored.

4.2 Teacher Confidence

A dominant theme that emerged was how confident teachers felt in teaching mathematics to ELLs. Some felt very confident, whilst others lacked confidence, both in working with ELLs and in teaching mathematics.

Questions 6 and 7 (appendix one) investigated teacher confidence. These were:

> 6. How confident do you feel teaching mathematics to English language learners? Why/ Why not?
>
> 7. What would make you more confident in teaching mathematics to English language learners?

Table 2 shows the number of teachers reporting problems with confidence in teaching mathematics, and in teaching ELLs.

Table 2: *Reported issues surrounding confidence in teaching mathematics and in teaching ELLs.*

	Number of participants		
Type of Issue	New Zealand	USA	Total
Lack of confidence in teaching mathematics	2	0	2
Lack of confidence in teaching ELLs	0	1	1

Participants reported varying degrees of confidence. Seven reported feeling very confident in teaching mathematics to ELLs, two reported having a moderate degree of confidence, and one participant reported a lack of confidence. Participants gave a number of reasons why they felt this way.

One reason three American participants were confident was because they felt mathematics was somewhat universal. Andrew and Emily both discussed it as being universal in comparison with other subjects, especially literacy/language arts.

Isabella and Emily suggested that basic computation in mathematics can be universal, but there can be issues with understanding complex written problems as opposed to simple arithmetic computation. As Isabella described it

> *...I almost feel that math is something that is somewhat universal... Numbers are things that people can understand no matter where they're at, so I find that math – straight computation, is comfortable for them. I think what's always difficult is … understanding… math problems and multi-step problems…these words are unfamiliar, the kids don't hear them at home.*

The language requirements of mathematics were also why New Zealand teacher Dominic felt only moderately confident. He felt that the language and vocabulary required to explain concepts to students often exceeded their English ability.

> *Sometimes, when you're explaining things, there are particular words you*

need to use or you feel you should use makes it kinda, sometimes, sometimes a bit difficult.

He can often mitigate these difficulties by using manipulatives and visual aids, however, giving him a greater degree of confidence:

But, by and large, when you're using materials and you're using, like, images… it tends to be a bit easy because you're still using the language and still able to describe what you're doing [but] it's not like you have to explain everything because they can see you. The numbers, the materials – it's just speaking for itself.

Ninth Grade American teacher Brian reported lacking confidence in teaching ELLs. ELLs were the lowest performing demographic in his classes. When asked how he could improve his confidence he responded that training, resources, translation and support would be the biggest confidence boosters for him. Overall, Brian describes the situation regarding teaching ELLs as "a mess", negatively affecting his ability to effectively teach ELLs.

Two of the participants, both New Zealanders, reported lacking confidence in their mathematics ability, but both of these participants reported having a high degree of confidence in teaching mathematics to ELLs. One of these teachers, Helen, felt comfortable and confident teaching her level, Years one and two, but felt that higher levels would challenge her own mathematical ability.

The second teacher who had a lack of confidence in her mathematical ability was Felicity, who felt confident in most areas of mathematics, but not in her algebraic ability, and felt this was an issue that negatively affected her ability to teach all students, especially ELLs.

The one that's still hard is … when you don't have the same confidence in a particular strand. So algebra does my head in, I have to be very honest about that… I mean repeating patterns, sequential patterns, is all fine, but I'm talking about x to the power of two et cetera. I'm totally lost myself. That is obviously going to severely impact my ability to teach it to

an English speaking child, who has always spoken English, as much to an ESOL student as well. And that comes back to your own mathematical knowledge.

Three participants felt their difficulty in teaching mathematics to ELLs related to the age of the students. Both of the New Zealand junior level teachers interviewed, Helen and Justine, stated that they felt confident with their age level but wouldn't feel as confident with older students. For Helen, this was because of her own lack of confidence in higher-level mathematics.

For Justine, it was because of the language requirements needed to explain the more complex concepts encountered at a higher age.

My English language learners are at the lower end… and so it's very hands on, yeah, very basic. Very, "find colours in magazines… and cut them out and stick them together. We walk around shapes, we – there's a lot of vocab. If I were to go up to [Numeracy Project] Stage 4 and above with English language learners, I would not feel as confident. Although, I dunno, we are doing quite a bit at our school vocab-wise anyway, so I suppose I'd just transfer what I do in English and writing into maths, but yeah, probably not as confident in the higher levels.

Brian also thought that teaching older ELLs was more difficult. He felt that high school was more challenging, because of the higher degree of language and conceptual understanding required. In his experience, younger levels focus more on procedure, which is easier to teach to ELLs, as procedure involves clear steps. In high school, however, asking students questions that involve more analysis and discussion needs higher language ability.

I think when you get to secondary level with math you start to move away from the procedural type math, where it's step one, two, three, which in my mind is much easier to teach when there's a language barrier. Show the work, step-by-step, what's going on. [High school mathematics] is moving toward the more abstract contextual type questions which is much harder to explain and express when you don't have clear communication.

> *So if you want to teach a student to find the slope, even when they don't speak any English, you can show them how to use the slope formula…But when you say to a kid "O.k., here's a situation where you're looking at a graph that says distance over time, what does the slope represent?" Getting them to say the slope represents the speed you're travelling is a whole other beast. And when they're not speaking English, getting that point across and getting that conceptual understanding, as opposed to just procedural understanding, is extremely difficult.*

In summary, seven teachers felt either very or somewhat confident in teaching mathematics to ELLs, whilst three did not feel confident. Two lacked confidence in their own mathematics ability, whilst one lacked confidence in teaching ELLs. Three participants' confidence was based on the age that they teach, with lower confidence being associated with older students. One aspect that was discussed that can influence teacher confidence is training.

4.3 Training

Training was discussed with every participant. Insufficient training hinders teachers' ability to teach mathematics to ELLs. The training discussed included pre-service and professional development training. Some participants had undertaken further training, including ESL endorsements or graduate diplomas in teaching ELLs.

One two-part question addressed training:

> 8. How much training have you had in teaching English language learners? Do you feel this is sufficient?

Lack of training was an issue that influenced participants' abilities to teach mathematics to ELLs. Eight participants had expressed a desire for more training. More training was a common response to questions about how to increase confidence.

Table 3 shows the areas participants reported having training in. It includes training specifically pertaining to teaching mathematics to ELLs and general training in teaching ELLs.

Table 3: *Reported training in teaching ELLs*

	Number of participants		
Type of training	New Zealand	USA	Total
Preservice: Teaching mathematics to ELLs	0	3	3
Preservice: Teaching ELLs	3	4	7
Professional Development: Teaching mathematics to ELLs.	0	2	2
Professional Development: Teaching ELLs	5	2	7

Note: One New Zealand participant had discussions with his peers within professional development training on teaching mathematics to ELLs, but no formal training.

Only three participants had undertaken training that specifically addressed the needs of ELLs when teaching mathematics. Two participants, Cameron and Emily, had both trained in California and trained under the assumption that ELLs would be in their classes. Therefore, in all of their training, including mathematics, they received instruction on how to apply it to ELLs. Both had then taught in areas with heavy ELL populations, where this assumption continued to be reflected in their professional development.

> *So all of our trainings and stuff we would do, all the P.D.s would normally have some aspect of, "and you're gonna have ELD kids and this is how you teach them". So it's just always built in.* - Cameron

> *I think everything they do is catered to English language learners, whether they say it or not, because our demographics are just that.* – Emily

Brian, from Texas, received three hours of training on teaching mathematics to

ELLs as part of his preservice alternative certification training. While he found this training to be a good starting point, he did not receive in-school training, so he still felt extremely unprepared to meet the needs of ELLs.

> *I remember thinking it was a good introduction and they definitely gave solid ideas...But I remember thinking it didn't really delve into the specific strategies. It was kind of like an overview.... I think it was something that they had thought we would get more of when we got back to {city he teaches in}, but that training never materialised.*

Of the seven remaining participants, all of them apart from Andrew had received training on teaching ELLs that was not mathematics-specific. The amount and quality of this training varied. Three teachers had extensive ELL training: New Zealand teacher Helen, who had completed a Graduate Certificate; American teacher, Emily, who had completed an ESL Endorsement; and New Zealand teacher, Gabrielle, who had attended extra professional development workshops as an ESOL unit holder. At the other end of the scale was New Zealand teacher Felicity, who had received three hours of training throughout her 25-year career, including webinars. She felt frustrated at the recent transition to webinar-based professional development, as this did not work for her learning style. She felt her lack of professional development was an important issue.

> *...One of the really bad things I think New Zealand has [done is] gone down the webinar thing... Webinars don't really work for me, and neither does sitting in front of a book on my own. I'm like a lot of our Maori children, actually, I learn best by talking. So no, I've had very little, and I actually think New Zealand needs to take a good long look at that because we're actually offering these kids... quite a disservice really.*

Furthermore, whilst Gabrielle felt that she had received sufficient training in teaching ELLs due to being the ESOL unit holder, her colleagues had not.

> *I've got a little bit extra because I've got the ESOL funding, but I know that a few teachers feel... kind of almost in the dark about what to be doing with their ESOL kids.*

Commonly, preservice training involved very little training on teaching ELLs. For Gabrielle, this was only a few readings. New Zealand teachers Dominic and Justine and American teacher Isabel received one lesson in their class on teaching learners with special needs. They did not have a specific paper or class on teaching ELLs.

Two teachers from New Zealand, Gabrielle and Felicity, had a school-wide focus on mathematics teaching in their professional development. Gabrielle mentioned that, whilst mathematics professional development might not specifically address ELLs, the information learned is relevant, because good pedagogy is especially important for ELLs.

> *Although [professional development] isn't specifically geared toward English language learners, a lot of it is pedagogy that benefits English language learners. So, a lot of it is toward an engaging context [and] not assuming students can understand the problem, which is kind of even bigger when you're talking about English language learners... So I think the training that I have had, even though it's not geared to English language learners, has been really good.*

Gabrielle summarised the link between good pedagogy and ELLs, referring to the strong pedagogy required to effectively teach ELLs mathematics.

> *What I've been learning a lot on the courses I've been going to is teaching English language learners is about really, really good pedagogy, and what is good pedagogy for English language learners is good pedagogy for everyone.*

Training was considered important. Eight participants desired more training as part of professional development. Only three participants, all American, had received specific training in teaching mathematics to ELLs. The amount of training participants had varied, both in preservice training and in professional development. It was acknowledged by Gabrielle that it is important teachers are trained in good pedagogy for teaching mathematics, which would improve

outcomes for all students, especially ELLs. This is especially true when considering language and mathematics; teaching with an awareness of language issues is good for all students, but especially important to ELLs.

