

PRE-TEACHING MATH LANGUAGE LESSONS FOR
THE SUCCESS OF
ENGLISH LANGUAGE LEARNERS

by

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CHAPTER ONE: INTRODUCTION

Julio¹ entered third grade at my elementary school shortly before winter break. Before we went on vacation for two weeks, there was just enough time to determine that he did not speak any English at all though he had formal schooling experience in Spanish in Mexico. According to my district ESL terms, he was a newcomer or beginner. I began teaching him daily in a self-contained English as a Second Language (ESL) classroom for beginners, in which language is modified so as to make content comprehensible to students. Additionally, I worked with him during whole class math lessons, weekly math language lessons that I taught to Julio and all of his classmates in the mainstream classroom. Despite his solid computational background in mathematics from his home country and my integration of techniques for English Language Learners (ELLs), Julio was not usually able to access my whole class math lessons. In other words, he was not able to comprehend the lessons as they were delivered. This was extremely troubling to me. According to Echevarria, Short and Powers (2006), students such as Julio need to continue learning grade-level content simultaneously with their acquisition of English language skills if they are to succeed in the current “high stakes” environment of standardized testing. Though I was pre-teaching the content areas of science, social studies and health to my newcomers, I had not placed the same priority on

¹ All names have been changed to provide anonymity.

prior instruction for mathematics.

I began discussing my concern over Julio's lack of comprehension during my whole class math lessons with colleagues—both the third grade team that I teach with and the ESL team. Out of these discussions came the suggestion that I pre-teach whole class math language lessons to Julio so that he would be better prepared for those lessons when I taught them in his mainstream class. Subsequently, I attempted an informal investigation to determine whether pre-teaching would increase the comprehensibility of whole class math lessons for ELLs with low English proficiency, like Julio. The students I investigated were typically ESL beginners (Level One in my district) or low-intermediate students (Level Two). The results of my investigation were positive overall. I informally observed ESL students who had received pre-teaching during the whole class math lessons and noticed increased engagement, competence and enthusiasm—observations that were corroborated by their classroom teachers. This information was purely anecdotal and not based on formal test scores, but promising enough that I began to seriously ponder the possibilities of pre-teaching for rendering math language lessons accessible to beginning and low-intermediate ELL students.

This chapter introduces the issues associated with pre-teaching whole class math language lessons to Level One and Two ELLs in third grade at the school where I teach, a pre-K – 3 elementary school located in a first-ring suburb of a Midwestern metropolis. I explain why my school and grade level use this particular model for teaching English through mathematics, and why it is important to further investigate pre-teaching whole class math language lessons to beginning and low-intermediate ELLs.

Mathematics and the Beginning English Language Learner

Unfortunately, beginning ELLs do not have the luxury of hibernating in a language incubator until their English proficiency has ‘hatched’ to comprehend all of the language embedded in a mainstream classroom. While acquiring a second language, they must continue learning grade level content to stay at the same academic level as their native-English speaking classmates. However, academic language proficiency can take five to seven years, if not more, to develop (Cummins, 1992). Given this rate of acquisition, it is extremely difficult for beginning ELLs to comprehend non-modified instruction in the content areas. Therefore it is vital that they acquire grade-level knowledge at the same time as English language skills. For this reason and others, it is ideal to teach language through content (Chamot & O’Malley, 1992; Echevarria, Short & Powers, 2006; Hawkins, 2005; Snow, Met & Genesee, 1992). Mathematics has recently emerged as one of the content areas through which it is prudent to teach language. This is due, in large part, to the National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards for School Mathematics* of 1989 (NCTM, 1989) and its subsequent *Principals and Standards for School Mathematics* of 2000 (NCTM, 2000). These documents suggest reform of the teaching of mathematics by focusing on math instruction that incorporates a problem-solving approach, mathematical communication, reasoning and proof, and connections between math and everyday life; additionally, *Principals and Standards for School Mathematics* incorporates representation using symbols (Garrison, 1997; Hawkins, 2005). In the reform-oriented classroom, calculation and computation alone no longer suffice as mathematics literacy;

students are now expected to dialogue and write about mathematical processes (Garrison, 1997; Moschkovich, 1999). This emphasis on language makes mathematics very challenging for students with low English proficiency. However, it is imperative that teachers make mathematics accessible for all students. As society becomes more technological and driven by mathematic and scientific principles, the future economic consequences are devastating for those who lack mathematical skills (Ortiz-Franco, 1999; Secada, 1990; Steen, 1990).

There are many reasons why mathematics is difficult for students learning English, not least of which is its linguistic demands. Math is very language-dependent with its own particular vocabulary, syntax and discourse (Crandall, Dale, Rhodes, & Spanos, 1990; Cuevas, 1984; Dale & Cuevas, 1992; Kessler, Quinn, & Hayes, 1990; Rubenstein & Thompson, 2002; Spanos, Rhodes, Dale, & Crandall, 1988). Moreover, the language of mathematics is very precise and includes linguistic phenomena such as polysemy, in which words that have related meanings are differentiated by their context. For example, students may understand a word such as *table* in a non-mathematics context, but they will not necessarily understand its meaning in a mathematical sense (Rubenstein & Thompson, 2002). In addition to language, students may grapple with mathematics concepts, particularly if they have limited formal schooling in their L1. Even for ELLs with a strong command of math language and concepts, there are cultural differences in mathematics instruction that may negatively affect students' comprehension. These include variances in symbolic representation and units of measurement, a focus on fractions in the U.S. that is not present in countries that use the

metric system, and emphasis on analytical and conceptual aspects of mathematics versus accuracy and speed of computation (Chamot & O'Malley, 1994).

With so many challenges it appears difficult to begin teaching math to ELLs, especially those with little or no English proficiency. Garrison and Mora (1999) present a helpful format for determining which aspect of mathematics to focus on, language or concept, when teaching mathematics in a bilingual context (see Appendix A). They explain: "The basic principle underlying the different strategies for bilingual instruction can be summarized as follows: *To teach an unknown concept, use the known language; to teach an unknown language, use a known concept*" (p. 37). These principles for bilingual language instruction are not always achievable in schools without bilingual resources. Still Garrison and Mora's advice is applicable for determining where to begin with math instruction for ELLs given the language-concept relationship.

Once it is established whether to teach language or concept, or both, in relation to math instruction, it is important to determine the most effective way to provide such instruction to beginning and early-intermediate ELLs. For such students, comprehensible input is imperative (Peregoy & Boyle, 2001). One way to foster comprehensible input during the *whole group* math lesson is through accessing prior knowledge and building background before students interact with new material. This can be accomplished by relating children's personal experiences to mathematical ideas and using the informal language that accompanies their stories to develop conceptual understandings in everyday language before introducing technical mathematical terminology (Curcio, 1990; Silverman, Strawser, Strohauer & Manzano, 2001; Whitin & Whitin, 1997). However,

since there is limited time for accessing prior knowledge during the whole group lesson, and it may not be as extensive as needed in order to be comprehensible to Level One and Two ELLs, this facet of instruction may be taught prior to the main language lesson, through pre-teaching. Dutro and Moran (2002) advocate ‘front-loading’ English language development to “[e]nsure access to content instruction taught in English by preteaching for upcoming language demands” (p.3).

Role of the Researcher

When I began teaching ESL in my current placement, the school was attempting to have ESL teachers and classroom teachers work collaboratively, specifically through an inclusion model, in which students are integrated into the mainstream classroom and receive subject matter instruction along with English-speaking peers and supported by collaboration with ESL teachers (Hawkins, 2005). I was excited about the possibilities this model entailed but also frightened to teach with or in front of seasoned classroom teachers when I was so new to the teaching field. My first year, I never had to confront this fear. This was because both my grade-level team and I agreed that I would deliver my English support through a pull-out model, in which ELLs were ‘pulled out’ of their mainstream classroom and taught in small groups in the ESL classroom. At year end, we did not feel this model was successful for students or teachers, as students were not necessarily given access to the core curriculum.

Subsequently, my team and I decided to cluster several of the ESL students in two classrooms the following year. A higher number of ELLs were placed in the clustered rooms than in the non-clustered rooms, so I could service them more efficiently. I then

taught in the two clustered classrooms during mathematics instruction. In these classes I supported ELLs and all students by offering mathematics mini-lessons, extra help, and periodic language lessons to the whole group. It was not a perfect model, but I learned a lot about my school's third-grade math curriculum, what was working and not working, and how two of my mainstream colleagues presented their math instruction. Moreover, while math had always come easily to me as a young student, I had never taught it before. The mathematics instruction I had received as a child was very traditional, involving rote memorization and computation drills. As I began to teach math and its accompanying language, I was also explicitly learning the underlying concepts of mathematics for the first time.

The next year at my school, and the third year of my team's movement toward inclusion, we decided to try a different model based on what was working well in kindergarten at our school. We had realized that clustering was not appropriate for our students, since the percentage of ELLs in third grade was so high. There were also several students in our classes who may have qualified for ESL services but were not identified as such due to their parents' responses on our school's Home Language Questionnaire (HLQ). (The HLQ is an initial tool for screening potential ELLs by identifying those who speak languages other than English at home.)

Our new model consisted of my teaching one whole class math language lesson per week on a rotating schedule in each of the third grade classrooms. I would design this lesson in collaboration with the third-grade classroom teachers so that it correlated with the current content of their math curriculum and the language necessary to

comprehend and explain this content. These lessons ranged from language arts style lessons with math content and language woven in to group or pair work that required students to practice target language and corresponding concepts. I alternated whose room I began in, so that the same students were not ‘victim’ to my first—and less well-developed—lesson each week. In summary, each week I taught the same whole class math lesson in each of the four third-grade classrooms, one classroom per day, and on the fifth day of the week I supported a classroom teacher as she taught her lesson. By mid-year my grade-level colleagues and I agreed that this model suited our students’ needs well. It contributed to the language development of ELLs as well as non-ESL students, some of whom were not identified as ELLs but demonstrated language needs. Furthermore, when I taught, my mainstream colleagues had a chance to observe their students—a rare opportunity—and the students received the benefit of two teachers rather than one.

Despite the perceived success of this model, there was a problem tugging at the edges of my brain. My beginning and low-intermediate ESL students were not always able to access or comprehend my whole class math language lessons. I would notice them lying on their desks or with their eyes glazed over as if they were about to fall asleep. Similarly, they were not necessarily participating, either non-verbally by nodding or shaking their heads or responding to other prompts, or verbally, by sharing in class or with partners and/or groups. This happened despite my best attempts to implement lessons using best practices for English language instruction in mathematics, such as providing a known context, incorporating small group cooperative work, explicitly

teaching vocabulary, and using models and manipulatives (Cuevas, 1984; Garrison, 1997; Hawkins, 2005). This result was unacceptable to me and rather confounding. I could not figure out an appropriate ‘intervention’ on my own. I talked to some of my ESL and grade-level colleagues, one of whom suggested I pre-teach math language lessons to these struggling students. Later that year, I began doing so during my pull-out time with them.

This instruction, in effect, comprised a basis for my current study. Based on the results of this explorative study I carry some explicit assumptions into my current study:

1) I believe the students who receive pre-teaching will participate more during math language lessons; 2) I expect these students will demonstrate more problem-solving abilities during said lessons; and 3) I anticipate that beginning and early-intermediate ELLs who receive pre-teaching for math language lessons will demonstrate more confidence and enthusiasm during the instruction of the lessons in their mainstream classroom.