4.4 Language and Mathematics

Participants frequently discussed issues surrounding language and mathematics. Two common themes emerged. The first theme was around the language requirements of mathematics; that teaching and learning mathematics required a lot of language. The second was word problems, where reading levels and contexts were inappropriate for ELLs.

Language issues in teaching and learning mathematics were discussed in response to four open-ended questions:

11. What are the greatest challenges you face in teaching English language learners mathematics?
12. What do you think could help you with these challenges?
13. What other issues do you face in teaching English language learners mathematics?
14. How do you think these issues could be minimised or avoided?

Table 4 shows the number of participants who reported having issues with the two identified themes surrounding language and mathematics; mathematical language and word problems.

Table 4: *Reported issues surrounding language and mathematics*

	Number of participants		
Area of Issue	New Zealand	USA	Total
Mathematical language	4	2	6
Word problems	3	3	6

4.4.1 Mathematical language. Eight participants discussed mathematical language. For Emily and Cameron, mathematical language was something they

acknowledged and planned for, but not something they had issues with. Cameron acknowledged his dual role in teaching mathematics to ELLs; that of both a mathematics teacher, and an English teacher.

> *Even the math stuff is a language arts lesson, because you still have to talk or write to explain.*

Mathematical language posed a challenge for six participants; four New Zealanders and two Americans. The language needed for effectively explaining mathematical concepts and the requirements for children to be able to participate in mathematics posed a challenge, especially with the shift to more conceptually based mathematics. As ninth grade American teacher Brian discussed:

> *When [students are] not speaking English, getting that point across and getting that conceptual understanding as opposed to just procedural understanding is extremely difficult.*

New Zealand teacher Felicity also discussed this.

> *There is a much higher demand for them writing down their answers now, and [being] literate in a literary manner, rather than just a numerical manner, and that's again, not accommodating to [ELLs'] needs.*

Non-numerical strands posed a challenge for three participants, two from New Zealand and one from the United States. Participants described the strands as posing extra challenges because they required a larger vocabulary and more explanation than numeracy. Felicity discussed this.

> *I mean, "interpret the data", "explain" - as soon as you use those words, which make up the strand requirements, really, of maths, it's language demands that are coming back at these children.*

This sentiment was also shared by New Zealand teacher Helen.

> *Your measurement and geometry and the other strands can be not as*

successful because there's more language being introduced that they don't know.

American fifth grade teacher, Isabel, also discussed the language and vocabulary demands of strand work, suggesting a need for simplified vocabulary to enable ELL understanding.

So yeah, maybe having a more simplified vocabulary in a sense can be helpful because in fifth grade we're really just trying to get that algebra rich – and geometry, and new things are just really kicking up and we're getting a lot of new concepts.

4.4.2 Word problems. Word problems were also an issue for six participants. Word problems require strong literacy skills, and were a struggle for students who had not mastered the English required to interpret and understand them. New Zealand teacher Felicity discussed the challenges of students not being able to understand the word problems in assessments.

There's almost a paragraph... in a story or setting, and the kids are having to unpack the literacy demands to work out what the literacy question really is, and a lot of errors are coming through with that...and so we've automatically , you know, we're not accommodating their needs, simply by what we've done there.

Another challenge with word problems was the cultural capital required for students to understand what is being asked in the word problems. American teacher Emily discussed this.

Sometimes if there's something where [ELLs] need to have some background knowledge, some real world experiences, they won't...Maybe they might have [background knowledge and experience] but they won't know what I'm talking about in English... So sometimes their background knowledge and my background knowledge don't relate.

There were two main areas in which participants reported having issues regarding

language and mathematics. There were concerns about using mathematical language with ELLs and the extra challenge this presented both the teachers and the learners themselves. Furthermore there were concerns with word problems and the difficulties ELLs faced with both the language used and the context of word problems. This is especially important because word problems are frequently used in assessment.

4.5 Assessment of English Language Learners

Teachers faced issues surrounding both formative and summative assessment. There were particular concerns around the language demands of assessment and in ascertaining whether a student is struggling because of a language barrier or because of the mathematics itself.

Assessment was commonly discussed when teachers were asked the final four questions:

11. What are the greatest challenges you face in teaching English language learners mathematics?
12. What do you think could help you with these challenges?
13. What other issues do you face in teaching English language learners mathematics?
14. How do you think these issues could be minimised or avoided?

Table 5 shows the number of participants who expressed having issues with assessments, specifically with the language demands of assessment and in determining why an English language learner is unable to answer a question.

Table 5: *Reported issues surrounding assessment*

	Number of participants		
Area of Issue	New Zealand	USA	Total
Language demands	2	2	4
Determining if difficulty is in language or mathematics	1	1	2

The language demands of assessment were an issue identified by four participants, with concerns over both standardised testing and formative assessment. There

were concerns that the language requirements of American standardised tests were too high, meaning ELLs were unable to understand what was being asked of them, thus invalidating the assessments. This was especially frustrating because typically there are no accommodations allowed to help students understand the questions in the American high-stakes standardised tests (Wright & Li, 2008). Cameron expressed his frustration at this.

> *On the big tests ... you're not allowed to help them. It's it's kinda rubbish, it sucks... Cause like we've said, they may not be testing the content knowledge, you're testing other things that are not what you're supposed to be testing. It's like grading somebody for spelling during the math test. You spelled this word wrong. Who cares? It's a math test.*

Understanding student thinking was also a challenge faced by three teachers, two from New Zealand and one from the United States, especially when undertaking formative assessment. In both New Zealand and the United States there is a focus on students being able to describe their thinking, and it is important for the teacher to be able to understand student thinking. When there is a language barrier, this becomes a challenge. New Zealand teacher Helen described her greatest challenge in teaching mathematics to ELLs as:

> *Knowing how they got their answer and then being able to explain their thinking or the processes that they've used.*

Cameron discusses this as a challenge that has been increased with the implementation of the Common Core standards.

> *So they might be able to do the numbers, but then we say, "Ok, now we need you to explain to me what you did." They have a really hard time with that because they don't have the words to explain the way you want them to or the way the standards say that they're supposed to.*

Two teachers, Justine from New Zealand and Isabel from the United States, also expressed concern at being able to identify whether the difficulties a student was facing were due to a lack of understanding in mathematics or due to a language

barrier. Justine, a New Entrants/Year 1 teacher from New Zealand, found this especially challenging, as she had to assess students on entering school, including determining whether they were able to count. A number of students could not count in English, but could say numbers in their home language.

> *When I do [the Junior Assessment for Mathematics] for, say, my Somalian speaking child – If I sit that child down and say "count to ten for me", and he can't, I don't know if that's because he can't in English or if he can't [count], and so I don't get a really good understanding of where the child is at when they first come in.*

American teacher Isabel also found this to be a challenge, especially when determining if a child needs referring to special education services.

> *At what point do I go, "Oh, it's because they're ELL", and then, "maybe it's special education?" Maybe we've gotten into the world where there might actually be a learning disability as well, because you can't test that early on because of the ELL.*

Teachers struggled with assessing ELLs. There were concerns about the language requirements of standardised testing and how this impacted ELLs. Participants also expressed concerns with understanding student thinking in students who were unable to express their thinking in English. Furthermore, there were concerns from teachers about whether a student's struggle in mathematics was due to not understanding the mathematics itself or the language barrier of being an ELL. Offering teachers support and resources that enable students to demonstrate their thinking could potentially help this.

4.6 Support and Resources

Participants had issues with support and resources. There were concerns over the support given from management and other personnel, available funding, and the availability of appropriate resources.

Questions 9 and 10 addressed the support that participants received:

9. Do you feel you are supported enough in teaching English language learners mathematics? Why do you think this?

10. What other support would you like?

Table 6 shows the numbers of participants who reported having issues regarding support from management and other personnel, available funding and the availability of appropriate resources.

Table 6: *Reported issues surrounding support and resources*

	Number of participants		
Area of Issue	New Zealand	USA	Total
Support from personnel	1	2	3
Funding	4	2	6
Resources	3	3	6

4.6.1 Personnel support. Lack of support from management and other personnel was an issue three of the participants identified, two Americans and one New Zealander. For American teacher Brian, a first year teacher, this lack of support had major implications for his confidence and ability to teach students who were ELLs. He eventually found out that there was support available in monthly meetings, but he was not informed about these meetings until April, late in the American school year.

American teacher Emily also felt unsupported. Although she had a lot of training and experience teaching ELLs, and felt confident in her ability to teach ELLs mathematics, she still felt the implications of not having sufficient support.

> *There was a time when we had the support of the community...but I think teachers overall feel like they're on their own, whereas before we had the support of the families, of the administration, and the community. We had the respect. So that kind of support always makes a big difference.*

She did find, however, that due to the lack of support from leadership and the community, her colleagues formed strong support networks.

Then you build relationships with your fellow teachers, and we would bond together and help each other out if we needed that. So, at a school like that, your support comes from your teachers.

New Zealand teacher Justine felt that she wasn't supported in teaching mathematics to ELLs either, due to not having a strong ESOL leader. When asked if she felt supported, she responded with:

I'm going to say no, because I don't think the person who holds the [ESOL] unit has a handle on things herself, so yeah, I'm thinking not much at our school.

When asked if the holder of the mathematics unit might offer support, she mentioned that they were the same person.

4.6.2 Funding. Funding was a concern mentioned by six participants, four New Zealanders and two Americans. Two of the participants, American teacher Isabel and New Zealand teacher Justine, had students who did not receive ESL/ESOL funding because of age. In the case of Isabel, her students were not funded because they were too old; at her school ELLs were only funded up to fourth grade. The person in charge of ESL did voluntarily work with her students twice a week after school, but was under no obligation to do this. In Justine's case, her ELLs did not receive funding because they were too young; in her school students only received funding after being in school for one and a half years, which none of her students had been.

There were also apparent discrepancies in funding. New Zealand teacher Dominic discussed student funding in his class, where three students were from non-English speaking backgrounds but only one received ESOL funding.

It'd be good to have maybe more funding time for the other students...It would be quite nice to be able to get [the non-funded English language learners] up as well, because this child in the ESOL programme, she's now beginning to overtake some of the other kids... It's only a small difference, but it's still hmmm, this child who is getting the ESOL support

is doing really well but the other child is not making progress as quickly, so it would be nice if the other child could get funding as well.'

Isabel was also concerned that in her district they hired a paraprofessional, instead of hiring an ESL specialist teacher like other districts. She felt that, even though the paraprofessional did a good job considering the circumstances, it was a disservice to both the paraprofessional and the students.

In our district they hire a Para-educator to do the job where a lot of other districts hire people who have ELL backgrounds, which I think is very unfair to the students and to her because she is doing a job that other people have college degrees specialised in to do.

Furthermore, there were concerns about the funding for teacher aides from two participants. American teacher Emily had previously taught alongside teacher aides assisting the ELLs, but, due to budget cuts, had found that in recent years she no longer had aides.

For New Zealand teacher Gabrielle, the issue was less about receiving funding, and more about how the funding is used. She was especially concerned with how aides are able to be used, citing concern about teachers being unable to use the teacher aides in the way they feel is best for the needs of their classroom.

I actually need to be teaching my ESOL kids, not the teacher aide. Some schools are fine with allowing you to use your teacher aide to work with other students, while some are really strict on your using the aide for the kids you've been given it for. But then you've got a case of, you've got a teacher aide trying to teach quite a high needs kid and yet the teacher is there teaching all the other ones when it should be the other way around.

Two participants, however, had teacher aides and found them to be an excellent resource and support for the learning of their ELLs. Dominic, from New Zealand, had teacher aide support for his funded ELL, and was able to write an IEP for the students, and have this guide the 1:1 support the student received. American teacher Cameron had a teacher aide available to him during mathematics, who

was able to assist in any way he felt best.

4.6.3 Resources. Lack of sufficient and appropriate resources was an issue identified by six participants, three American and three from New Zealand. There were concerns that written resources and textbooks used language that was too complex for ELLs. Gabrielle found this to be especially true with the *Figure it Out* books. She appreciated the cultural context, but found that the language used in word problems was frequently too complex.

> *I think [Figure it Out's] downfall is that it's very text based. There's a lot of reading that you have to do... before you actually get to the maths problem... You also need a simplified version for English language learners, where it's simple, it's still contextual, but it's less reading before you get to actual work.*

Furthermore, there was frustration over having a number of literacy resources for teaching ELLs, but a lack of mathematics resources for ELLs. Gabrielle discussed this.

> *There's a really good website that we're encouraged to use. It's called ESOL online and it's by the Ministry of Education, and then that's a lot of really good resources to use with English language learners, but it's mainly literacy geared. I think there's a real gap in the resource market for mathematical content for English language learners.*

One participant, Emily, a grade five teacher working in a charter school, felt her resources were not sufficient for most of the year, until the school decided to switch to Common Core standards and received more resources as a result. She still felt, however, that in California, district schools were well resourced, whereas charters tended to be more hit and miss, with some having excellent resources, and others lacking.

> *When I first came out to be very honest, when I first came to the charter school, no. We had our little computer class, computer online programme that they had to take tests every week and we had to come up with the*

lessons ourselves online and if you are a new teacher, no matter what your experience was, you figure it out. At the end, then we got resources, because we switched over to the common core standards at the very end of the year then we got really good resources, but that wasn't until the end. I'm gonna say that the district's on top of it when it comes to resources, charter schools, it depends on the school. You know some of them will give you great resources, great support. Some of them you're on your own.

One teacher had a positive experience, however, feeling he was very well resourced. Andrew, from New Jersey, had a computer lab for a classroom because he was previously the computer teacher. Because of this, he had access to a large number of digital resources, and used a number of websites and programmes to support the learning of all of his students, including his ELLs.

Since I was the computer teacher I still have the computer lab so I teach exclusively on computers. As I'm pretty good with the computers... I don't need a dime from anybody.

Five other teachers also used digital resources that they sourced themselves, especially to make up for the lack of other resources suitable for ELLs that were available. YouTube has proven to be a valuable resource in assisting teachers to teach ELLs mathematics for three teachers. Justine discussed this.

There's so many good things for maths on YouTube, that that's been a real help. YouTube is a real lifesaver with math, especially for a lot of those rote things. Instead of sitting there counting, we can sing, we can dance. Yeah, it's good.

Three teachers were concerned about lack of support from school leadership influencing teacher ability to effectively teach ELLs. Teachers also reported concerns relating to funding, including funding of teacher aides and the lack of availability of appropriate resources for ELLs.

4.7 Cultural Influences

Culture permeated all of the interviews. In particular, there was discussion on building cross-cultural relationships with parents; on cultural differences between student and teacher and how that influenced classroom practice; on the views that are held about the role of the teacher; and on how the New Zealand Numeracy Project did not always work well with the way students learned and understood mathematics in their own cultures.

Culture was a theme that presented itself throughout the questions, rather than being a specific answer to a singular question or set of questions. When participants were asked questions regarding their own confidence, they often identified cultural issues as a hindrance to confidence. One participant discussed culture with regard to his own training: learning to be a culturally responsive teacher enhanced his ability to teach ELLs. When teachers were asked their greatest challenge, or asked in the final question about any other issues they faced, forming relationships with the parents because of cultural and linguistic difficulties was a common response. In response to being asked whether there was enough or sufficient support, the cultural relevance of word problems in various resources was commonly discussed. Ultimately, culture permeates every aspect of life, and this was reflected in the answers of the teachers.

Table six shows the types of issues participants reported having regarding culture.

Table 7: *Reported issues surrounding culture*

	Number of participants		
Area of issue	New Zealand	USA	Total
Parental relationships	1	3	4
Student cultural differences	2	1	3
Numeracy Project	3	N/A	3 (out of five)

A number of the issues teachers faced centred on the cultural issues that exist when interacting with ELLs, and building relationships with students' parents. All participants discussed building relationships with parents, with four finding this challenging. Eight participants, all five from New Zealand and three from the United States, mentioned having to consider the cultural background of their ELLs in their classroom practice. Five of these participants had an overall positive experience in recognising and addressing issues to do with culture in the classroom. For example, New Zealand teacher Gabrielle chose to use word problems that were culturally relevant to the students, and found that students responded well.

> *I tried to make a lot of my questions really contextual to my students so if I was coming up with a word problem I'd try and use their names or use names of people that are in their family. A context that they may be familiar with. So with the Tongan students I used a lot of kind of beachy things to help my mathematics. It sounds a bit token, but it really did help. You saw their faces light up when you used one of their names in a sentence or something like that... and I mean it was just simply changing to context from going to the shop and buying 3 t-shirts to going to the shop and buying, um, pairs of jandals or something like that. Like really, really simple stuff but it just engaged them and their eyes light up and go "oh I can associate with that and see where they're coming from".*

Other teachers struggled with addressing the cultural background of their ELL students. One issue mentioned by two New Zealand participants was that many of the ELLs came from countries where the teacher is never challenged by the students, therefore students would not ask for help or clarification, making it hard to know how to help these students. Dominic struggled with this:

> *Using, we've got a couple of different programmes here at school one called mathletics...[where] they may have tried something 8 times and they still don't understand how to do it because their score is say 85% ...so it keeps coming up as red but they don't have the confidence to come and ask me – as compared to the students who as confident in their language*

> *and in maths they'll just come up and say "excuse me Mr 'Dominic', I don't understand this skill here. Will you help me please?"*

Teachers also had to face the cultural expectations of parents. For American teachers, this was an issue because of the difference in the role of the teacher between Latino cultures and the dominant American culture. In American culture, there is an expectation that parents and teachers form more of a team; parents are able to come to the teacher and address any issues they are facing, and homework is seen as a way of cementing this partnership and having a strong home-school relationship. In Latino culture, according to participants, this is seen differently; the teacher is the one who is in charge of learning and is the authority. To challenge the teacher and question what they are doing is seen as disrespectful and homework is seen as less important because the most important learning happens at school. This can give the false impression that these parents are not interested in their children's schooling. American teacher Cameron discussed what he learned in a Professional Development seminar about these differences.

> *Working with Hispanic cultures and the differences between what a traditional or you know, quote unquote, "traditional American" cultures are compared to what more traditional Hispanic cultures are. So like "how come the parents aren't just more involved?" well because in their culture they just give the kids to you because you're the expert. They don't want to be all up in you. And that was really interesting um P.D. because it was more explaining this is why parents aren't coming into your class. This is why homework might not be getting done as much. All of that kind of stuff. That was really interesting P.D. That was really helpful just to think about - more big picture, more than specifically math.*

Differences in the perceived role of the teacher were also discussed by New Zealand participants. New Zealand teacher Felicity had a large population of Filipino students in her school. Not only did they attend her school, but their families went to the same church she did as it was affiliated with the school. She found that the teacher was seen in a much higher role than in New Zealand culture.

...within Filipino culture the teacher... is put up on a pedestal.

Another common issue was the language barrier between parents, students and teachers, and the impact this has on forming relationships. All of the American participants and four of the New Zealand participants discussed translation. Interestingly, four of the American participants mentioned wanting to learn Spanish, the most common home language after English in the United States (Goldenberg, 2008). None of the New Zealand teachers mentioned learning the language of their students.

Fourth grade American teacher, Andrew, felt that the language barrier between him and the parents of ELLs was his biggest struggle when teaching ELLs.

> *The greatest challenge I have with the ELLs is not the kids, but their parents, because I can't communicate with them. I have some kids that I can't even call their parents on the phone. So discipline becomes a problem. If they're not doing their homework what have you.*

Andrew was assisted by Spanish-speaking members of the school who were able to translate, enabling communication with these parents. Whilst he appreciated the assistance given, he struggled because he felt he was an unfair imposition on them.

These kinds of informal translation situations occurred with a number of teachers, who relied on colleagues, or even other members of the community or other students to translate, because there was a strong language barrier and teachers were given no formal assistance to communicate with these parents. American teachers Cameron and Isabel, however, had formal translators employed to assist them in communicating with parents. Cameron's school had been especially working on being user-friendly for parents from non-English speaking backgrounds, especially those who speak Spanish.

> *My current school is excellent at translating stuff because they know we have so many parents who don't speak English. They're very on top of - if you're gonna send home something you need to send it to the office first*

well get it translated first and send it back. All of our parent teacher conferences we have the option of having a translator there. So my school is very on top of being very friendly for the ESL parents. Also all the signage in the school is in English and Spanish. That was one of our big goals this year actually was looking around the school and saying: "Ok, well, all these signs are just in English and that's not very friendly considering how our population is. We need to have an English sign and a Spanish sign".