Background of the Researcher

This topic is inherently interesting to me as it directly affects my instruction and the level of my students’ success in mathematics. Additionally, I believe my results will be important to others. First, they will be pertinent to my third-grade team, since we are teaching the same students. If pre-teaching renders my whole class math language lessons more accessible for our Level One and Two ELLs, hopefully this understanding will translate into greater comprehension of math language during mathematics lessons taught by their mainstream teacher as well. Second, my findings will be important for

my ESL team, which includes four ESL teachers, including myself. We each work with one grade level, K – 3. One of our protocols for ESL delivery school-wide—as we decided in collaboration with our principal—is teaching English through math language rotations (as outlined above). Since there are Level One and Two ELLs in all of our grade levels, my ESL team will benefit from a study regarding effective pre-teaching of mathematics language lessons for these students.

Finally, I hope that my findings will be of interest to other classroom and ESL teachers of mathematics who have beginning and low-intermediate ELLs whom they teach. Though there is plentiful research on strategies to make math more accessible for ELLs, I have not encountered a study that specifically examines elements of successful pre-teaching in this content area. In the reform-oriented era of mathematics instruction, it is exceedingly important that teachers know how to make math accessible for all students, including those with limited English proficiency.

Guiding Question

While I had the chance to informally explore the question concerning whether pre-teaching whole class math language lessons renders them more comprehensible to beginning and low-intermediate ELLs last spring, I want to systematize my process of inquiry to discover whether the successes that my colleagues and I informally observed were valid. In particular, I want to discover important elements of pre-teaching instruction that enable students with low English proficiency to access or comprehend whole class math language lessons by looking for global patterns in my pre-teaching instruction that lead to increased participation and engagement from Level One and Two

ELLs during whole class math lessons. My question, therefore, is: How can I pre-teach whole class math language lessons to make these math lessons more comprehensible to beginning and low-intermediate ELLs?

Summary

In this study, I will focus on how to pre-teach math language lessons in order to make them more accessible for beginning and low-intermediate third-grade ELL students at my school. As language demands related to the field of mathematics become more rigorous, it is imperative for all ESL teachers as well as mainstream teachers who teach ELLs to understand how to make math lessons comprehensible for all students, including those with little or no English. Though there are many challenges for students with low English proficiency in learning mathematical skills in a language other than their L1, it is vital to their future success that they have a firm grasp of math concepts and language. This study will hopefully contribute to a greater understanding of effective pre-teaching techniques for making math accessible to Level One and Two English Language Learners.

Chapter Overviews

In Chapter One, I introduced my research by establishing the purpose, significance and need for this study. The context of my study was briefly introduced as was the role, assumptions and biases of the researcher. The background of the researcher was provided. In Chapter Two I will provide a review of the literature relevant to pre-teaching math language lessons to beginning and low-intermediate English Language Learners. Chapter Three will include a description of the research design and

methodology that guide this study. Chapter Four will present the results of the study. In Chapter Five I will discuss the implications of the data collected. I will also address the limitations of the study, implications for further research and recommendations for pre-teaching math language lessons to beginning and low-intermediate ELLs.

CHAPTER TWO: LITERATURE REVIEW

Overview

In this chapter I will address the existing literature that explores how to pre-teach mathematics to make it more accessible for ELLs. First, I will examine the current status of ELLs' performance in mathematics. Then I will discuss why it is especially important in contemporary U.S. society for all students to have a firm grasp of mathematics. Next, I will examine why math is difficult for English Language Learners, in particular. Finally, I will present a rationale for pre-teaching mathematics to ELLs. Through exploration of these topics, I hope to discover how to pre-teach mathematics language lessons to make them comprehensible for beginning and low-intermediate ESL students.

Performance in Mathematics by ELLs

According to Echevarria, Short, and Powers (2006), the general academic achievement of ELLs as measured by standardized tests is significantly lower than that of non-ELLs. Khisty (1995) specifically discusses the disproportionately low performance of Latino students in mathematics in the United States as problematic. Several other studies (Gutstein, Lipman, Hernandez, & de los Reyes, 1997; Ortiz-Franco, 1999; Secada, 1996) reach similar conclusions. The performance of Spanish-speaking ELLs is significant since the majority of ELLs in the K – 12 school system in the U.S. is Spanish-

speaking. In fact, prior to the year 2000, it was believed that 77% of that year's ELL population would be Spanish speakers (Khisty, 1995).

There are a variety of theories as to why ELLs are not achieving on English standardized math tests. One is that there is a lack of parental involvement in mathematics education, which suggests that parents not only need to assist their children with math work at home, but they must understand the manner in which math concepts are currently taught versus how parents themselves were taught these concepts (Lo Cicero, Fuson, & Allexaht-Snyder, 1999). Others claim that teachers may lack the skills to effectively teach math curriculum that is accessible for students with a lower socioeconomic status who are ethnic minorities, including those who are non-native speakers of English (Khisty, 1995). Another theory proposes that school conditions may be more dangerous for students who are learning English, as these populations tend to be located in urban centers, which may then negatively affect attendance (Secada, 1996). Additionally the math assessments themselves may be linguistically biased and unfair indicators of mathematical knowledge (Abedi & Lord, 2001). Burns, Gerace, Mestre, and Robinson (as cited in Spanos, et al., 1988) found a positive correlation between English proficiency of Latino students enrolled in college-level technical classes and their mathematics tests scores. Their work and that of others supports the notion that regardless of other factors, low English proficiency can be a factor in poor mathematics achievement.

Two documents published by the NCTM, *Curriculum and Evaluation Standards for School Mathematics* and *Principles and Standards for School Mathematics* (NCTM

1989, 2000) increased the difficulty for students with low English proficiency to achieve at high levels according to the new mathematics standards. It became evident that there was a new priority for students to communicate “mathematically” through speaking and writing (Hawkins, 2005; Moschkovich, 1999), a task that is more difficult for students with low English proficiency levels. Despite the NCTM’s aim to create equity in mathematics through reform, these documents did not explicitly state how to reach this goal, and some educators theorized that the reform-oriented classroom might magnify previously existing inequalities in mathematics instruction and education (Gutstein, 2003; Secada, 1996).

Mathematics: An Economic Necessity

Why is mathematics so important, anyways? As Secada (1990) states, “The level of mathematical literacy needed to participate fully in [the] world, its jobs, its economic and social orders, and its democratic institutions is steadily increasing” (pp. 137 – 138). Furthermore, mathematics is at the basis of science and technology, considered to be two of the more important fields in the future of our society (Steen, 1990). In other words, students who want to prosper economically will need to be highly skilled in mathematics in order to fill job positions increasingly created by our changing society. Moreover, those who possess these skills will have more civic power to influence governmental and other changes (Gutstein, 2003; Secada, 1995). This increasing need for mathematicians creates a crisis of sorts as current educational institutions are not producing a sufficient amount of students who are highly skilled in math to fill this void.

Simultaneous to this growing need for mathematicians, the face of our student

population is rapidly changing. Demographics show that non-white “minorities” are quickly becoming the majority (Secada, 1990; Steen, 1990). Unfortunately, as of 1990, only 2 percent of scientists, mathematicians, or engineers came from these “underrepresented minorities” (Steen, p. 2). These trends have strong implications for mathematics education. It is imperative that students, including ELLs, secure solid math skills for their personal, economic, and civic prosperity, as well as the economic well-being of the U.S., and in order for this to occur, educators must ensure that mathematics education is available and accessible to all learners (Secada, 1990; Steen, 1990).

Why is Math Difficult for English Language Learners?

Academic language in general is difficult for ELLs to acquire. According to Cummins (1992), it takes five to seven years on average to learn academic language skills. In the past, there has been an inaccurate assumption that mathematics is devoid of language and, therefore, presents the perfect opportunity for integration of ELLs with low English proficiency into the mainstream classroom. However this belief has been proven to be a “myth” as math has a language all of its own (Kimball, 1990; Cuevas, 1992). This is sometimes referred to as the “language of mathematics” or the ‘mathematics register’. Pimm’s explanation of the mathematics register hints at its complexity: “The requirements of the expression of mathematical ideas in natural languages lead to the development of mathematics registers in which discourse about mathematical ideas, objects and processes can take place” (1987, p. 77).

According to Cuevas (1990), one of the reasons math language is so difficult is due to its lack of redundancy or paraphrase in relation to natural speech. Everyday

communication is redundant; its message is repeated in the context of communication and does not require one to understand every word or phrase in order to grasp the overarching message. Conversely, mathematical language includes words and phrases that represent specific ideas. If students do not understand these words and phrases, it precludes their complete comprehension of the message. Several studies (Crandall, et al., 1990; Dale & Cuevas, 1992; Rubenstein & Thompson, 2002; Spanos, et al., 1988) have thoroughly delineated the specific linguistic features that make the language of mathematics challenging for ESL students, including vocabulary, syntax, semantics, discourse and pragmatics. For elementary students with low English-proficiency who are just beginning to produce English words and phrases mathematics vocabulary and structures can be particularly troublesome.

Vocabulary

Rubenstein and Thompson (2002) present an excellent examination of mathematics vocabulary by category (see Appendix B). Of these categories, there are several that appear especially challenging for beginning and low-intermediate ELLs. To begin with, there are many words that are solely found in mathematical contexts, such as *isosceles*, *denominator*, and *rhombus*, that must be explicitly learned by all students, including those who are native English speakers. (Spanos, et al., 1988). However, there are also words shared by math and everyday English that have different meanings in the two contexts. For example, in math, a *table* is a chart displaying data, and in everyday English, a *table* is a piece of furniture. Equally confusing are math terms that are homonyms with everyday English words, including *sum* and *some*, *pi* versus *pie*, or *four*

and *for* (Rubenstein & Thompson, 2002). For students with a tentative grasp on everyday English the context and orthography that render these terms comprehensible may be quite elusive.

Likewise, some words have multiple meanings in mathematics; “[*s*]quare as a shape versus *square* as a number times itself” while other terms have cross-disciplinary meanings, such as *divide* in mathematics as opposed to the Continental *Divide* in social studies (Rubenstein & Thompson, 2002). Furthermore, there are several synonymous words and phrases, such as those for addition and subtraction. Addition can be signaled by the words *add*, *plus*, *combine*, *sum*, *more than*, and *increase by*, while subtraction terms include *subtract*, *minus*, *difference*, *less than*, *decreased by*, and *take away* (Spanos, et al., 1988). In addition to the inherent difficulty of learning the vocabulary of the mathematics language register, these terms must be used in relation to a specific context, not just learned randomly as a list of words. A word as simple as *by* can be difficult to comprehend; in the phrase *5 multiplied by 2* it signals multiplication, while *5 increased by 2* means addition (Dale & Cuevas, 1992).

In addition to the words and phrases inherent in the math register, there are also specific symbols and mathematical notation that are used. Some symbols may have different meanings cross-culturally, causing difficulties for ELLs. For example, many Spanish-speaking countries use a period instead of a comma to write numerals for multiples of a thousand, and they use a comma rather than a period for decimals (Chamot & O’Malley, 1994).

Structures

Apart from the lexicon of mathematics language, there are linguistic features such as comparatives, prepositions, passive voice and logical connectors that can be confusing for ELLs. For example, the following three sentences convey the same information in different ways:

1. Circle A is as small as Circle B.
2. Circle A is the same size as Circle B.
3. Circles A and B are equal in size.

(Adapted from Spanos, et al., 1988)

Similarly, prepositions such as *by* and *into* may express the same meaning, as in *four divided by two* and *two divided into four*. Dale & Cuevas (1992) view the lack of one-to-one correspondence between mathematical symbols and what they represent to be a key component of syntax used in mathematics. “[I]f the expression *eight divided by 2* is translated word-for-word in the order in which it is written, the resulting mathematical expressions $8 \ 2$ would be incorrect” according to U.S. notation (Dale & Cuevas, 1992, p. 334). These few examples suggest the breadth of structures in the math register that make it quite challenging for ELLs to master.

Extra-linguistic Features

Linguistic features such as vocabulary and structures are not alone in making math difficult for ELLs. Dawe (as cited in Spanos, Rhodes, Dale, & Crandall, 1988) hypothesized that students need a “threshold” level of cognitive academic mathematics proficiency (CAMP) in order to successfully perform on demanding mathematics tasks. CAMP consists of cognitive knowledge of mathematical concepts and the appropriate

language to convey this knowledge. Bilingual research indicates that new concepts should be taught in the student's first language (Garrison & Mora, 1999); however, this is often not possible. Therefore, many ELLs must process language and mathematical concepts simultaneously, which is not always successful:

If the student's thought processes are not automatic in the language in which the problem is expressed, but require deliberation due to confusion over unfamiliar meanings of words and phrases, the student's attempts to solve the problem will be delayed if not interrupted altogether.

(Chamot & O'Malley, 1992, p. 231)

Due to this intrinsic relationship between math language and concepts, it may be very difficult to assess and properly address the proficiency of ELLs in the mathematics classroom.

Just as the language and underlying concepts of mathematics may be foreign to ELLs, background knowledge or experience may be similarly unknown. For example, students may lack the experience to relate to word problems. Spanos, et al. (1988) cite the tendency of word problems to make references to market-place concepts as particularly difficult. Likewise, countries that use the metric system may not place an emphasis on fractions as we do in the U.S., or students may come from countries where memorization of computational rules is valued over the focus on analysis and conceptual understanding in this country, among other cross-cultural phenomena (Chamot & O'Malley, 1992). As a result of these cultural differences, students' background experiences in mathematics that were developed within their cultural framework may not

necessarily relate to the traditional U.S. math curriculum. This is highly problematic since studies have shown the importance of using personal experience as a starting point for the development of math skills (Curcio, 1990; Silverman, Strawser, Strohauer, & Manzano, 2001; Whitin & Whitin, 1997). In other words, it is necessary to integrate elements of mathematics and children's lives in order to teach effectively, and this integration is not always present in math curricula (Lo Cicero, Fuson, & Alleksaht-Snider, 1999).

Making Mathematics Accessible Through Pre-Teaching

Teaching Language through Mathematics

Though ELLs are often taught lessons in a self-contained or pull-out classroom when mainstream lessons are not accessible, this does not necessarily correlate with best practice. Hawkins (2005) discusses a continuum of ELLs' needs vis-à-vis various models of instruction. She concludes, "ELLs should be taught subject matter in the mainstream classroom, if not from the very beginning, then from the early stages of second language (L2) proficiency" (p. 379). She then describes the importance of teaching mathematics in the English medium classroom from a primarily constructivist approach, citing the importance of the social context to shape children's knowledge. Several other studies share this viewpoint of combining mathematics and English instruction (Crandall, Dale, Rhodes & Spanos, 1990; Dale & Cuevas, 1987; Spanos, Rhodes, Dale, & Crandall, 1988).

Comprehensible Input

Krashen (as cited in Peregoy & Boyle, 2001), first discussed the notion of

comprehensible input, or making language understood by learners even when their L2 proficiency is limited. There are a variety of strategies that can be employed to render language comprehensible, such as acting out new words/phrases, speaking slowly and clearly, using visuals and manipulatives, and the like. In regard to academic language, such as that inherent in the math register, Cummins (1992) explains that not all environments are equally accessible for learning academic language. In his theoretical framework for communicative activities (see Appendix C) he presents four quadrants that represent a range of academic tasks. There are two continua that are used in this framework. The first addresses context-embedded versus context-reduced activities. In a context-embedded environment, speakers can negotiate meaning and learn from context cues, while context-reduced environments do not provide these supports. The second continuum ranges from cognitively undemanding to cognitively demanding tasks. There are four resulting quadrants: context-embedded and cognitively undemanding (quadrant A), context-embedded and cognitively demanding (quadrant B), context-reduced and cognitively undemanding (quadrant C), and context-reduced and cognitively demanding (quadrant D). Situations that fall in quadrant D or cognitively demanding, context-reduced settings are the most difficult for second language acquisition. This is often the realm of classroom activities and texts (Cummins, 1992). According to this framework, by making mathematics education more context-embedded, it will thus be more comprehensible for ELLs. But how can this be achieved?

Rationale for Pre-teaching

In order to create a contextually rich mathematics lesson for limited English

proficiency students, it is important to first assess what students know. Garrison and Mora (1999) provide a framework for bilingual education to determine which skill, language or concept, to teach to a student first. If the concept is known, teach the language. If the language is known, teach the concept. If neither are known, then instruction must be modified, and if both language and concept are known, then mastery has been achieved and a new concept can be introduced. In elementary schools without bilingual programs, beginning and low-intermediate ELLs often lack knowledge of the target concept and language of instruction. Therefore, it is necessary to modify instruction in order to provide comprehensible input. One way to do so is to access students' prior knowledge and embed instruction in a familiar context, as suggested by Cummins.

By starting with students' personal lives, learning can begin with informal, concrete experiences to which students relate. Silverman, Strawser, Strohauer, and Manzano (2001) discuss the authors' use of the children's book *On the Road with Cholo, Vato y Pano*, a story about Latino migrant farmers, to explore the concepts of estimating, measuring, mapping and problem-solving with fifth grade students. The students, themselves children of migrant workers, connected to the story through background knowledge, which then enabled them to access the mathematical concepts presented in the book. Curcio (1990), Ron (1999), and Whitin & Whitin (1997) recommend the same approach, beginning with concrete, personal experiences and allowing students to construct meaning until they are able to grasp more formal, abstract concepts. Ron, in particular, outlines a process for language learning in the mathematics classroom. She

suggests beginning with everyday language that is acquired naturally in social settings, and using this language to create mathematized-situation language in which mathematics relationships are made more important. The mathematized-situation language draws from the everyday language but also includes some “learned and taught terms” (p. 25). This language is then turned into the language of mathematics problem solving in which mathematical concepts are expressed through the math register; such language must be explicitly taught. Finally, the language of mathematics problem solving is “translated” (p. 26) into symbolic language, which includes the symbols and equations used in speaking and writing about mathematics. In Ron’s model, the emphasis is on enriching everyday language and using it as a springboard for the introduction of mathematical concepts, and then teaching problem solving and symbolic language when students have constructed the requisite corresponding conceptual knowledge.

For ELLs in the mainstream mathematics classroom, there may not always be sufficient time in the lesson to access and build background knowledge and the associated linguistic skills. Dutro & Moran (2002) recommend ‘front-loading’ English Language Development (ELD) by teaching the language demands of a content area lesson prior to that lesson. This may include pre-teaching linguistic forms, scaffolding language input and developing opportunities for practice with the target language. Front-loading, then, is an attempt to make content area lessons accessible to students, and is synonymous with pre-teaching or previewing a lesson. In the content area of mathematics, it may be necessary to pre-teach concept development in addition to ELD, due to the language-concept connection (Garrison & Mora, 1999).

Despite the abundance of research regarding the validity of teaching language to ELLs through content areas including mathematics, as well as the importance of previewing or ‘front-loading’ language to these students for content area lessons, it is difficult to find a study that specifically addresses the pre-teaching of math language and concepts for ELLs. It is hoped that this study can contribute to closing the gap by discovering how I can pre-teach elements of math language lessons to render them more accessible to beginning and low-intermediate ELLs. In addition, I want to examine how my instruction during pre-teaching will evolve during this study, the impact pre-teaching has on student participation during math language lessons, how pre-teaching affects students’ problem-solving abilities during these lessons, and in what ways pre-teaching will influence students’ attitudes during math language lessons.

Conclusion

In this chapter, I discussed the low achievement of ELLs in the area of mathematics. I then explored why equity in math instruction and achievement is so important to students and our nation as a whole. Next, I provided some reasons why mathematics is particularly challenging for learners with limited English proficiency. Finally, I offered a rationale for pre-teaching math language and concepts to ELLs to make them more comprehensible. In Chapter Three I will describe the research design and methodology that drive this study.

CHAPTER THREE: METHODOLOGY

This study was designed to examine the relationship between pre-teaching mathematics language lessons to English Language Learners and the accessibility of these language lessons. I wanted to know how I could pre-teach elements of math language lessons to render them more accessible for beginning and intermediate ELLs. In order to answer this question, I explored how pre-teaching impacted student participation and competence during math language lessons. Similarly, I examined teachers' observations of students' math performance during the course of the study. I also analyzed how my instruction during pre-teaching evolved over the course of the study.

This was a qualitative study, focusing on action research conducted on my everyday instructional practice. I used several different instruments to collect data. A rubric was used to observe student participation during whole group math language lessons. Interviews were conducted with students' classroom teachers and students themselves to triangulate data garnered by the rubric and assess student attitudes of math as well as their observed competence. Finally, I compiled my pre-teaching lesson plans and maintained a teacher log of reflections on these lesson plans to explore the evolution

of my teaching during the study.

Overview

In this chapter I will describe the methodologies used in this study. First the rationale and description of my research design is presented along with a description of the qualitative paradigm. Second, the data collection protocols are presented and explained. Next, the procedures I used are described. Then, the methods used for data analysis are presented. After that, the verification of data is explained. Finally, the ethical steps I implemented to safeguard participants are clarified.

Qualitative Research Paradigm

The focus of qualitative research is to evaluate social phenomena without disrupting the natural context in which they occur (Merriam, 1998). Since my research questions were born out of my daily instructional practice, it was appropriate for me to focus on qualitative research. Specific features of this style of research that align with my study include: an inductive mode of analysis, as I was seeking to find answers rather than beginning with a hypothesis and testing it; flexible and emergent design characteristics, which was vital as I was uncertain exactly how my instruction would evolve and needed to alter it continuously in order to meet student needs; and a small nonrandom sample, as I was studying the performance of beginning and intermediate ELLs whom I teach (Merriam).

Action Research

Additionally, I used an action research paradigm to conduct my study. According to McKay (2006), action research is carried out by practitioners or classroom teachers, is

collaborative, and is focused on changing things (for the better); its overall aim is “promoting more effective L2 teaching and learning” (p. 29). Considering these quantifiers, it was an appropriate match for pursuing my research question. My initial concern with making math language lessons more accessible for beginning and intermediate ELLs developed from self-reflection on my own teaching practice. Since I work within a primarily inclusive ESL model, my attempts at improving math instruction naturally involve colleagues, and I collaborated with them for potential solutions. Through this collaboration the concept of pre-teaching math language lessons was generated. Similarly, I believe that discovering the most effective manner in which to pre-teach these lessons involves an organic process of teaching and reflecting on students’ learning in concert with my colleagues.

Data Collection

Participants

This study was conducted on seven third grade ELLs, including four girls and three boys. Students ranged in age from eight to nine at the time of the study. Two of the students, Paola and Pedro were determined by the school district to have a Level One (beginner) English oral language proficiency. Four of the students, Juana, Tou, Roberto and Serena, had a Level Three (intermediate) oral language proficiency in English, and Yasmin had a Level Four (advanced-intermediate) English oral language proficiency. Six students were native Spanish speakers and one was a native Hmong speaker. Paola and Pedro (the two Level One students) were new to our school and the U.S. during the year of the study and had both attended school for several years in Mexico. All of the

participants qualified for free lunch, and thus came from families with a lower socioeconomic status. The math abilities of the students ranged widely, but all were recommended by their teachers to be included in this study due to perceived difficulties with math language in the mainstream classroom.