There were also concerns expressed by two New Zealand teachers about the Numeracy Project. Not only were there concerns with the language requirements, discussed above, but also concerns about ignoring or rejecting culturally appropriate ways for doing mathematics that children and parents from other cultures brought to the table. Dominic expressed concern that for a lot of parents, not only those of ELLs, there was a perception that algorithms were bad, and therefore these parents struggled to work with their children at home.

Algorithms are the preferred method and there's a strange idea out there that they can only teach with numeracy project and so I think some parents have been discouraged in teaching their children how they do things at home and teach them maths. [As a result, students are] quite below because they haven't had any support from both home they've already been held back because of struggle learning the English a couple of years ago.

Felicity also felt that at times the Numeracy Project requirements didn't account for students who had initially learned mathematics in a foreign education system.

The numeracy project just sucks for these children because it just does no work for them...I actually find for these children, as a general rule, have a very sound mathematics basis actually.

...One of my children started in August last year, and, you know that he's firmly cemented in his mathematical learning from his home school. I can't go and undo all that learning... that's part of him. So I think it's

exceptionally unreasonable to expect that he's going to meet every single little tick box on the numeracy project. I don't think that's reasonable...

Culture impacted all participants. For eight participants, the cultural differences between teacher and student had a direct impact on their classroom practice. As well as cultural differences between teacher and student, every participant discussed the challenges of communicating with and building cross-cultural relationships with parents. For some this was a positive experience, whilst for others it was a challenge. Finally, there were concerns about the appropriateness of the New Zealand Numeracy Project for students from other cultural backgrounds who had already learned mathematics.

4.8 Chapter Summary

A number of issues were identified by teachers with respect to teaching mathematics to ELLs. Amongst American participants, the most commonly identified issues, identified by three or more of the five participants, included issues surrounding culture, such as the ability to form strong relationships with parents and communicate with them, difficulties with mathematical language and word problems, and a lack of resources. Four of the five American participants desired further training. Amongst New Zealand participants, the most commonly identified issues included issues included issues surrounding mathematical language and word problems, issues with assessment and concerns with funding and lack of resources.

There were concerns that tended to be especially pertinent to teachers in one country. In New Zealand, teachers were concerned with the Numeracy Project, feeling that its demands were not always appropriate for students from other cultures and felt that often the way mathematics is done in other countries can be invalidated by the Numeracy Project. In the United States, four teachers expressed a desire to learn Spanish, the home language of the majority of ELLs in the United States.

Chapter Five: Discussion

5.1 Introduction

The research undertaken explored the question:

> *What are the issues faced by teachers in New Zealand and the United States when teaching mathematics to English language learners?*

Qualitative data was collected from semi-structured interviews with five teachers from New Zealand and five from the United States. A number of themes surrounding the issues teachers faced in teaching mathematics to ELLs emerged from the findings. Key themes included issues involving teacher confidence, lack of training, dealing with mathematical language, difficulties with assessment, lack of support and resources, and intercultural communication. The issues teachers reported facing are very broad, reflecting how complex mathematics teaching is and the strong relationship mathematics has with language. In this chapter these issues will be examined in the light of prior research, enabling a deeper understanding of the issues.

5.2 Teacher Confidence

This section discusses issues related to teachers' own confidence in mathematics and in teaching mathematics, their confidence in successfully teaching ELLs, and the relationship between the age of ELLs and teachers' confidence in successfully teaching them.

5.2.1 Lack of confidence in mathematics. Two of the teachers, both primary teachers from New Zealand, lacked confidence in mathematics teaching because of their own mathematical ability (section 4.2). For one of these teachers, Felicity, it was strand-specific. She felt confident in her numeracy ability, but felt less confident in her ability in other areas of mathematics, such as geometry and algebra, and believed that this impacted her ability to teach. For the other, Helen, it was a question of confidence in her teaching abilities at higher age levels, where

she felt that due to her own abilities in mathematics she would not be confident. She felt confident, however, with mathematics in the Year 1 and Year 2 classroom she taught in.

The link between confidence in one's own mathematics ability and one's confidence in teaching mathematics has been demonstrated in other research, particularly in research looking at teacher self-efficacy. Self-efficacy refers to a teacher's confidence in their own effectiveness and ability to achieve desired student outcomes (Briley, 2012). In a study of teacher self-efficacy by Briley (2012), it was found that stronger confidence in a teacher's own mathematical problem solving ability was directly linked to stronger confidence in their mathematics teaching. Strong teacher self-efficacy in their mathematics teaching is linked to positive student outcomes (White, 2009).

Whilst both of these teachers were concerned with their own mathematical ability and the influence this would have on their teaching, prior research has shown that primary teachers often tend to underestimate their own mathematical ability. In a study of Scottish preservice teachers, where teachers sat a mathematics test and answered questions pertaining to their own confidence and ability, it was found that over half of the teachers who scored over 70% in the mathematics test reported not being confident in their own mathematical ability (Henderson and Rodriguez, 2008).

It is important that teacher confidence in mathematics is addressed. Lack of confidence in their own ability is likely to have a negative influence on their self-efficacy in mathematics teaching, therefore leading to lower student outcomes. This especially has the potential to impact ELLs, because the extra challenges involved in teaching mathematics to ELLs are likely to be intimidating for a teacher who is not confident in their own mathematical ability.

5.2.2 Lack of confidence in teaching English language learners. In addition to doubts about their own mathematical ability, lack of confidence in teaching ELLs is also an issue some teachers face. In this study, Brian, a first year American teacher, lacked confidence in teaching ELLs. In addition, two New Zealand teachers had previously lacked in confidence, although they now felt

confident (section 4.2). Furthermore, English for Speakers of other Languages (ESOL) unit holder Gabrielle stated that while she felt confident because of the extra training she had received by being the ESOL unit holder, a number of the other teachers at her school did not have this confidence.

Teacher confidence is correlated with positive student outcomes. According to Jimenez-Silva, Olson and Jimenez Hernandez (2012), teacher confidence in teaching ELLs has a positive impact on teacher practice. It is therefore important that teachers have the support and training they need to feel confident in teaching ELLs. When teachers do not feel confident, their students do not have the same opportunities to achieve positive outcomes.

This is especially concerning considering that Brian worked in a large, urban district in an area with a high proportion of ELLs. Brian was concerned that his lowest-performing students were English language learners. Ensuring he had the tools he needed to feel confident in teaching ELLs would likely have had a positive impact on the outcome for these students because of the positive impact of teacher confidence.

5.2.3 Teacher confidence and age of students. An interesting perception that was discussed by three participants, Brian, Helen and Justine, was that teaching mathematics becomes more challenging as students get older. Two of these participants, New Zealand teachers Justine and Helen, taught students in their first two years of school and felt their own confidence would diminish if they taught older students (section 4.2). Helen felt her own mathematical abilities would be challenged. For New Zealand teacher Justine, this was based on the fact that all of her New Entrants and Year 1 students were learning mathematical language and vocabulary, not just her ELLs. She felt that at higher levels the language barrier would be more challenging. The third was American teacher Brian, who taught ninth grade. He felt that teaching mathematics was more difficult at this grade because there was deeper conceptual understanding required. Brian gave the example of a slope: it is one thing to calculate a slope using a formula, but another thing altogether to explain what a slope might represent.

Whilst these teachers felt there was added difficulty in teaching older students,

this does not negate the complexity involved in teaching primary/elementary mathematics. Wu (2009) suggests that there is a level of sophistication found in elementary mathematics that is often more complicated than people may perceive. In primary/elementary school, beginning with learning to add and subtract whole numbers, students are not only learning to do mathematical calculations, but are setting the foundational understanding for later mathematics. When students develop a strong understanding of numbers and how they function, this is referred to as number competence. There is a strong correlation between early number competence and later mathematics outcomes (Jordan, Kaplan, Ramineni & Locuniak, 2009).

Understanding and viewing the early levels of mathematics as foundational and challenging is important for all students, especially ELLs. For ELLs to succeed, they not only need to have a high degree of number competence, but they also need to be able to successfully master the mathematical registers. Building foundational understanding and developing mathematical vocabulary and language is an important and challenging task.

Teachers lacked confidence in two main areas. Two New Zealand primary teachers lacked confidence in their mathematical ability. American teacher Brian was not confident in teaching ELLs, where confidence can translate into positive student outcomes. Interestingly, amongst some teachers, there was a perception that teaching mathematics to ELLs is more difficult as students become older. Ensuring teachers have preservice and professional development training both in mathematics and in teaching ELLs could help to mitigate this.

5.3 Training

Training tended to be valued by participants. This included both preservice training, and professional development training. Eight of the ten teachers interviewed indicated that they wanted more training. This included teachers who had undertaken a lot of training, and teachers who had very little training. For example, when Cameron, a teacher who had received a lot of training, was asked how his confidence could be increased, he answered with, “More training. Always more training.” Lack of training was seen as an important issue, as it meant

teachers were not as prepared as they could be to teach ELLs mathematics.

Only three of the participants, American teachers Brian, Cameron and Emily, had undertaken any training that specifically addressed teaching mathematics to ELLs, and for Brian this was inadequate (section 4.3). All three of these teachers trained in states with high ELL populations. New Zealand participant Dominic had undergone some professional development where this was discussed with other teachers, but it was not a formal training course.

5.3.1 Preservice training on teaching English language learners. As well as the preservice training undertaken by Brian, Cameron and Emily, New Zealand participants Dominic and Justine, and American participant Isabel had received training for teaching ELLs in their preservice teacher training (section 4.3). For all three, however, this training had been a small part of their class on teaching learners with special needs and had limited depth. Furthermore, New Zealand teacher Gabrielle had only been given readings in her preservice graduate diploma, but had not had any class time devoted to learning how to teach ELLs. The two New Zealand teachers who had undergone extensive training in how to teach ELLs had received this training outside of their initial teacher training; one had undertaken a graduate diploma in teaching ELLs, and the other had attended courses because of her role as the ESOL unit holder.

Lack of preservice training in teaching ELLs is concerning. In a mixed-methods study by Durgunoğlu & Hughes (2010) of American preservice teachers of a variety of subjects, including algebra, it was found that lack of training led to low teacher self-efficacy in teaching ELLs. Low teacher self-efficacy is linked to less use of different strategies and a higher degree of stress on teachers.

The lack of preservice training for New Zealand teachers is concerning because of the large number of ELLs, with an estimated 23% of New Zealand school students being ELLs (section 2.6). Furthermore, it is interesting to note that ELLs tend to be distributed throughout New Zealand.