Setting

This study was conducted at the school where I teach, which is located in a first-tier suburb of a Midwestern metropolitan area. It is culturally, linguistically and ethnically diverse, with high populations of Hmong, Liberian and Latino students. There are about 350 students in grades pre-K – 3. About 85% of these students qualified for free or reduced lunch at the time of the study. Furthermore, approximately 44% of the population was identified as being ELLs. In addition, there were a number of students who would possibly have qualified for ESL who were not identified as such.

Data were gathered during math language lessons, which I taught in each of the four third grade classrooms on a rotating basis. Every week I developed a math language lesson that correlated with the mainstream mathematics curriculum. The lessons were taught during a multiplication unit and thus taught math concepts related to multiplication and corresponding language needed to express these concepts. I taught six lessons as part of the multiplication unit. Each week I taught a math language lesson in one of the third grade rooms on Monday, the next on Tuesday, and so on, until each class had received the same instruction. Naturally, my lesson tended to improve throughout the week as I taught it multiple times. For this reason the following Monday I taught the next lesson of the unit in a different classroom than I had taught in the previous Monday (see Table 3.1).

In this way, I rotated who was receiving my “best” lesson on Thursday.

Table 3.1

Rotation Schedule for Math Language Lessons

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Class 1	Class 2	Class 3	Class 4	Observe
Week 2	Class 2	Class 3	Class 4	Class 1	Observe
Week 3	Class 3	Class 4	Class 1	Class 2	Observe
Week 4	Class 4	Class 1	Class 2	Class 3	Observe

I also collected data during pull-out instruction in the ESL classroom. Pre-teaching of the math language lessons occurred at this time. These pre-teaching lessons were taught for one-half hour the day prior to instruction of the whole class math language lesson in the students’ classrooms. At times, there was a lag of two to four days between the pre-teaching of a lesson and its realization in the classroom. This took place when I pre-taught a lesson on Friday for the following Monday, and there was the weekend in between. In one case there was no school on a Friday and a Monday, and that group of students was pre-taught the lesson for Tuesday on the previous Thursday, before the short break. In one other instance, there was a three-day weekend, and students were pre-taught on Thursday for a whole group math language lesson on the following Monday.

Data Collection Technique 1

I compiled my lesson plans and reflected on their actualization in a teaching log.

As Freeman (1998) explains, “Lesson plans describe the objectives of a class, the materials and processes planned to meet those objectives, and the expected roles of participants” (p.212); lesson plans are the *prospective* account of a planned lesson. Conversely, teacher logs record what happened during a lesson, providing a *retrospective* account of the lesson (Freeman, 1998). In order to compile my teaching log, I had a copy of my lesson plan on hand during a target lesson, so I was aware when I veered from it or students required adapted instruction. Directly following the half-hour pre-teaching period I had a free period and would then enter my reflections and comments at the bottom of the original document and save it in my computer according to the date. Each half-hour pre-teaching lesson was taught four times, so four separate entries were made in the teaching log for each week and/or distinct lesson.

Herr and Anderson (2005) assert that “keeping a research journal is a vital piece of any action research methodology” (p. 77), and a teaching log was my version of the research journal. The purpose of this technique was to capture my self-observation of instructional strategies and their effects on student participation and understanding. Bailey and Ochsner (as cited in McKay, 2005) claim the benefit of this method is that a researcher is able to study her own teaching and report on instructional strategies, perceptions and affective factors. Contrarily, some limitations of diary studies are their subjective nature and their tendency to be negatively affected by memory loss over time. In order to combat this, I wrote my entries during my free period, which directly followed the pre-teaching lessons.

Data Collection Technique 2

In order to capture aspects of student performance with and without pre-teaching, I used outsider-observation. Merriam (1998) believes “[o]bservation is the best technique to use when an activity, event, or situation can be observed firsthand” (p. 96), among other things. In order for observation to be considered a research technique, it must contain certain components, including having a specific research purpose, being planned deliberately, being recorded in a systematic manner, and being subject to checks for reliability and validity (Merriam, 1998). I integrated these components as explained below.

Classroom teachers, who were present as support teachers when I led math language lessons in their classrooms, observed students’ eye contact with the speaker (who was sometimes me, their classroom teacher or a peer), their level of on-task sharing in the whole group as well as during small group and partner activities, and on-task individual work. They kept track of this data in the Student Participation Rubric (see Appendix D). Additionally, in order to increase inter-rater reliability, an ESL Educational Support Professional (ESP), who is a paraprofessional trained in ESL methodology and strategies, also observed students according to this rubric.

This assessment took place first without pre-teaching in order to establish a baseline for student performance, and then during lessons for which students had received pre-teaching to note possible changes in baseline performance. Furthermore, all of this documentation was triangulated with teacher/student interviews (see “Data Collection Technique 3”). Triangulation is a way to strengthen reliability and internal validity by using multiple methods of data collection and analysis (Merriam 1998). Prior

to using the Student Participation Rubric for data collection, the classroom teachers and ESL ESP practiced using the rubric on students who were not participants in the study. I then made necessary changes to the rubric and developed Student Participation Rubric Definitions (see Appendix E) in order to clarify areas of confusion and increase consistency.

Outsider-observation by a full participant is not intrusive; however, it may be influenced by bias (Merriam 1998). In the case of this study, bias may have stemmed from classroom teachers' established relationships with their students as well as the ESL ESP's rapport with students. Additionally, it was sometimes logistically challenging for classroom teachers to accurately mark a rubric since they were full participants in the classroom when they supported my lesson, and needed to assist all students in the classroom and not just the one or two being studied. This was most notably an issue on one or two occasions when there was a behavior incident that a classroom teacher had to address. In these cases, I simply took over the rubric and made observations for the classroom teacher during those times, or no markings were made on the rubric for the period they were unable to observe. However, this happened infrequently enough so as to not significantly influence the study results.

Data Collection Technique 3

To triangulate the data collected through outsider-observation, I conducted separate interviews with students and their teachers. Interviews are data collection techniques that are used to discover what someone thinks or believes (Merriam, 1998). I followed a semi-structured interview format in which there were some pre-determined

questions and possible follow-up questions, depending on an interviewee's comments. Dexter (as cited in Merriam, p. 72) contends that, "Interviewing is the preferred tactic of data collection when...it will get *better* data or *more* data or data at *less cost* than other tactics!" I believe that interviewing gave me better data in that the information came directly from struggling students and the teachers that were most familiar with their performance in the mainstream classroom. It provided me with more complete information than can be garnered through outsider-observation or questionnaires as I had the flexibility to probe specific strands of thought more deeply during an interview. Finally interviewing was cost-effective for my study as student interviews related to their everyday learning and took place as part of instruction, and teachers were compensated for their interviews with a small token of my appreciation.

A positive aspect of interviews is that an interviewer can probe and get feedback (Merriam, 1998). To be effective, interviews must be rehearsed ahead of time, both to practice interviewing and to 'try out' interview questions. In order to practice interviewing students, I tested out my questions on third grade ESL students who were not participants in the study. For teacher interviews, I used questions that were modified from those used in a capstone completed by a colleague who teaches in a similar math inclusion model at my school. Teacher interviews contained the following questions: 1) Have you noticed any changes in the student's ability to solve problems accurately during math language lessons when s/he's had pre-teaching for those lessons? 2) Have you noticed any changes in the student's ability to explain problem-solving processes verbally during math language lessons when s/he's had pre-teaching for those lessons? 3) Have

you perceived any differences in the student's performance and/or abilities in math that you would attribute to pre-teaching? (Ostlund, 2005)

Student interviews were conducted after lessons for which students had not received prior instruction in order to capture a baseline response. In addition interviews were conducted multiple times after math language lessons for which students had received pre-teaching. The format I used for student interviews was the Two-Minute Interview (Freeman, 1998). This style of interview was well-suited to my study as it allowed me to interview students within the time constraints of classroom instruction, asking only a few questions. Responses were written down during the interview in shorthand. After I completed a math language lesson, I individually pulled students aside and asked them the following questions: What did you do in math today? What did you like about math class today? This format had the benefit of not seeming remarkable or threatening to students since it occurred in the realm of their classroom, and there were no intimidating recording devices present.

Procedure

Participants

As mentioned previously, the participants were placed in pull-out groups according to who their classroom teacher was; all of teacher A's students came together on the same day, all of teacher B's students came together on the same day, and so on. Pre-teaching of the whole class math language lessons occurred during pull-out instructional time. Half-hour pre-teaching lessons were taught one day prior to implementation of the whole class math language lesson in the students'. At times, due

to school breaks, there was a lag of two to four days between the pre-teaching of a lesson and its realization in the classroom.

Prior to receiving pre-teaching for math language lessons, students were observed by their classroom teacher while I taught one of these math language lessons. At this time, the teacher and ESL ESP filled out the Student Participation Rubric in order to establish a baseline for their performance during math language lessons for which they had not received pre-teaching. Directly after I taught the target math language lesson, I interviewed students to ascertain their account of the whole group lesson and their opinion of math class without having received pre-teaching. Over the course of the following five weeks, students were observed multiple times by their classroom teacher and the ESL ESP, via the rubric, after having received pre-teaching for math language lessons. Likewise, I conducted two-minute interviews after each math language lesson for which they had received prior instruction to gauge their accounts of and sentiments toward the whole group math language lesson after having received pre-teaching.

As stated above, pre-teaching occurred during students' designated ELL pull-out time. These lessons were taught prior to students encountering the target concepts or language in my whole class math language lesson or in their classroom. Directly after each pre-teaching session, I wrote my reflections on the lesson in my teacher log. Since the pre-teaching lessons were taught four times, my instruction changed during this process based on student needs and observations I made in the interceding whole class math language lessons, i.e., if key objectives or activities changed based on the realization of the lesson in the mainstream classrooms.

At the end of my six-week data collection period with students, I interviewed the four classroom teachers individually to triangulate the data collected through outsider-observation (the Student Participation Rubric) and student interviews. I used the semi-structured interview format, because I believed it captured the most plentiful and pertinent data regarding teachers' perceptions of student performance.

Materials

Rubric. This tool was used for outsider observation of participants by their classroom teachers and the ESL ESP. The rubric contained a space to record students' names (all names will be changed), dates of observation, and lesson topic. It had boxes for recording students' eye contact with the speaker, on-task sharing with the whole group, on-task sharing with the small group, on-task sharing with a partner, and on-task individual work. These boxes corresponded with each component of a lesson. For example, component one may have been the anticipatory set, component two a read aloud, component three a class discussion, and so on. There was also a section for other comments where classroom teachers and the ESL ESP could write in observations that did not fit within the provided parameters. I presented this tool to classroom teachers during a team meeting, and taught them how to use it, and I explained it to the ESL ESP individually. Then they tested it on study non-participants, and I tweaked it accordingly as well as creating a list of definitions to clarify the meaning of terms on the rubric.

Data Analysis

Technique 1

I examined my teacher log to compare my instruction at the beginning of the

study with my instruction at the end of the study, as well as changes that occurred within a given pre-teaching lesson during its multiple teachings. I looked for common threads and themes throughout my reflections. For example, were there books or activities that were particularly successful or unsuccessful? What were the factors that induced me to change instruction? I used differently colored highlighters to capture common themes.