In this study, there were teachers from large cities and small towns located on

both of New Zealand's main islands. It is highly likely that teachers will encounter ELLs in their teaching career because of the diverse nature of New Zealand's population. To offer limited training to teachers in how to effectively teach ELLs, both generally and specifically in mathematics, is to do a disservice to these students.

The lack of preservice training for the teacher from Washington State is also concerning because of the ever increasing ELL population (Elfers et al., 2009). Even though Washington State has traditionally not been a state with a lot of ELLs, the number of ELLs across the United States is increasing at a rapid rate, and Washington State has experienced a large increase in ELL numbers. Traditionally, ELLs were concentrated in urban areas (Walker, Schafer & Iiams, 2004). Recently, however, the growth of ELL populations in rural areas has been faster than the growth in suburban or urban areas (Shim, 2013).

There are negative ramifications in not giving sufficient training to teachers in areas where there are not currently a high number of ELLs. When teachers do not have the training or the experience to meet the needs of ELLs, the education of the ELLs suffers.

5.3.2 Professional development in teaching English language learners. Whilst seven participants, five from New Zealand and two from the United States, reported having some professional development training on how to teach ELLs, the amount and quality of training varied (section 4.3). Coming from an area with a high concentration of English language learners, Cameron and Emily had received a lot of in-service training on teaching English language learners. All five New Zealand teachers had received in-service training, but the quality varied. The in-school training received by Gabrielle and Felicity was especially lacking, although Gabrielle had attended courses because she was the ESOL unit holder for her school.

The lack of professional development reported by five participants is concerning. The concern about lack of training leading to lack of self-efficacy is not only relevant to preservice training, but is also a concern for practicing teachers. Ross (2013) discussed the fact that teachers lacked self-efficacy when teaching ELLs as

opposed to students from English speaking backgrounds, leading to lower achievement. She investigated the impact professional development had on teacher self-efficacy, however, and found that when teachers had professional development training, it improved their self-efficacy in working with ELLs.

With eight of the ten teachers interviewed desiring more training, including four of the teachers who had received limited in-service training, there are positive implications of increasing professional development. Increasing professional development training is likely to increase the confidence and self-efficacy of these teachers, leading to greater student outcomes. This aligns with the fact that amongst the teachers interviewed, more training was commonly suggested as a way to build confidence.

5.3.3 Mathematics training and pedagogy. Whilst there was a worrying lack of training offered for New Zealand teachers, for two participants there was a school-wide focus in improving mathematics outcomes for all students (section 4.3). Good pedagogy affects all students, including ELLs (Moschkovich, 2012). Effective teaching of mathematics involves elements such as explicit teaching of vocabulary, awareness of the language demands word problems pose, and using relevant contexts for students. All of these are especially important to consider when dealing with ELLs. This does not negate the need for professional development in mathematics however, as ELLs have distinct needs.

New Zealand teacher Gabrielle discussed the fact that often "good pedagogy for ELLs is good pedagogy for everyone," and vice versa (section 4.3). This is an idea that a lot of researchers support. Garrison & Mona (1999) suggest that there is a lot in common between effective mathematics instruction and effective instruction in mathematics for ELLs, which challenges teachers to improve their practice for all students. Moschkovich (2012) discussed this idea, suggesting that there are two key components of mathematics teaching: (1) that concepts are taught and considered explicitly; and (2) that students are given the time they need to consider mathematical concepts and ideas. These are hallmarks of effective teaching for all students, and, according to Moschkovich (2012), should be a focus when teaching mathematics to ELLs.

Good pedagogy is important, regardless of student language background. When students are ELLs, however, it is especially important that teachers understand and practice good pedagogy, as ELLs do not have the same language and cultural cues to infer from.

Lack of training is an issue that was of concern. A desire for more training was shared by eight of the ten participants from a range of backgrounds. Training for teaching ELLs was lacking in general, and especially in teaching mathematics to ELLs. Two New Zealand teachers did report a school-wide focus on mathematics, which has a positive influence on ELLs. There was a tendency in the United States for teachers from areas which traditionally have fewer ELLs to have less training. This is of concern because the shifting demographics of the United States mean a lot of ELLs will be underserved.

5.4 Language and Mathematics

Participants discussed two main challenges regarding language and mathematics. The primary issues teachers faced involved the use of word problems. As well as this, participants discussed issues surrounding the language demands the mathematics itself brings. There tend to be two main issues surrounding word problems; the language requirements not matching the language ability of students and the cultural capital required to understand them (section 4.4).

5.4.1 Mathematical language demands. There was concern expressed by six teachers, four from New Zealand and two from the United States, about the challenges they faced with the language demands in teaching students mathematics using the New Zealand Numeracy Project and the American Common Core mathematics standards (section 4.4.1). Both of these involve a strong focus on understanding, not just procedure (Common Core Standards Initiative, 2015; New Zealand Ministry of Education, 2010). Participants mentioned that the language requirements associated with newer styles of learning mathematics are much higher than they previously were, and this could affect both ELLs' ability to learn mathematics in class and the teacher's ability to fairly assess a student. For example, Brian expressed his difficulty in developing conceptual understanding with English language learners: "When they're not speaking

English, getting that point across and getting that conceptual understanding, as opposed to just procedural understanding, is extremely difficult."

Moschkovich (2002) discusses this change. There has been a shift in what the role of the learner entails. Students are no longer primarily receptive in the mathematics classroom. Instead they need to learn to communicate mathematically, a skill that is more challenging for ELLs. As active participants in mathematical discourse, ELLs need to be able to communicate using mathematical registers (Xi and Yeping, 2008). These extra demands also challenge teachers, because they need to find ways to enable this communication.

These challenges do not, however, negate the value of teaching mathematics with an emphasis on conceptual understanding. Moschkovich (2012) discusses the importance of making classroom mathematical discussion and understanding accessible to ELLs, and emphasises the importance of focusing on the participation of ELLs in discussion and discourse, not on the lower level pronunciation or grammatical skills. Xi and Yeping (2008) discuss this further, emphasising that teachers should encourage ELLs to justify, think and interpret meaning in mathematics. They recommend that with ELLs, activities are used that encourage development of argumentative discourse, discussion and the building of vocabulary.

Teachers can foster both language development and mathematical understanding in ELLs by providing rich activities that use authentic mathematical communication. ELLs should be engaged in active communication in mathematics, alongside their peers from English-speaking backgrounds.

5.4.2 Word problems. Seven teachers discussed having difficulty with the language requirements of word problems. There tended to be two main aspects of word problems that caused issues; the language demands of the word problems themselves, and issues with the relevance of the contexts of word problems to students' life experiences (section 4.4.2).

5.4.2.1 Language demands of word problems. Teachers found that the high language demands of word problems can especially be an issue when using

textbooks and other similar resources (section 4.6.3), and in assessment (section 4.4.2). There were concerns that often word problems use language that is too complex for their ELLs to understand, as they are written under the assumption that students will have similar mathematical and linguistic abilities. For example, Isabel found this to be an issue with her ELLs, where she found that "they could often do straight computation but when it became a word problem they couldn't identify what operation they had to do."

The issues surrounding linguistic complexity in word problems are reflected in other research. Martiniello (2008) reviewed word problems used in standardised tests, and found that the word problems often reflected complex grammar and vocabulary. This complexity makes it more difficult for ELLs to solve word problems (Abedi and Lord, 2001). Research indicates, however, that when simplified English is used in word problems, whilst keeping the mathematical content the same, ELLs tend to be more able to understand and solve word problems successfully (section 2.5).

The language demands of word problems can cause difficulties for ELLs whose mathematics ability is higher than their English literacy ability, as they leave students unable to read and comprehend the questions in mathematics resources and assessments, thus hindering their mathematical progress.

5.4.2.2 Context of word problems. There were also concerns about word problems having irrelevant contexts. Interestingly, there was discussion by New Zealand teacher Gabrielle on writing and adapting word problems to use contexts that were familiar for her students. She gave the example of adapting problems so they were beach themed for her Tongan students: "So with the Tongan students I used a lot of kind of beachy things to help my mathematics. It sounds a bit token, but it really did help." By doing this herself, she was able to mitigate some of the challenges students faced when having to do word problems where the context of the word problems does not match students' own life experiences.

Often one of the largest challenges faced by ELLs is not being able to understand the examples being used in word problems, because of differences in cultural context (section 2.1.2). This can be further exacerbated by the fact that textbooks

writers tend to use examples based on their own experience, as opposed to contexts that are relevant to the lives of students (Schleppegrell, 2007). ELLs are even less likely to understand these contexts, due to the fact that they have different cultural and linguistic backgrounds to begin with, making it harder.

In going out of her way to change contexts to make problems relevant, Gabrielle chose to take on a higher workload. Whilst on the one hand it would be good for textbook and other resource companies to create resources with more relevant contexts, because children's cultural backgrounds vary so widely, it will not be possible to entirely mitigate these issues.

5.5 Assessment

An integral part of teaching is assessment. When teachers have to assess ELLs in mathematics, the language barriers that exist can cause difficulties. From these findings, it emerged that teachers face challenges in formative assessment, in-class summative assessment and in large-scale standardised testing.

5.5.1 Understanding student thinking. Assessment of ELLs' mathematical understanding and abilities is challenging. Three participants, two from New Zealand and one from the United States, discussed having difficulties in understanding student thinking, with students being unable to clearly articulate their thinking in English. Helen described this struggle: “They often get the answer very quickly, but it’s to know how they got the answer so that you can expand their skills and strategies.”

One factor that can be both a help and a hindrance in understanding student thinking in mathematics is the fact that there is an almost universal system of symbolic notation in mathematics, as most countries have adopted the Arabic system of mathematical notation (Garrison & Mora, 1999). On the one hand, this can enable students to demonstrate to teachers their thinking through writing using this symbolic notation. On the other hand, this can cause more confusion for teachers in determining an ELL’s level of understanding, because if they simply see students correctly completing mathematical equations without being able to discuss their thinking with them, and therefore gain a grasp of their conceptual

understanding, teachers can overestimate the understanding and abilities of ELLs and therefore move at an inappropriately fast pace (Garrison & Mora, 1999). It is also important to consider, however, that if teachers are basing their assumptions on a student's ability to do language-intensive mathematics activities such as word problems, or basing assessment on their in class discussions, they could potentially underestimate their mathematical ability. This would therefore lead to a pace that is inappropriately slow for their needs.