Technique 2

Using data collected from the rubric, I quantified students' eye contact with the speaker, on-task sharing with the whole group, on-task sharing with a small group, on-task sharing with a partner, and on-task individual work, both with and without pre-teaching. Since students were observed one time by each observer during each component of a lesson, there was a possibility of one eye contact or on-task behavior per observer for each component of a lesson, when these behaviors were applicable for that component. For example, if the component of a lesson were a read aloud, each observer would view the student one time during the read aloud to determine whether the student was making eye contact with the speaker; however, the observer would not view the student for on-task sharing with a small group at this time, since this behavior was not applicable during this component of the lesson. If the student was making eye contact, it would be coded as "Yes", and if the student was not making eye contact, it would be coded as "No". Meanwhile, the category of on-task sharing with a small group would be coded as "N/A", since it was not applicable.

I tabulated the number of times a student was observed making eye contact with a speaker or completing on-task work in one of the above categories, when applicable, for

each component of the lesson. I then divided this number by the total number of possible times a student had the opportunity to make eye contact with a speaker or complete on-task work in a particular category. From this I determined a percentage that was used to compare student performance without pre-teaching and with pre-teaching and look for differences and similarities. I both compared students to themselves without and with pre-teaching and looked at overall changes in all students observed behaviors without and with pre-teaching.

Technique 3

For student interviews, I read through all of them, searching for similar responses. I highlighted similar responses and gave them a heading or theme. Then, I chose the most common themes and explained these using students' quotes. For teacher interviews, I followed a similar protocol. However, I first listened to all of the interviews and transcribed them verbatim. After this was completed, I read through each interview in its entirety and looked for common themes amongst the teachers' responses. Then I chose the most prevalent themes and pulled out anecdotes that supported these themes. Finally, I compared them with students' responses as well as information documented in the rubric for any correlation.

Verification of Data

In order to ensure internal validity, I used several strategies. Data was triangulated in the following ways: successes and failures of my pre-teaching lesson plans were triangulated by multiple sources—my teacher logs and student and teacher responses to interview questions. Similarly, student participation and engagement in

math language lessons was triangulated by multiple sources—teacher interviews versus student interviews, as well as by multiple methods—outsider-observation (by classroom teachers and the ESL ESP on the rubric) and interviews. In addition, to increase reliability of data, two different observers, a classroom teacher and the ESL ESP, were used to complete rubrics on students. Finally, I conceded my bias as to the expected outcomes of this study and pointed out the bias that exists in the collection of data, specifically classroom teacher and ESL ESP documentation of student participation in the rubric.

Ethics

This study employed the following safeguards to protect informants' rights:

- Written permission slips were obtained from parents/guardians prior to data collection.
- A human subjects review was completed and approved to ensure proper protocol for research involving human subjects would be followed.
- Research objectives were shared with participants.
- All interviews were transcribed verbatim.
- Research materials were kept on password-protected computers and in locked files.
- All names were changed to protect anonymity.

Summary

In this chapter, I outlined the methods I used to conduct my study. I explained

why I chose a qualitative research paradigm, and specifically how action research best served the exploration of my research questions. I described my data collection process including participants, location and three distinct data collection techniques. I then discussed the procedures I followed. Next, I listed the methods I used during analysis of the data. Finally, I explained how I verified the dependability and reliability of my data, and the ethics I employed to protect my participants. In Chapter Four I will discuss the results of my study.

CHAPTER FOUR: RESULTS

This chapter will present the data I collected in order to discover how I can pre-teach elements of whole group math language lessons in order to make them more accessible to beginning and intermediate ELLs. Data were collected over the course of six weeks during a unit on multiplication. My whole group math language lessons were precursors to the classroom teachers' lessons on multiplication, so concepts such as equal groups and arrays were taught during my lessons prior to students receiving this instruction in their classroom. Pre-teaching lessons occurred in a pull-out setting before I taught whole group math language lessons in the mainstream classrooms.

Several instruments were used to collect data. The results of each will be discussed in turn. A teacher lesson log was kept of all the pre-teaching lessons to track instructional adjustments made to these lessons based on student needs and reflections on each lesson. A Student Participation Rubric was used to measure student participation and engagement during whole group language lessons, both without and with pre-teaching. This was done without pre-teaching as an attempt to gather a baseline for

students' performance when they have not been pre-taught a math language lesson. Additionally, students were interviewed after whole group math language lessons to determine what they remembered about the lesson and how they felt about it. Their attitude toward a lesson was deemed important as it ostensibly affected student motivation and engagement in a lesson. Finally, at the end of the six-week data collection period, students' classroom teachers were interviewed to triangulate data and assess their anecdotal observations regarding the effects of pre-teaching math language lessons on students' math abilities.

Teacher Lesson Log

Compiling a teacher lesson log enabled me to formalize my reflection on math language pre-teaching lessons. The pre-teaching lessons allowed me to work through potential problems with the whole class math language lesson prior to teaching it in the mainstream classroom. The whole class math language lesson, in turn, informed my instruction during pre-teaching. The two lessons worked symbiotically, then, since I taught each of them a total of four times; this repetition allowed for constant improvement in both the whole class math language lesson and pre-teaching instruction, based on what I learned in each of them on a given day and subsequently applied the following day, or the next time I taught the lesson. In other words, I reflected after each pre-teaching lesson and based on my reflections, modified the next day's pre-teaching lesson accordingly. I then compiled all of my reflections on pre-teaching lessons in my teacher lesson log and reviewed them. Based on these reflections, there are three instructional areas that seemingly improved by keeping a teacher lesson log. These are

vocabulary, multi-step instructions and planning classroom logistics for the whole class math language lesson.

Vocabulary

At times I focused on vocabulary during a pre-teaching lesson, and other times I did not. When teaching arrays, we focused on the word “each,” for example. Students had difficulty grasping the concept that accompanies this word, namely that mathematically speaking, “each” is a signal for equal groups. Furthermore, in the case of arrays, equal groups are represented in a diagram of rows and columns with equal amounts in each of the rows and columns. Based on students’ challenges to comprehend equal groups in the pre-teaching lesson, I knew they would need a lot of time to practice demonstrating the amount in each row and/or column during the whole group math language lesson the next day.

Conversely, there were times I believed it was important to teach certain vocabulary when it was not. When pre-teaching *Each Orange Had 8 Slices*, I focused on more technical terminology than needed to describe pictures in the book; I found myself writing in my teacher lesson log, “It really wasn’t vital to introduce the terms “sets” and “groups.” It was more pertinent to use the item name shown on each page, such as how many flowers, or six petals.” This realization was due, in large part, to students in the whole class math language lesson the day before having difficulty accessing the text based on their limited knowledge of the general vocabulary for items in the text’s illustrations. They did not need to know the words “groups” or “sets,” instead, they needed to explain that there were a certain number of trees with a certain number of nests

in each of them and a certain number of eggs in each nest. Based on this discovery, I began pre-teaching the tier two words needed to discuss the illustrations and subsequently answer the multiplication questions, rather than focusing on technical mathematical terms that described the underlying mathematical concept students were practicing.

Multi-step Directions

One of the four third grade classes in which I taught whole group math language lessons had a higher number of ESL students than the other three. Every time I taught a math language lesson in this classroom, students—native and non-native English speakers alike—had difficulty following the directions during the practice portion of the lesson, despite the number of different ways I tried to convey and review the directions. This was a circumstance in which the whole class language lesson informed my instruction for subsequent pre-teaching lessons. As a result of the students' difficulties following directions during whole group math language lessons, I addressed this aspect of my whole class lesson during pre-teaching. As I stated in a related reflection, "This classroom [not just the small pre-teaching group] has had a lot of problems following multi-step directions I give during my whole group math language lessons, so I added the objective of pre-teaching the directions as well." For the ESL students in that classroom, then, I painstakingly pre-taught the steps to each activity for the whole class math language lesson. In this way, they could feel more confident during the actual lesson in their classroom, and additionally be leaders for their non-ESL peers during the various whole group math language lesson activities. Additionally, if I suspected that directions were going to be more rigorous or difficult in relation to a particular lesson, I pre-taught

these lessons to each of the four pre-teaching groups.

Planning Classroom Logistics for the Whole Class Math Language Lesson

The pre-teaching lesson conversely affected the implementation of my whole class math language lesson, as well. One student in particular was routinely tired and his attention would wane during my lessons in his mainstream classroom. I noticed during pre-teaching that he worked very well with another ESL student from his class, and subsequently decided to pair them up for partner work during the following day's math language lesson in his classroom; "I noticed that Tou worked well with Enrique during this lesson, so I am going to have them work together tomorrow, as Tou tends to let his Hmong friends do his work in class." This proved to be a successful technique for Tou as he stayed on task and practiced his English since Enrique does not speak the same native language. Without the pre-teaching lesson, I would not have realized that partnering these two would be effective during the whole class math lesson.

Student Participation Rubric

The Student Participation Rubric (see appendix D) was used to track student behaviors during whole group math language lessons. Each time a student was taught a target lesson in the whole group, two observers—the student's classroom teacher and the ESL Educational Support Professional (ESP)—captured the student's behaviors on the Student Participation Rubric. Two observers were used in order to create inter-rater reliability. For three out of the four third-grade classrooms, the classroom teacher and ESL ESP were observing two students per target lesson, and for one classroom they were observing only one student.

The rubric had the student's name, observer's name, lesson topic and date listed at the top. The first row simply described the classroom context, or "What is happening in the classroom right now?" This indicated which activity in the lesson plan was occurring and was filled out prior to the lesson. There was room for five lesson components, or activity changes on the rubric; the actual number of activities varied based on the lesson. Each observation then took place during a distinct component of the lesson. During the activity, observers could observe the student at any time. In other words, if Observation #2, or the second component of a lesson, on the rubric was for a story read aloud, that may have occurred over a ten-minute period. Observers would pick a time during that ten-minute window to watch student behaviors, rather than watching the student for the whole ten-minute period of the activity.

During each observation, the classroom teacher and ESP observed each student according to the following categories: 1) Eye contact with the speaker, 2) On-task sharing with the whole group, 3) On-task sharing with the small group, 4) On-task sharing with a partner, and/or 5) On-task individual work. There was also a row at the bottom to collect anecdotal comments from the observers. Each of these categories is explained in Student Participation Rubric Definitions (see appendix E). This document was given to classroom teachers and the ESL ESP ahead of time to clarify terms that were found to be confusing during preliminary tests with the rubric prior to data collection.

Based on student behaviors, each of the above categories was coded as "Yes", or "No". For example, if a student made eye contact with the speaker during Observation

#1, this would be coded as “Yes”. If the student did not make eye contact, this was coded as “No”. If a particular behavior, such as “On-task individual work” was not observable, or not part of the lesson at that point, it was not able to be coded and was considered not-applicable, “N/A”. Different observers sometimes classified activities disparately. While the classroom teacher may have considered a story read-aloud to not contain opportunities for on-task sharing with the whole group, the ESL ESP may have considered there to be chances for such sharing through gestures or responding to questions. Therefore, the classroom teacher may have determined that category incapable of coding and chosen “N/A” on the rubric. Conversely, the ESL ESP may have deemed the category as worthy of coding, and chosen “Yes” or “No”. In order to account for this disparity, percentages for coded answers as given below are based on the number of times a student received a “Yes” over the total number of times an observer classified this category as able to be coded.

Baseline Engagement and Participation Without Pre-teaching

The first time students were formally observed during the data collection period was during a whole class math language lesson for which they had not received pre-teaching. This was to ideally establish a baseline for comparison with subsequent whole class math language lessons for which students would have received pre-teaching. In addition, if a student was absent for pre-teaching during the data collection period, their behavior during the whole class math language lesson was included in Table 4.1. The results of the baseline lesson(s) are as follows.