Understanding student thinking is a complex, yet important, part of mathematics instruction, especially when teaching for conceptual understanding. Teachers face the challenge of enabling their students to communicate mathematically, without over- or under-estimating their ability based on their ability to perform computations using Arabic notation or express themselves verbally. Creating assessments that are designed for ELLs, where the language demands are simple and clear enough for the learner to understand and express themselves, but not so low as to overestimate their ability, would begin to mitigate this.

5.5.2 Standardised testing. The issues surrounding assessment also pertained to standardised tests, as discussed by American teacher Cameron. He expressed his frustration with the standardised testing requirements in his state, where he felt that the tests were fundamentally unfair to ELLs, as they effectively tested them on language, not mathematics. He felt it was especially unfair that they were offered no accommodations, therefore putting them at a disadvantage compared with their peers from English-speaking backgrounds. Other American teachers also mentioned test scores, with Brian, for example, mentioning that his ELLs had the lowest test scores, and that this was a cause for concern.

This focus on test scores is a big factor in education in the United States today. Moschkovich (2012) discusses the long term implications of this: because ELLs tend to score lower on standardised tests due to language difficulties, they are more likely to be inappropriately streamed or labelled as having special needs, when in reality it is the language of the test that they struggle with, not the mathematics itself.

The negative ramifications of using English-medium standardised mathematics

tests for ELLs without adaptations not only apply to the individual learner, but can also be wider; negatively affecting schools and districts. Wright & Li (2008) discuss the wider implications of assessing all students using English-based tests, without adapting or accounting for ELLs. In doing this, often schools with high numbers of ELLs are labelled as failing, as a large number of ELLs do not meet expected standards in mathematics. As discussed in the literature review, Bill-Barton & Barton (2005) found that when ELLs were tested in English as opposed to their home language, they tended to score 10-15% lower.

When this happens on a mass scale, for example in a school with a high number of ELLs, it gives a false impression of the school's achievement. In an environment where teachers, schools and administrators are held responsible for student test scores, and schools can be closed or restructured based on these scores, this can have a very negative effect.

Teachers of ELLs face challenges in assessing the mathematical ability and understanding of their students. Understanding student thinking can be difficult when a language barrier hinders communication. When students have to take standardised tests in mathematics in a second language, the validity of the assessment is questionable, as they tend to not perform as well. There may also be issues in assessing students against standardised benchmarks when language difficulties are not accounted for.

5.6 Support and Resources

Teacher support was another matter that concerned teachers in both New Zealand and the United States. This included support from management, as well as funding and resources used to support their teaching.

5.6.1 Personnel support. New Zealand teacher Justine and American teachers Emily and Brian discussed having a lack of support from management and how this impacted their practice (section 4.6.1). This lack of support had a different impact in different contexts, but added difficulty for all three teachers. For first-year teacher Brian, this was especially pronounced as he didn't have the support he needed as a beginning teacher to effectively meet the needs of his

ELLs. As a result, his ELLs were the lowest-performing group of students he taught, something he regrets. At the same time, Emily was experienced and had an ESL endorsement qualification, and still found lack of support from management and other personnel to be an issue.

The fact that Emily, a teacher who has an endorsement in teaching ELLs, found that the lack of support from personnel was an issue mirrors other research. In a California study by Gandara, Maxwell-Jolly and Driscoll (2005), it was found that teachers with the highest level of certification in teaching English language learners were more likely to report having issues with lack of support from school management and wider policy makers.

This correlation between training undertaken and issues with lack of support is interesting. When a teacher holds a qualification in teaching ELLs, it is likely that they are aware of the unique learning needs ELLs bring and the support needed to enable them to effectively teach these learners. Giving this support to teachers, whether it is a beginning teacher who still needs a lot of guidance, or a teacher with years of experience and advanced qualifications in teaching ELLs, enables teachers to best meet the needs of their ELLs.

5.6.2 Funding. Lack of funding was an issue for six participants, four from New Zealand and two from the United States (section 4.6.2). This lack of funding affected them in a variety of ways. For some teachers, it meant a lack of appropriate resources, especially those with appropriately challenging mathematics content that also used simple, straightforward English, suitable for ELLs. For others it affected whether students received ESL or ESOL funding.

In New Zealand, ELLs who score below the benchmark on an ESOL funding assessment receive three to five years of funding based on the length of time they have been in a New Zealand school, the year level they are in and whether they are a migrant, the child of a migrant or a refugee (New Zealand Ministry of Education, 2014). There appears to be limited research on whether teachers or school leaders find the amount of funding received to be sufficient.

In the United States, funding levels can vary between states and districts. In a

Washington State study by Elfers et al. (2009), it was common for the funding that districts received for ELLs to be insufficient. As a result, districts often focused on a priority area for English language learners, such as early childhood education, and sought extra money from other sources of funding, such as grants.

A study in Colorado also found that insufficient funding was common and had a negative impact (Ramirez, Siegrist, Krumholz and Rainey, 2013). This was especially true in districts with high numbers of ELLs, where, although English language learners typically received two years of funding, it was usually not enough to cover their needs. Furthermore, they typically took longer to achieve proficiency in English, meaning the school budgets were spread thin to meet the legal obligation to meet the needs of all ELLs.

Not having sufficient funding to meet learner needs is an issue for teachers. Without sufficient funding, teachers do not have the resources required to meet the needs of ELLs, and ELLs do not receive the instruction that is necessary to develop academic language proficiency.

5.6.2.1 Teacher aides. Two teachers discussed how the lack of funding, or choice of how funding was to be used, influenced their teacher aide time or lack thereof (section 4.6.2). For Emily, it meant no longer having teacher aides. For Gabrielle, it was an issue with having teacher aides but not for enough time to make a substantial difference, and lacking the autonomy to decide how the teacher aide would be used. Gabrielle discussed the difficulties that can result when a teacher aide is required to work only with specific students, such as the ELLs, when the teacher may feel that it is better for the aide to be of help to the class in general and for the teacher to work one on one with the students who need extra support.

There is, however, some debate about the effectiveness of teacher aides, especially when they are used in an instructional role. A study of teacher aides in the United States by Gerber, Finn, Achilles & Boyd-Zaharius (2001) found that the use of teacher aides has little impact on student performance, except when the same aide is with students over a 2-3 year period, which then leads to some reading improvement.

This reading improvement is likely to have a positive influence on mathematics outcomes, because word problems are dependent on reading (section 2.1.2). Giving teachers the autonomy to decide how they use their teacher aide time could enable more effective use, based on the assumption that teachers have more knowledge of their learners' needs than management do.

5.6.3 Resources Six teachers discussed having a lack of appropriate resources for teaching ELLs (section 4.6.3). There were issues with the relevance of the problems used in textbooks. Furthermore, often the standard resources were not appropriate for ELLs, with the level of reading comprehension required being too high.

Schleppegrell (2007) discussed the fact that typically textbooks use written problems that fit the desired calculation well, as opposed to problems that are relevant to the everyday lives of students. This means that often the written problems are not fully accessible to students. This is especially a concern for ELLs: they do not have the same cultural background and experiences as students from English-speaking backgrounds and therefore struggle with word problems based on the expected experiences of their peers. When textbooks do not take that into consideration, the chances of relevance for an ELL diminish, making textbook mathematics further out of reach for ELLs. As discussed above, a number of participants discussed adapting problems themselves to make them relevant for their ELLs.

It was suggested by Gabrielle that there would be value in having mathematics resources that specifically targeted ELLs. In her experience, she found that a lot of mathematics class time was used on literacy; it took a lot of class time to work with her ELLs to understand the problems. She suggested that this could be mitigated with resources designed for ELLs: "You almost need a simplified version for English language learners where it's simple, it's still contextual but it's less reading before you get to the actual work." Creating these resources could potentially mitigate the issue of having resources that are linguistically too advanced for the appropriate mathematics level.

Teachers had issues with the amount of support, funding and resources they received. For three teachers, there was concern about the amount of support they got from management and those in charge of ESOL or ESL for their school. More commonly, though, there were issues with ESOL or ESL funding, with six participants discussing problems with underfunding in that area. Teachers especially felt unsupported because of the lack of teacher aides and resources. Concerns were not only with the lack of teacher aides, but also the lack of autonomy in how to use them. There was concern that resources in mathematics tend to be written assuming that students have similar mathematical and language abilities, thus making it difficult to get resources that are appropriate for ELLs, who often work at higher levels in mathematics than in literacy.

5.7 Cultural Influences

Culture was addressed by all participants. To work with students from non-English speaking backgrounds requires negotiating cross-cultural relationships. For some teachers, this involved adapting their teaching to meet cultural needs and using contexts relevant to students (section 5.4.2.2). There were also concerns from New Zealand teachers about acknowledging and embracing the mathematical knowledge and understanding that students from other cultures bring, and how this fits within the Numeracy Project (5.5.2). For all teachers this involved navigating the complex nature of intercultural relationships with parents.

5.7.1 Parental relationships. Because of the intrinsic link between language and culture, teaching ELLs means teaching people from different cultures than the dominant, English-speaking cultures in New Zealand and the United States. Parental interactions are especially governed by these cultural and linguistic differences.

Developing strong relationships with parents was a concern that was brought up by all of the participants (section 4.7). American participant Andrew considered this his greatest challenge in teaching ELLs: “The greatest challenge I have with the ELLs is not the kids, but their parents because I can’t communicate with them. I have some kids that I can’t even call their parents on the phone.” When developing relationships with the parents of ELLs, there is not only a language

barrier to consider, but also a cultural barrier. Often parents have different expectations and experiences of school, because of their own experiences with education in their home countries. When these differences are ignored or downplayed, it can have a negative impact on parent-teacher relationships (Shim, 2013).

Nine of the participants desired or had chosen to use translators to assist with communication with parents. Translation was used for both oral and written communication; at American teacher Cameron's school, all documents that were to be sent home were translated into Spanish for parents first. When it came to the use of oral translators, which were more common, it ranged in formality, from American teacher Emily's school district, which ensured that translators were available for all parents who spoke languages other than English, through to New Zealand teacher Helen, who would often use other students from the same country as translators. Interestingly, whilst two of the Americans reported having formal translators and translation assistance available, none of the New Zealand participants did. When translators are available for teachers, it enables strong relationships to be formed. Frequently, language barriers between teachers and parents of ELLs hinder the relationship between them (Shim, 2013). Translators can help bridge this gap, as they enable parents who don't speak English to communicate with schools and teachers, and become full partners in their child's learning.