Table 4.1

Baseline Engagement and Participation					
	Eye contact with speaker	On-task sharing with whole group	On-task sharing with small group	On-task sharing with partner	On-task individual work
Pedro	77%	100%	80%	N/A	N/A
Yasmin	100%	80%	100%	N/A	N/A
Roberto	83%	80%	100%	N/A	N/A
Juana	60%	66%	100%	N/A	N/A
Tou	90%	80%	100%	N/A	N/A
Paola	100%	44%	83%	100%	100%
Serena	90%	83%	100%	100%	N/A
Averages	86%	76%	95%	100%	100%

The above results suggest a high level of engagement and participation by students without pre-teaching for the math lesson. I believe these results were somewhat skewed by the topic and activities for this math language lesson. This particular lesson was students' first introduction to multiplication in the third grade, which is very exciting for students at this developmental stage. A highly popular book, *Amanda Bean's Amazing Dream*, was used for the lesson, and students tend to be very drawn in by this text. Also, the last two categories, "On-task sharing with partner," and "On-task individual work," were not truly represented by all students, as only two students were observed in the former category and 1 in the latter. The areas that seem to be in the greatest need of improvement are students' eye contact with the speaker and on-task

sharing in the whole group.

Engagement and Participation With Pre-teaching

Table 4.2

<u>Engagement and Participation with Pre-teaching</u>					
	Eye contact with speaker	On-task sharing with whole group	On-task sharing with small group	On-task sharing with partner	On-task individual work
Pedro	87%	86%	95%	100%	100%
Yasmin	97%	91%	100%	100%	100%
Roberto	83%	72%	88%	75%	100%
Juana	96%	89%	93%	100%	100%
Tou	82%	70%	77%	100%	100%
Paola	89%	85%	100%	100%	0%
Serena	88%	75%	93%	100%	100%
Averages	89%	81%	92%	96%	86%

When viewed as averages, student performance and engagement does not appear very different after having received pre-teaching for a math language lesson versus without pre-teaching. Students' eye contact with the speaker and on-task sharing in the whole group rose slightly, from 86% to 89% for the former, and from 76% to 81% for the latter. Meanwhile on-task sharing with the small group and partner and on-task individual work declined slightly, from 95% to 92% for on-task sharing with a small group, from 100% to 96% for on-task sharing with a partner, and from 100% to 86% for on-task individual work. However, when viewed closely, these averages are deceptive.

On-task sharing with a partner was observed 100% of the time during lessons with pre-teaching, except for one student. Conversely, during the pre-teaching lesson this on-task behavior was only observed for two students 100% of the time, and the others were not observed for this behavior. Similarly, on-task individual work, was observed 100% of the time for six of the students. The remaining student, Paola, had 0% of on-task individual work based on one lesson. This result may have been due to her emotional or physical state on that particular day. Without more data, both without and with pre-teaching, it is difficult to draw conclusions from these two categories.

The greatest impact is apparent when looking at individuals' observed behaviors according to the rubric. With pre-teaching, Pedro, a level 1 ESL student, had much more eye contact with the speaker and on-task sharing in the small group. Likewise, Juana, a Level Three ELL, had over 30% more eye contact with the speaker and on-task sharing with the whole group when she had pre-teaching for a whole class math language lesson, versus when she did not. Finally, Paola, another Level One ESL student, nearly doubled on-task sharing with the whole group during lessons for which she had been pre-taught. It is interesting to look at the impact on these students in particular, as Pedro and Paola were both beginners to English and the United States this year, and Juana, an intermediate ESL learner, has a language processing disorder. This possibly indicates that pre-teaching may be especially significant for students with lower levels of language proficiency and those with other learning disabilities.

Two-minute Interviews

After the completion of each math language lesson in the third grade classrooms,

participating students were interviewed individually. This usually took place just outside of their classroom in the hallway, so students could focus and respond to interview questions without the interruptions of their peers. A few times, these interviews took place in the student's classroom, when the hallway was loud or filled with students. In this case, target students were interviewed in a quiet area of their classroom. The two-minute interviews consisted of two questions: 1) What did you do in math today? and 2) What did you like about math class today? The intention of the first question was to determine how well students comprehended the objectives of the lesson, or how accessible it was to them. The second question aimed to determine how students felt about the lesson, in other words, their engagement and motivation.

Responses from students did not generally indicate a difference between their views without or with pre-teaching. In this regard, there were only two notable responses. When asked what he liked about math class after a whole class math language lesson for which he had not received pre-teaching, Tou responded, "Kind of nothing." However, in the following five weeks, when he had received pre-teaching for whole class math language lessons, Tou always supplied an answer to this question, and it typically focused on liking the book, a theme that will be fleshed out below. Additionally, Paola, the student in the study with the lowest English proficiency had a difficult time expressing what she liked about the math class for which she had not received pre-teaching, whereas in the following weeks after lessons for which she had been pre-taught, she was more able to express her views. Despite the general lack of difference between student responses without and with pre-teaching, their comments were quite revealing as

to their overall experience of math and math language. Five themes emerged that I investigate below.

Positive Experience Learning Math through Children's Literature

More than any other response, students overwhelmingly appreciated the texts incorporated into each of the six math language lessons that were taught over the course of the data collection period. When asked, "What did you like about math class today?" common responses included: "When we read the book." "We read a new book." "I liked the book...because it was so funny." "That we used the books and pictures to help us." Often, students went on to explain a particular part of a book that they liked, which moreover proved how well they comprehended the stories.

The universality of students' appreciation for the children's literature used during math language lessons, and their abilities to explain lessons in terms of the books used lends strong support for using children's literature to introduce or teach a math concept. In the case of the unit I taught during the six-week data collection period, the storybooks were truly an introduction to multiplication and helped to create a common context to which students could refer back. Apart from the first lesson, for which there was not pre-teaching, books were introduced to students during pre-teaching lessons but not read in their entirety at those times.

Support for Using Hands-on Manipulatives

Similar to the popularity of children's literature during math language lessons was the use of hands-on materials or manipulatives to practice a concept. During the whole class math language lesson, we usually read and discussed a text first, and then students

practiced the concepts and corresponding language with a small group, partner, or infrequently, individually. For this practice time, manipulatives were always used, including buttons, beans, and fake cookies. One student explains, “I liked how we used the ants [buttons].” Another answered that her favorite part was “when we worked with the partners and did the buttons.” A different student said, “The fun that I had was when we did the slices and counting the seeds [during *Each Orange Has Eight Slices*]. Another student shared that she liked “that we used the cookies and that we had to share them.”

All of these answers show the positive connection students made to math through manipulatives, and how they were able to explain what they did with math manipulatives even after the lesson was over. This suggests that manipulatives can play a strong role in helping children grasp a math concept, particularly when it is first introduced, if they are used in an effective manner.

Math Language Lessons Assist in Academic Vocabulary Development

When asked what they had done in math on a given day, students normally needed to be able to use academic vocabulary to describe what had happened. This occurred even in the case of Paola, a beginning ESL learner, who explained, “Today...count the row (shows a horizontal line with hands) and like this (shows a vertical line with hands). Oh, and the groups.” She was describing what happened during the first lesson on multiplication, during which we described arrays, in terms of rows and columns, and groups, as far as equal groups. Though she was not able to supply the term columns, she did use the terms row and groups correctly and was able to show what a column is with her hands. This is rather impressive for a beginning ESL during

her first exposure to these concepts.

Likewise there were many more examples of proper implementation of academic vocabulary. One student described what he had done in math class, correctly stating, “We did multiplying.” Others explained, “We learned about multiplication.” In each of these examples, students used the proper grammatical term associated with multiplication. In another response, a student expands, “ We talked about multiplication and arrays.” And even more expansively, one third-grader shared, “We multiplied word problems in groups instead of arrays.” Not only was she able to identify the operation taking place, but the type of multiplication being represented by equal groups rather than arrays, which are diagrams with an equal number of rows and columns that visually represent multiplication equations. These answers indicate that math language lessons and the pre-teaching lessons associated with them can really improve upon a student’s academic vocabulary, to the point that s/he can expound upon a concept by using the correct terminology to explain it.

Repetition is Vital to Grasping Math Concepts and Vocabulary

Despite the successful language usage cited above, there were also a number of times when students knew exactly what we had done in class, but could not express it because they lacked the academic vocabulary to describe the concept. Often times, they substituted words that sounded similar or were related but grammatically incorrect. When describing what we did in class, Juana talked about sitting in a group and sharing “what is the factory.” She was trying to express that small groups had shared the factors of given numbers, the word “factor” having just been introduced during that lesson.

However, she substituted the word “factory,” which sounds very similar, but has no relational meaning. Similarly, Yasmin, an advanced-intermediate ESL learner shared that she learned about “rays and that they’re equal.” She was talking about arrays, but used the term “rays” instead. Though this word sounds almost the same, it not only has a different meaning outside of math as in ‘rays of sunshine’, but also has a different meaning in math, ‘a line that extends endlessly in one direction only’.

On the other hand, it was quite typical that students would respond that we “did times” in math that day. They had not yet acquired the term multiplication but knew the word associated with the multiplication symbol. Another time, Tou was saying that he liked “When we times and when we do d...d...” I had to supply the word “divide”, which he recognized and affirmed was what we practiced during the lesson, but he had not yet acquired the word to use it without elicitation.

These examples point to the importance of giving students repeated opportunities to interact with key math language and practice using it over and over. This need for repetition supports the pre-teaching model, as pre-teaching was the first exposure students had to key vocabulary for a whole class math language lesson, then they had limited practice with it before again practicing it in the classroom. After my whole class math language lessons in their classroom, they would then have more opportunities to use key terminology during regular math classes taught by their classroom teachers.

Differentiated Assessments are Necessary to Determine What Students Know

As mentioned above, students interacted well with the children’s literature used to introduce and explain math concepts. Additionally, they often used the framework of the

story or follow-up activities to describe what they had done or liked in a math language lesson. Without being aware of the lesson background, namely the story and activities, it is very possible that students' knowledge of a concept would not be apparent. For example, in explaining a lesson on arrays, Serena explained, "We learned about lines and columns. And then we was making lines and columns [with the buttons]. We counted the buttons and made sure we had the same number on the buttons." Taken out of context, it is difficult to ascertain how well she grasped the lesson. However, she explained that she and her partner had to make their own arrays ("lines and columns") and counted to make sure they had the same number of buttons (in each row and column). For, if the rows and/or columns were not equal, it was not an array and they needed to use a different total of buttons. Given the context, Serena's response demonstrates a fair grasp of that day's lesson.

Another example of a potentially confusing description that could be assessed inaccurately is Juana's explanation of a lesson on factors mentioned above; "We do multiply about the ants. And we do twelve then we did our own. Then we sit in the group and tell what we did. What is the factory." She actually gave a very accurate recall of what occurred in math class that day. We worked on multiplication through a story about ants. Then they practiced putting twelve "ants" (buttons) in arrays in which no ant would be left out. If it worked that no "ant" was left out, as in the case of three rows, this signaled that three (or whichever number of rows they were attempting) was a factor of the total, in this case, twelve. After trying to do arrays with twelve "ants", they were able to pick their own total with which to create arrays.

These responses show how misleading language around math can appear. In both cases, the students had a grasp of the concept they had learned that day and some of the terminology to go along with it, but without knowing the background of the lesson their answers could be indecipherable. This implies that it is important to seek out multiple ways of assessing students on what they learn in math, including through open-ended responses to particular books and activities, which can provide a framework for student responses.