When parents only receive documents in English, it can mean important information does not get to them. In contrast, ensuring documents are translated into the parent's primary language means that they have the information they need to participate and make informed decisions about their child's education. Often, however, translation is not available. Also, when it is available, it doesn't necessarily mean parents receive it. In a study by Yasui, Wong & Lau (2006) of language and communication for Chinese parents in the San Francisco school district, it was found that even through the district provided translation services, frequently the parents never received translated documents. This need for accurate written translation is especially important with mathematics. Because of the changes in how mathematics is taught, for parents to be able to work with their children, they need to be able to understand the teaching process and what is

expected of their child.

Oral interpreters are also helpful in ensuring school is a welcoming place for parents of ELLs (Clark & Dorris, 2007). When oral translators are available it facilitates stronger relationships: parents are able to be an active part of parent teacher interviews, and other aspects of school life.

When strong relationships are formed, they facilitate improved student learning and achievement (Shim, 2013). Parental involvement is one of the most important factors that drives student success. When cultural and linguistic barriers exist, and teachers lack the understanding and resources to push through them, it can be extremely difficult to form these strong relationships, negatively influencing outcomes. It is vital, in both New Zealand and the United States, that resources and structures are available to enable parent involvement.

5.7.2 Numeracy Project. There were concerns about the cultural appropriateness of the Numeracy Project for English language learners. Both Felicity and Dominic felt that the Numeracy Project focussed on specific strategies, and that under the Numeracy Project the mathematics students had learned in their own culture was not valued.

There were particular concerns that the Numeracy Project assessments unfairly penalised ELLs. Felicity discussed the fact that there are strict guidelines in the Numeracy Project for determining which level a student is at, which don't necessarily take into account the fact that students enter New Zealand schools with different strategies after learning mathematics in their home countries. Felicity was frustrated because it was obvious to her that students were using and applying strategies learned in their home countries, but were unable to express them in English; therefore they ended up being placed at a lower numeracy stage (section 4.7). This, to her, reflected a wider perception that her student's cultural mathematics knowledge was not valued.

A deliberate effort has been made by the Ministry of Education to make the Numeracy Project a model that is culturally inclusive and both involves and values parents and whanau. This can be seen in the Home–School Partnership

Numeracy Handbook which accompanies the Numeracy Project (New Zealand Ministry of Education, 2008). In this handbook there is a focus on culturally inclusive practices, with teachers being encouraged to learn about their student's cultures, form relationships with parents from all cultural backgrounds, and utilise the cultural mathematical knowledge that each student and family brings.

Unfortunately, judging by the response of participants in this study, that message of cultural inclusion within the Numeracy Project is either unclear or not practical within the constraints of the project. Participants felt that students and parents instead were getting the message that their mathematics knowledge from their culture was not valid.

Both linguistic and cultural barriers can prevent the formation of strong teacher-parent relationships. The language barrier can be addressed when schools provide translation and interpretation, enabling clearer communication between student and teacher. The cultural barrier can be harder. Examining the role of the teacher and the reasons behind the patterns of interaction with parents from other cultures, as opposed to making negative assumptions, can help break these barriers. Furthermore, considering and embracing the mathematical knowledge students bring from their cultures creates a more inclusive environment for English language learners.

5.8 Chapter Summary

There are many issues that affect teachers when teaching mathematics to ELLs, including teacher confidence both in teaching mathematics and teaching ELLs. Lack of confidence in teaching ELLs can lead to reduced outcomes for ELLs. More training was desired by eight of the ten participants, only three of whom had received any training specifically on teaching mathematics to ELLs. Language and mathematics concerned teachers, both in the language requirements of mathematics itself and of word problems. Assessment was a challenge. Standardised testing, when given without modification to ELLs, tends to lack validity. There can also be challenges in formative assessment and understanding student thinking, making it difficult for teachers to give instruction at an appropriate level for each student. Three teachers had concerns about the support

they received from management, whilst six felt that lack of funding led to a lack of appropriate resources. There were concerns with culture, especially in forming relationships with parents from different cultural backgrounds. There were also concerns about the focus on conceptual understanding in schools in both New Zealand and the United States, which has increasingly stronger language requirements, rather than the historical emphasis on procedure.

Chapter Six: Summary of Findings, Limitations and Implications

6.1 Introduction

This qualitative study was undertaken to investigate the following question:

> *What are the issues faced by teachers in New Zealand and the United States when teaching mathematics to English language learners?*

The study was undertaken through the use of semi-structured interviews, enabling participants to express their perspectives on the research question. The study was then analysed through codifying the transcripts of these interviews and identifying pertinent themes within these codes. From the study, a number of issues emerged that teachers face when teaching mathematics to ELLs. These related to teacher confidence, training, language and mathematics, assessment, support and resources, and cultural factors.

In this chapter, these findings will be summarised. The limitations of this study will be discussed, and the implications of this research will be explored, including identifying areas for further study.

6.2 Summary of Findings

Teachers in New Zealand and the United States faced a number of issues. The most widely discussed issues, surrounding the language of mathematics and word problems; lack of sufficient training; lack of funding; challenges related to assessment; and issues surrounding culture and parental relationships, were faced by teachers in both countries. Each country, however, had specific issues that had a wider impact. In the United States, teachers most commonly faced issues surrounding language and mathematics, issues in communicating cross-culturally with parents and students, and issues surrounding lack of resources. In New Zealand, teachers most commonly faced issues in mathematics and language, assessment and lack of funding and appropriate resources.

Teachers faced issues regarding mathematics and language. There were two aspects of language that they found caused concern; the language demands of mathematics, and word problems. Mathematics requires a fairly sophisticated command of language, especially with the focus on conceptual understanding that occurs in both counties. Word problems also cause difficulties, both in the high language requirements needed to read and understand them, and in the contexts that are used, as often these contexts are not familiar to ELLs from cultures other than mainstream New Zealand or American culture. In the United States, four teachers were concerned with their own ability to speak Spanish, the most common home language in the United States after English. They felt that their lack of proficiency in Spanish was an issue as it caused a barrier between them and parents, and stated that it would improve their ability to form relationships with parents and family if they spoke Spanish. In contrast, no teachers from New Zealand expressed a need to learn a different language.

Teachers reported various degrees of confidence in teaching mathematics to ELLs. Two participants discussed their own lack of confidence in mathematics. One American participant expressed a lack of confidence in teaching ELLs. There were also three participants who linked their own confidence level with the age of the students, with the perception that teaching mathematics to ELLs becomes more difficult as students get older.

Lack of training was an issue common to teachers in both countries. Eight of the ten participants wanted more training, especially professional development, and this did not appear to be reflective of how much training the teacher had previously had. Teachers with a lot and with very little prior training still wanted more.

Issues with assessment were common, primarily in New Zealand, but the actual issues involved differed between countries. In the United States, there was more of a focus on standardized testing and student test scores, whilst in New Zealand there was a greater focus on difficulty in understanding student thinking, which is one of the hallmarks of the Numeracy Project. In New Zealand there were concerns that the Numeracy Project was not always appropriate in a cross-cultural

context and that it ignored how students from other cultures have learned mathematics. In contrast, no American teachers expressed concerns over the cultural elements of mathematics and their appropriateness within their curriculum.

Culture impacted all participants. Every participant discussed forming cross-cultural relationships with parents, whether as something positive and enriching, or as a challenge they need to deal with. Teachers had issues with other elements of culture as well; ensuring resources and word problems were culturally appropriate and ensuring the cultural mathematical background of learners is valued.

6.3 Limitations

There are limitations to this study. One major limitation is sample size. Whilst the ten participants represented a wide variety of situations in both countries, including urban and rural settings, experienced and beginning teachers, and high and low concentrations of ELLs, ultimately there were still only ten participants. Doing semi-structured, qualitative interviews enabled a deeper understanding of the issues the individual participants faced, and enabled trends within the perspectives of these ten participants to be examined. Nonetheless, when there are only ten participants, it is not possible to gain a representative sample. It is, however, a starting point on which further research can be based. Finding out if the issues faced by these teachers are similar to issues faced across a wider range of contexts could help develop a broader understanding of the issues teachers face, therefore enabling appropriate changes in policy direction.

Secondly, the fact that the participants were volunteers who opted into the study could have affected how representative the sample was. If a teacher did not feel confident teaching ELLs, or confident in their mathematics teaching ability, they may have been reluctant to volunteer to participate in this type of study. On the other hand, a teacher who felt comfortable in teaching ELLs or who was particularly strong in mathematics, or both, may have been more inclined to volunteer for this type of study. This is a challenge because for research to be ethical, all participants must be volunteers, so doing a completely random study is

not possible.

Thirdly, although referrals were sought for teachers of all primary/elementary and secondary levels, only one secondary teacher volunteered to be interviewed. He was kept in the study because his situation was especially interesting and relevant, being a first-year teacher in a school with a high level of ELLs. Some of his issues paralleled those discussed by the primary/elementary teachers in the study, especially relating to parents and teaching with a focus on conceptual understanding. On the other hand, he had to deal with a much larger number of students for shorter periods of time than any of the elementary teachers, which possibly influenced his perspective. He was also the only first-year teacher in the study, meaning the issues he faced could have been exacerbated by lack of experience. As a result the research tended to focus on primary/elementary teachers and the issues that they faced, as this pertained to the majority of participants.

Finally, there was no triangulation within the study design. Triangulation is where multiple methodologies are used or data sets are collected to enhance validity (Cresswell, 2005). According to McMillan & Wergin (2006), triangulation creates more trustworthy data. When data is consistent across multiple sources, there is a higher degree of validity. Because data was only gathered from one source, there are more likely to be concerns with validity in this study.

6.4 Implications

In this study, it was found that there are many areas in which teachers face issues when teaching mathematics to ELLs. In some cases these are unique to a specific country; for example, the issues with large-scale standardised testing in the elementary grades in the United States, or the wide-scale concerns about the cultural appropriateness of the Numeracy Project in New Zealand. As well as this, there are issues that both countries face, such as a lack of training. Addressing these issues has the potential to benefit student learning.

6.4.1 Training. In both New Zealand and the United States, there would be benefit in giving more in-depth pre-service training in the teaching of ELLs to

all mainstream teachers, including in mathematics education papers, and professional development that specifically addresses how to teach mathematics to ELLs.

In the United States, ensuring all teachers receive sufficient training in teaching mathematics to ELLs is important, not just those who teach in areas with high ELL concentrations, especially considering the current demographic trends that indicate that the ELL populations in rural and less traditional areas are increasing at a faster rate than urban areas with a currently high concentration of ELLs (section 5.2).

6.4.2 Resources and funding. In both countries, ensuring there are resources available that are designed to be used with ELLs by having simplified language but still involving challenging mathematical problems would enable ELLs to work at an appropriate level. There was a common desire for teacher aides to assist in mathematics classes with ELLs. Funding teacher aides in classrooms would enable students to receive more individualised attention, either from the aide, or from the classroom teacher whilst the aide works with other students. In the United States, equity of funding would also be beneficial, as ELLs are often disproportionately represented in areas which receive lower school funding (section 2.3)

6.4.3 Assessment. In the United States, students are required to take standardised tests in mathematics with no accommodations made because of language proficiency. As a result, ELLs are unfairly penalised by these tests (section 2.5). To ensure greater validity and less unfair penalisation of ELLs in standardised testing, it would be appropriate to offer reasonable modifications and support to ELLs, or exempt ELLs from standardised testing in mathematics until they have gained academic language proficiency in English.

In New Zealand, two teachers expressed concerns with the Numeracy Project, feeling that the assessments unfairly penalised students who had previously been schooled outside of New Zealand. There were particular concerns about students being unable to explain their thinking in English. Developing assessments

specifically designed for ELLs that align with the Numeracy Project but require students to demonstrate rather than explain their thinking, for example by providing more manipulatives and pen and paper, could help to mitigate these issues.

6.4.4 Culture. Whilst translators were frequently used as a way to bridge the language barrier between teachers and parents who speak languages other than English, no New Zealand teachers reported having formal translators available, and only two American teachers had access to formal translation. Hiring translators to assist with parent-teacher communication in both countries has the potential to help build stronger parent-teacher relationships. Furthermore, as suggested by New Zealand participant Felicity, holding parental information sessions in common home languages could enable parents to develop a better understanding of how mathematics education works in New Zealand and the United States.

6.4.5 Areas for further research. Because this study only had ten participants, further research, in the form of either comparative or independent studies in both countries, could add more depth and breadth to the knowledge and understanding gained. Using the present study as a basis, a wider quantitative study could be conducted in survey format to see if the results found are generalisable. This would enable these issues to be investigated on a larger scale. Furthermore, qualitative focus group research methods could enable deeper discussion of these issues and add validity to the survey data through triangulation (section 6.2). Focus groups are a useful vessel for exploring trends that have emerged in quantitative research, so a better understanding can be gained (Menter et al., 2011). Therefore, if a large scale quantitative survey were done to further explore the generalisability (section 3.4) of the themes that emerged in this research, following up with focus groups could enable a deeper understanding of the results in the survey, giving a deeper understanding overall.

Whilst this study was open to participants who taught both primary/elementary and secondary school, because of the referral and voluntary nature of the study, only one secondary teacher volunteered. A study that specifically addresses issues

secondary teachers face in teaching mathematics to ELLs could offer valuable insight, due to the fact that secondary teachers in both New Zealand and the United States tend to be subject specialist teachers, and because working with adolescents brings a different set of challenges.

There were concerns by three New Zealand teachers over the cultural appropriateness and language demands of the Numeracy Project. Exploring these issues further would enable them to be addressed through training and providing appropriate tools for assessment.

Finally, each issue that has been identified could be investigated individually. This would mean a greater focus on that specific issue, therefore encouraging deeper understanding. This could be through further comparative study, or restricted to one country or setting.

6.5 Concluding Thoughts

There are many issues that teachers in New Zealand and the United States face when teaching mathematics to ELLs. In this study, it was found that teachers faced issues connected to their own confidence, the amount and quality of training they had undertaken, language and relationships, support and funding, assessment, and the formation of culturally sensitive relationships with students and their families. Understanding these issues is the first step toward being able to address them at both school and policy levels, which will enable teachers to be better supported and equipped to teach ELLs, therefore enabling better mathematics instruction for ELLs. With the large numbers of ELLs in New Zealand and the growing numbers of ELLs in the United States, it is crucial that teachers are equipped to meet their needs.

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Appendix One: Interview Questions

1. What age level do you teach?
2. Do you only teach mathematics, or do you teach a range of subjects?
3. How many English language learners do you teach in a (typical) class?
4. Tell me about the demographics of your school and area.
5. Tell me about your background and experiences in teaching mathematics to English language learners.
6. How confident do you feel teaching mathematics to English language learners? Why/ Why not?
7. What would make you more confident in teaching mathematics to English language learners?
8. How much training have you had in teaching English language learners? Do you feel this is sufficient?
9. Do you feel you are supported enough in teaching English language learners mathematics? Why do you think this?
10. What other support would you like?
11. What are the greatest challenges you face in teaching English language learners mathematics?
12. What do you think could help you with these challenges?
13. What other issues do you face in teaching English language learners mathematics?
14. How do you think these issues could be minimised or avoided?

Appendix Two: Letter of Introduction

Laura Jourdain
5677 Cross Timbers Circle
Ravenna
Ohio
44266
USA

INSERT DATE

Dear Sir/Madam,

My name is Laura Jourdain and I am a student at the University of Waikato, New Zealand. I am currently working on a thesis as part of my Master of Education degree, looking at issues teachers face when teaching English language learners mathematics in mainstream classrooms.

I am in the process of finding a range of teachers from the USA and New Zealand to interview as part of this research. To be eligible to participate, teachers need to be teaching mathematics to a mainstream class with at least one student who is an English Language Learner. Primary/Elementary teachers are eligible to participate as long as they teach mathematics as part of their overall classroom teaching. I anticipate one interview with each participant, to be conducted over Skype at time of mutual convenience sometime in May, June or July. I anticipate the interview will last between one hour and one hour and thirty minutes. These interviews will be recorded for my future viewing, with participant permission.

The information I gather will be held in the strictest confidence, with no identifying information being available to anyone but myself. Pseudonyms will be used and at no time will I ask for the specific name of a participant's school. Participants will have access to their data at any time they wish and are free to pull out of the study at any time. No reason needs to be given for withdrawal. Once the data has been interpreted, a thesis will be written up that participants will be able to access. There will be nothing in the final thesis that could give the reader a participant's identity. If the interpretation of this data is used in further publications, I will inform participants. Ethical approval to undertake this research has been granted by the Faculty of Education Research Ethics Committee at the University of Waikato, New Zealand.

If you are interested in participating, or have any questions about this research, please feel free to contact me [lauravjourdain@gmail.com or +1 (330) 389 4271]. If a question cannot be addressed to me, please contact my supervisor, Dr. Sashi Sharma, Faculty of Education, University of Waikato [sashi@waikato.ac.nz or 07 8562889 ext 6298].

Yours sincerely,

Laura Jourdain

Appendix Three: Participant Information Sheet

Dear Participant,

Thank you for considering participating in this research.

Title of Research:

Teaching mathematics to English Language Learners: A comparative study of issues faced by teachers in New Zealand and the USA.

Information about Research:

I am currently a Master's student at the University of Waikato, New Zealand. For my Master's thesis, I am doing a small study looking at the issues faced by teachers in the USA and New Zealand when teaching mathematics to English Language Learners. I intend to interview 4-5 teachers in the USA and 4-5 teachers in New Zealand about their experiences and the issues they have faced. To enable interviews to be conducted over a wide geographic area, I will be conducting these interviews over Skype.

I intend to record these interviews for my own reference (video and audio). They will be kept on a password protected computer and will not be labelled with your name. You may ask for the recordings (and other data) to be sent to you and/or destroyed at any time. If you are not comfortable with the interviews being recorded, I will not record them. Then initial data will be destroyed after five years.

I would really appreciate your participation in my research, but you are under no obligation to participate. All participation is entirely voluntary and there is no reward, monetarily or otherwise, offered to participants. You may choose withdraw participation at any time prior to submission, without giving reason.

All results and data will be kept confidential. Nothing in the final report will be able to be used to identify you. You will have access to any information that has been recorded about you, and the final write up. You will be able to pull out of the study at any time, and withdraw your data, up to the point of analysis.

If you choose to participate, I will give you a consent form to sign and return (either by mail or email). An addressed envelope will be available for you if needed. Once I have received this form, I will contact you to make an appointment for an interview time.

Ethical approval to undertake this study has been granted by the Faculty of Education Research Ethics Committee at the University of Waikato, New Zealand. If you have any questions about this research, please feel free to contact me [lauravjourdain@gmail.com or +1 (330) 389 4271]. If a question cannot be addressed to me, please contact my supervisor, Dr. Sashi Sharma, Faculty of Education, University of Waikato [sashi@waikato.ac.nz or 07 8562889 ext 6298].

Sincerely,
Laura Jourdain

Appendix Four: Consent Form

Research topic: Teaching mathematics to English language learners: A comparative study of issues faced by teachers in New Zealand and the USA.

Name of researcher: Laura Jourdain

Please initial

1. I have read the information letter and information sheet and have been able to ask questions. Any questions I have asked have been satisfactorily answered. _____

2. I understand that participation is voluntary and I can withdraw without penalty at any time for any reason, and no reason must be given. _____

3. I understand that all data and information that Laura Jourdain collects is confidential. I will not be able to be identified at any point during the study. _____

4. I understand that Laura Jourdain will be recording the interview for her own records. I may ask for a copy to be sent to me and/or for these recordings to be destroyed at any time up to the point of analysis. All data will be destroyed after five years. (If you wish to participate but don't wish to be recorded, please write no on the line) _____

5. I agree to participate in this study. _____

_____ _____

Name of Participant Date

_____

Signature

Two copies: One for participant and one for researcher.

Appendix Five: Topics Discussed by Participants

The table below shows how many participants discussed a particular code. This includes all participants who discussed each code, not only those who had issues in each area. Some of these were further developed into sub-categories.

Theme	Codes	Number of Participants		
		NZ	USA	Total
Confidence	Teacher confidence	5	5	10
	Mathematics confidence	2	0	2
	Age and difficulty	2	1	3
Culture	Cultural difference	5	3	8
	Teacher use of L1	0	4	4
	Translation	4	5	9
	Family relationships	5	5	10
Language and mathematics	Mathematical language	4	4	8
	Word problems	4	3	7
	Pedagogy	4	3	7
	BICS/CALP	2	1	3
	Universality	0	3	3
Assessment	Assessment	3	3	6
Training	More desired	5	4	9
	ELL pre	5	3	8
	ELL in	5	4	9
	Mathematics pre	0	4	4
	Mathematics in	2	2	4
	Mathematics to ELLs	5	4	9
Support and funding	Personnel support	5	5	10
	Funding	4	3	7
	Aides	2	2	4
	Resources	4	4	8
	Digital resources	4	2	6