Classroom Teacher Interviews

Students' classroom teachers were interviewed during the two weeks following the conclusion of data collection on students. Teachers were interviewed individually and our conversations were tape recorded and later transcribed. Each teacher was asked the same three questions with individualized follow-up questions according to the information given in the interview. The three questions were as follows: 1) Have you noticed any changes in the student's ability to solve problems accurately during math language lessons when s/he's had pre-teaching for those lessons? 2) Have you noticed any changes in the student's ability to explain problem-solving processes verbally during math language lessons when s/he's had pre-teaching for those lessons? 3) Have you perceived any differences in the student's performance and/or abilities in math that you would attribute to pre-teaching? For the first two questions, teachers were being asked to reflect on students' abilities during my math language lessons since I had no control over math instruction given by the classroom teacher. For the third question, teachers were invited to reflect on more global changes they noticed in students' math performance and

abilities that they attributed to pre-teaching, whether these observations occurred during my whole class math language lessons or not. Based on teacher responses, the following themes emerged regarding the impact of pre-teaching on student performance and engagement during whole group math language lessons.

Improved Problem Solving

All four teachers noticed that students were more able to solve problems during math language lessons when they had been pre-taught that lesson. Teacher 1 commented, “I think they have a much greater understanding on how to solve problems.” Teacher 2 offered, “I think he’s been solving his problems, at least during that time...more accurately than he has before.” Teacher 3 noticed one student had a stronger understanding of math concepts, “and she is beginning to transfer from concrete to abstract.” Finally, Teacher 4 explained, “They have a better understanding of what they need to do to solve the problem.” This suggests that pre-teaching math language lessons provided students the chance to learn strategies that they could later apply in the classroom during whole group math language lessons.

Increased Ability to Explain Math Concepts Verbally

All four teachers noticed students correctly using academic vocabulary related to math language lessons after being pre-taught. Teacher 1 commented, “I think they can use for the most part language that you have probably used with them.” Teacher 3 explained, “Both students were successful because the pre-teaching provided the academic language support needed to communicate effectively.” Teacher 4 provided, “I think they have more vocabulary. They have more words that they can use to explain

what they're doing." These comments imply that pre-teaching played an important role in introducing academic vocabulary and offering students opportunities to practice using new terms prior to a whole class math language lessons. This is particularly important when introducing new concepts and terms simultaneously, as the language load might negatively affect comprehension of the concept.

Transfer of Knowledge

Three out of the four teachers noticed students making connections between what they had learned during a pre-teaching lesson and what they were learning in the whole group math language lesson. Teacher 1 explained, "They just know what you're talking about...it's reinforcing if they've had a little prior knowledge." Teacher 2 offered, "[T]here've been a lot of times where I've walked over [to him during a math language lesson] and he'll say, 'Oh, we did this with Ms. V. yesterday.'" Teacher 3 talked about how a student was able to successfully write a multiplication story problem during the whole group math language lesson due to the connection he made to ideas pre-taught to him the day before. This suggests that pre-teaching math language lessons helped students build a conceptual base to which they could add new information during whole group math language lessons.

Increased Participation

Three out of the four teachers cited an increase in students' willingness to share in the whole group when they had pre-teaching versus when they had not. Teacher 1 observed, "[I]f he's got the pre-teaching he knows...what's coming, and he knows some of the questions, and he knows what's going to happen. Therefore he's willing to take

the risk to answer because...he knows it.” Teacher 3 shared, “[T]he students’ anxiety level has reduced and their active involvement has increased. Both are more eager to share in both the small group and whole group.” Teacher 4 claimed, “They’re more willing to solve the problem.” This would indicate that pre-teaching prepared students mentally for what they needed to share during a math language lesson and reduced their affective filter, enabling them to participate more effectively. This appears to be of particular importance as lowering the affective filter is broadly cited as vital to successful language learning (Cummins, 1992).

Heightened Confidence

The majority of the teachers observed an increase in confidence as a result of pre-teaching. Teacher 1 mentioned, “I think he feels more confident, and I think [the pre-teaching] has made an impact.” According to Teacher 3, “Both students felt more confident and comfortable with their abilities. At times they [were} able to use the academic vocabulary with confidence.” And Teacher 4 expounded, “I’ve noticed them more confident. Without the pre-teaching very often they would not share information, would not volunteer to answer questions, they would not be willing to explain how they solved a problem. But with the pre-teaching they seem much more willing to, actually they are wanting, they want to share.” The teachers’ comments noted above imply a positive correlation between pre-teaching and student confidence.

In conclusion this chapter explained the findings from the teacher lesson log, Student Participation Rubric, two-minute interviews with students and interviews with teachers. My analysis showed that pre-teaching did not appear to have a strong

quantitative effect on student learning, apart from slight increases in students' eye contact with a speaker and on task participation in the small and whole group. However, anecdotally, through the teacher's log and student and teacher interviews, there were many promising areas of discovery, notably in terms of using children's literature to teach math, the potential for academic vocabulary development, increased participation and confidence.

Chapter five will present the major findings of my study and explore implications of this study. It will also discuss recommendations for future research and detail how the results will be communicated and used.

CHAPTER FIVE: CONCLUSIONS

The purpose of this study was to determine how I could pre-teach elements of math language lessons to beginning and intermediate ELLs in order to make those math language lessons more comprehensible. In the last chapter I presented the findings of the teacher log, student participation rubric, and student and teacher interviews. In this chapter I will explain the major findings of this study, the implications of my research, areas for further research on this topic, and how the results of this study will be communicated and disseminated.

Major Findings

Pre-teaching can Inform Teacher Instruction

Based on my reflections in the teacher log, it appears that pre-teaching whole class math language lessons led to more focused instruction that better suited students'

needs. There did not appear to be particular pre-teaching activities that led to improved instruction, rather it seemed to be the process of pre-teaching and reflection on this instruction that created positive results. When I pre-taught a lesson it enabled me to make changes to that lesson prior to teaching it in the mainstream classroom that I may not have anticipated without pre-teaching it. This suggests that pre-teaching can be an effective instructional tool, as far as honing a lesson to teach it more effectively. By teaching components of the lesson ahead of time, a teacher can decide whether those components are truly worth teaching to the whole class, or whether the instruction should be delivered in a different manner. Likewise, in teaching models such as mine, I taught the whole class math language lesson multiple times, which then allowed me to incorporate necessary adaptations from a whole class lesson into subsequent pre-teaching lessons. The most notable example of this phenomenon in my study was determining that the technical vocabulary I had included in one whole class math language lesson's objectives were not truly important; conversely, students did not have the tier two vocabulary words to be successful relating to the text that was used in one of the lessons. I was able to take this information and change the pre-teaching lesson accordingly, by focusing on the tier two vocabulary words in the text.

Though pre-teaching may inform teacher instruction, it is possible that this is most likely to occur when a teacher reflects on pre-teaching in a formalized format, such as a teacher log. In my case, the teacher log ensured that adequate reflection took place. During the study, I was able to reflect on pre-teaching lessons after teaching them and wrote down my observations. This action prompted me to reflect more deeply and take

action based on my written reflections. It is easier to forget reflections that are not written down and thus, they may not translate into changed instruction. So effective pre-teaching and reflection may require more work on the teacher's part if it is to be transformed into improved instruction.

Students' Level of Participation and Engagement Increased with Pre-teaching

When taking into account the Student Participation Rubric and student and teacher interviews, student participation and engagement increased with pre-teaching. I was expecting this result as I have pre-taught various subjects and noticed the positive effect it has on student involvement in the mainstream classroom. However, it was rather difficult to discover a manner in which to quantify this data. The Student Participation Rubric was an attempt at doing so, and it had some serious limitations that will be explained below.

Based on the quantitative data from the Student Participation Rubric, the averages for student eye contact with the speaker and on-task sharing in the whole group increased modestly. This suggests that pre-teaching helps ESL students to stay more focused on speakers and leads to increased involvement in whole class lessons. This is somewhat significant, as these are two areas that are especially challenging for beginning and early-intermediate ELLs. In other words, it is not uncommon to observe students with limited English language skills staring off into space when others are speaking, particularly as the duration of the speaking increases and the student's comprehension becomes increasingly confused. Similarly, I frequently observe ELLs (classified as Level Three English language proficiency or lower) during a whole class lesson as being reticent to raise their

hand and speak, for fear of not being understood and subsequently, embarrassing themselves. Given the trend of the data, it appears that pre-teaching whole class lessons can increase student engagement and participation.

This effect was most apparent for students who had very low English language proficiency (Level One) and for the student in my study who had a language processing disorder. This makes sense as these are the students who had the most difficulty understanding others, and thus staying focused on a speaker through eye contact. They also were the students who had the hardest time making themselves comprehensible. Pre-teaching apparently offered them sufficient opportunity to practice with the activities of a lesson prior to experiencing it in their mainstream classroom, and they were more prepared to participate during the latter. So, pre-teaching seemingly gives early ELLs more preparation for a whole class lesson and they are more likely to participate with their peers, whether in a small group or with the whole class.

Teachers' responses during interviews also suggested that pre-teaching could potentially be a powerful tool for increasing student participation and engagement. Moreover, they noticed another aspect of student involvement that could bolster these effects. Namely, they commented on students' increased confidence during lessons for which they had pre-teaching. As mentioned above, ELLs can be intimidated to participate in front of peers due to their English limitations. However, if pre-teaching positively impacts their confidence, this would likely spill over into taking more risks by participating.

An unintended outcome of this study suggests that student participation and

engagement could be further magnified by the use of children's literature to teach content area subjects. Students unanimously commented positively on the integration of children's literature into whole class math language lessons, and pre-teaching affords students with early levels of English proficiency the opportunity to interact with a text sufficiently before reading it or listening to it in the classroom.

Accurate Assessments of Math Knowledge are Difficult to Create

During the six weeks of the study, students gave many different responses during their two-minute interviews. Sometimes they were able to use accurate academic vocabulary to describe what had occurred during the whole class math language lesson. Other times they substituted a word they were familiar with that sounded similar to a newly introduced vocabulary word; i.e., "factory" for "factor". And often, students described what had transpired during class or their newly acquired math concepts in terms of the children's literature we had used during the lesson. This made it very obvious that students need repetition and practice in order to acquire a mathematical concept and its corresponding academic vocabulary, and that teachers need to have a variety of assessments to capture student knowledge as they move toward mastery.

If an outsider had heard students describing math activities in terms of the children's book used during that class period, it may have appeared that s/he did not learn anything about the target mathematical concept. For example, a beginning ELL might refer to the cookies and bread at the bakery in *Amanda Bean's Amazing Dream* and then mention sheep holding yarn, without using math vocabulary. These details alone do not appear relevant or meaningful. However, if knowledgeable about the book, it is obvious

that the student is referring to two different kinds of equal groups, those represented as arrays (the cookies and bread), and those that are simply in equal groups, but not arranged as arrays. This reflects a higher understanding of introductory multiplication concepts than first indicated since the student has not yet acquired the terms “arrays” or “equal groups” to explain her/himself.

Subsequently, it appears that there is specifically a need for more ongoing assessments that involve open-ended questions and are administered by the teacher who is familiar with the activities and concepts a student has been practicing. This involves substantially more time to implement than multiple choice quizzes and tests, yet in terms of my study, was more telling as to students’ true math abilities.

Implications

My study has implications for ESL teachers as well as mainstream teachers who have beginning and intermediate ELLs in their classes. This study has shown that pre-teaching can play a role in content area instruction by enabling ELLs to prepare for a whole class lesson by practicing it and learning key concepts in a small group context. For ESL teachers who do not teach whole class lessons in an inclusion model, they can still pre-teach content area concepts and vocabulary in a pull-out model. Regardless of the language learning model employed, effective pre-teaching requires collaboration with the classroom teacher(s) to determine which objectives to pre-teach. It also necessitates follow-up with mainstream colleagues to ascertain how effective the pre-teaching actually was. Ideally this collaboration and instruction enables beginning and intermediate ELLs to participate more fully in the mainstream classroom.

In addition to requiring collaboration between teachers, pre-teaching also appears to be most effective when some sort of dedicated reflection by the teacher accompanies it. Without such reflection, pre-teaching lessons may not be targeting the components of a whole group lesson that are most important, and the pre-teaching lessons themselves may not be altered accordingly. Additionally, based on this study pre-teaching appears to be effective for beginning and early-intermediate ELLs, or those who do not participate in the mainstream classroom due to language limitations and lack of confidence. For ELLs who participate regularly in the mainstream classroom, pre-teaching may not be as vital or meaningful. Furthermore, the students who can benefit from pre-teaching may change based on the content and concepts being taught during such lessons and students' prior knowledge or lack thereof in relation to targeted objectives.

Finally, when determining if or how a student has benefited from pre-teaching, it is important to look at a variety of assessments, including open-ended responses that enable an ELL to use the language s/he has to explain a concept. My research also suggests this type of assessment may be vital for mainstream teachers in regard to testing math knowledge and potentially other content areas. ELLs may understand key concepts but not have the academic vocabulary to explain them. This is also an area where children's literature can be helpful, both in increasing student engagement in a lesson, and also in giving them some context and language to explain their understanding of a concept prior to mastering it and the corresponding academic vocabulary. These texts seem to create a common context that can be used as a springboard from which to understand and explain new concepts.

Limitations

This study was limited by several factors. Most prominent was the small number of participants, as there were only seven students in the study. Next, though there was gender diversity, all but one of the students were Latino and native Spanish-speakers. Subsequently my study was limited by the cultural and linguistic homogeneity of the students. Without a more diverse mix of cultural and linguistic backgrounds, it is unclear whether pre-teaching is effective for students in all ethnic groups and regardless of native language. Similarly, this study was only conducted with third graders, so it is unknown as to whether similar effects would be found at other grade levels.

Future Research

There are several directions for future research involving pre-teaching to increase the accessibility of whole class lessons. Based on the limitations mentioned above, a similar study could be conducted with a larger and more diverse sample and/or at a different grade level. Additionally, it would be interesting to conduct a similar study in a different content area such as social studies, health or science. It would also be helpful to attempt such a study using a different tool for quantitatively assessing student engagement and participation apart from the student participation rubric I employed. Finally, the data would potentially be more telling if a study researched a particular aspect of instruction in relation to pre-teaching. In other words, one could study the acquisition of academic vocabulary that is pre-taught and determine how many words are acquired and applied in the mainstream classroom by those who are pre-taught versus those who are not.

Communicating and Using Results

I will share the findings of my study with my grade-level and ESL teams during our regular meetings. I also plan to share the results with my principal and the ESL Coordinator for my school district. They may be able to use the results to help develop staff development for ELL and mainstream teachers in our school and other district schools that have an inclusion model and/or large number of beginning ELLs. Using pre-teaching as a tool to improve teacher instruction and increase student participation and engagement can be applied to any content area, not just math. Therefore, I think there are ample opportunities for ESL teachers and mainstream teachers to discuss the most appropriate use of pre-teaching for meeting their students' needs. Ideally, my research could be used as a starting point for such collegial discussions.

Summary

Conducting this study has enabled me to formalize the manner in which I implement pre-teaching math language lessons. Though I have pre-taught math language lessons prior to this study, conducting research helped me to formalize my reflections on students' behavior during pre-teaching lessons and during the mainstream lessons for which they were pre-taught. It was also vital for me to receive feedback from colleagues regarding student performance during whole class lessons, and I believe our professionalism was increased as the various research tools I used during this study required us to discuss students' participation and math abilities in a more systematic and focused manner. I hope to continue pre-teaching mainstream lessons, but to perhaps expand pre-teaching to include other content areas. I would also like to have more fluid

pre-teaching groups based on student needs. Ideally, pre-teaching will continue to be used as a tool for enriching student learning and increasing subsequent performance.

APPENDIX A

The Language-Concept Connection

Language	Concept	Learning
Unknown	Unknown	Limited learning opportunity; modify instruction
Known	Unknown	Concept Development
Unknown	Known	Language Development
Known	Known	Concept and language mastery; advance to next conceptual or linguistic level

Adapted from Garrison, L. & Mora, J.K. (1999). Adapting mathematics instruction for English-language learners: The language-concept connection. In L. Ortiz-Franco, N.G. Hernandez, & Y. De La Cruz (Eds.), *Changing the faces of mathematics: Perspectives on Latinos* (pp. 13 – 20). Reston, VA: The National Council of Teachers of Mathematics.

APPENDIX B

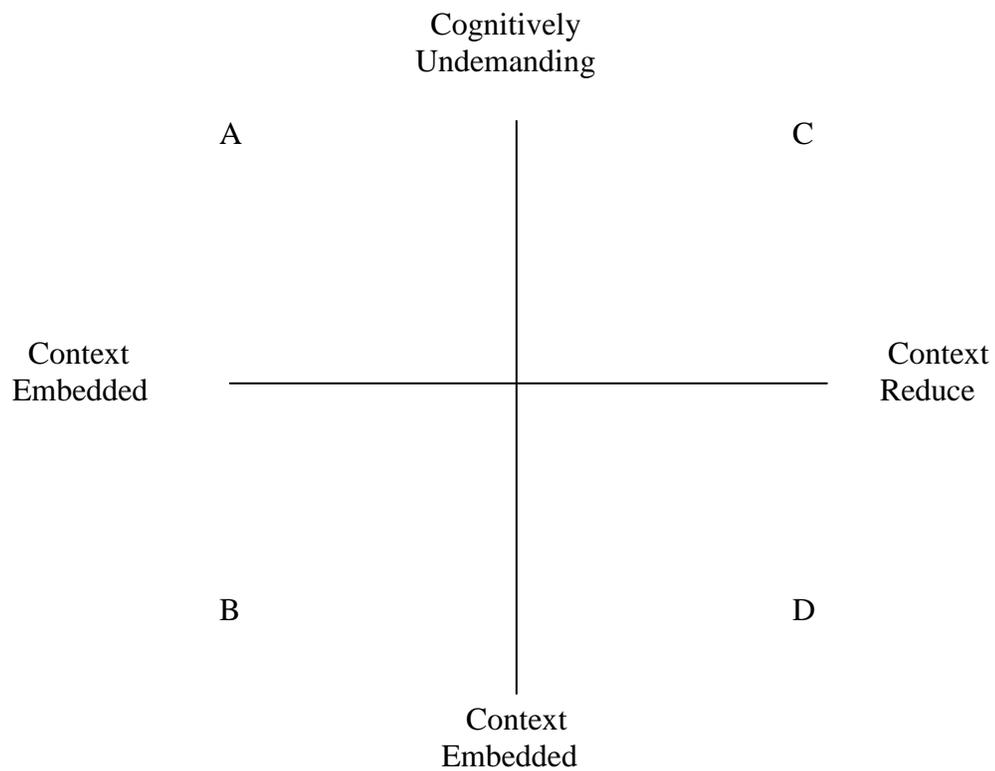
Vocabulary Difficulties and Examples

Category of Difficulty	Examples
Some words are shared by mathematics and everyday English, but they have different meanings in the two contexts.	Right angles versus right answer Right angle versus right hand Reflection as flipping over a line versus reflection as thinking about something Foot as 12 inches versus the foot on a leg
Some mathematical words are shared with English and have comparable meanings, but the mathematical meaning is more precise.	Difference as the answer to a subtraction problem versus difference as a general comparison Even as divisible by 2 versus even as smooth
Some mathematical terms are found only in mathematical contexts.	Quotient, decimal, denominator, quadrilateral, parallelogram, isosceles
Some words have more than one mathematical meaning.	Round as a circle versus to round a number to the tenths place Square as a shape versus square as a number times itself Second as a measure of time versus second as a location in a set of ordered items A side of a rectangle is a line segment versus a side of a prism is a rectangle
Some words shared with other disciplines have different technical meanings in the two disciplines	Divide in mathematics means to separate into parts, but the Continental Divide is a geographical term referring to a ridge that separates eastward- and westward-flowing waters. Variable in mathematics is a letter that represents possible numerical values, but variable clouds in science are a weather condition.
Some mathematical terms are homonyms with everyday English words.	Sum versus some, arc versus ark, pi versus pie, graphed versus graft
Some mathematical words are related, but students may confuse their distinct meanings.	Factor and multiple, hundreds and hundredths, numerator and denominator
A single English word may translate into Spanish or another language in two different ways.	In Spanish, the table at which we eat is a mesa, but a mathematical table is a tabla (Olivares 1996)
English spelling and usage have many irregularities.	Four has a u, but forty does not. Fraction denominators, such as sixth, fifth, fourth, and third, are like ordinal numbers, but rather than second, the next fraction is half.
Some mathematical concepts are verbalized in more than one way.	Skip count by threes versus tell the multiples of 3 One-quarter versus one-fourth
Students may adopt an informal term as if it is a mathematical term.	Diamond for rhombus Corner for vertex

Adapted from Rubenstein, R.N. & Thompson, D.R. (2002). Understanding and supporting children's mathematical vocabulary development. *Teaching Children Mathematics*, 10, 328-333.

APPENDIX C

Range of Contextual Support and Degree of Cognitive Involvement in Communicative Activities



Adapted from Cummins, J. (1992). Language proficiency, bilingualism, and academic achievement. In P. Richards-Amato and M. Snow (Eds.), *The Multicultural Classroom*. White Plains, NY: Longman Publishing, pp. 16-26.

APPENDIX D

Student Participation Rubric

Student Name:		Observer Name:			
Lesson Topic:		Date:			
	Observation #1	Observation #2	Observation #3	Observation #4	Observation #5
Classroom Context <i>What is happening in the classroom right now?</i>					
Eye Contact with Speaker	N/A Yes No				
On task sharing with whole group	N/A Yes No				
On task sharing with small group	N/A Yes No				
On task sharing with partner	N/A Yes No				
On task individual work	N/A Yes No				

Comments:					
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APPENDIX E

Student Participation Rubric Definitions

Eye contact with speaker	Student is looking at the speaker, whether the speaker is a teacher or classmate. The exception is when a speaker is drawing students' attention to a book, chart or screen (such as when using a document camera and projector), a student's eyes should be on the object of the speaker's attention.
On task sharing with whole group	Student is following the directions given in the whole group. If students are directed to whisper to a partner, share with their table or show an answer with their fingers in the context of whole group instruction and they follow the instructions, this would be considered on task sharing with whole group.
On task sharing with small group	Student is interacting with assigned classmates during small group activities. This interaction may include active listening, gesturing, oral sharing, manipulation of materials, and the like.
On task sharing with a partner	Student is interacting with assigned classmate during partner activities. This interaction may include active listening, gesturing, oral sharing, manipulation of materials, and the like.
On task individual work	Student is working on the given task individually. This may include manipulation of materials, reading, writing, or seeking assistance when needed to complete the task.

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