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Number Talks for Multilingual Learners

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NUMBER TALKS FOR MULTILINGUAL LEARNERS

by

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A special thank you to my partner, Stephen, for his unwavering support, and to our Anthony's many devoted grandparents, without whom I could not have found the space or time to complete this project. And to Anthony, my little bundle of inspiration.

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Introduction

Overview

Memories of math classes throughout my own education are not positive ones. I recall a focus on drills, speed and rote memorization. I remember covertly writing formulas on my hands, and not understanding what they meant. I remember saying very little and fearing being called on in front of the whole class, for fear my answer was wrong, or worse, I had no answer at all. Throughout my English as a Second Language (ESL) licensure program at Hamline, I learned a great deal about how to apply a linguistic lens to any content area, including math, but my coursework never addressed all of the ways that math pedagogy has evolved since my days as a primary school student. As I embarked on this project, I was eager to learn how approaches to math instruction have changed according to research on best practices and how those approaches can enhance opportunities for English language development in the mainstream classroom.

Educators now know that deeper learning occurs when students are able to make meaningful connections and engage in academic discourse with their teachers and peers (Kazemi & Hintz, 2014; Moschkovich, 1999; Zwiers, 2008). We know that success in mathematics depends upon a strong foundation of number sense (Boaler, 2015). My interest in synthesising best practices for language acquisition and best practices for mathematics instruction led to my research question: *How can Number Talks affect academic achievement and language development of fourth grade multilingual learners?* This chapter will provide the reader with the context and rationale for my interest in this topic, including personal and professional anecdotes that led to a deep dive into research on strategies for English Language Learners (ELs) that result in language proficiency growth and achievement in mathematics.

Context

For most of my childhood and into adulthood, I have been quick to profess my belief that I am not a "math person". I have never been good at mental math; I still use my fingers to count and still have tricks to find multiples quickly. At some point in my development as a student, I learned to identify as *not a math person* and that fixed mindset towards math has shaped my confidence and how I have approached academics my entire life.

Now, as an educator, it is not an option for me to identify as *not a math person*. What sort of role model would I be to my students if I embodied that self-doubt? I would not be the kind of educator my students deserve to have before them. And so, I openly admit to my students that it is difficult for me to do math in my brain; I need to see it to learn it. I need to interact with mathematical concepts and I need to understand why a strategy makes sense.

This is my preamble when I sit down with students who come to me for help in math. Because I am not in their math class during the day, I start out by asking them to teach me, or talk me through a strategy they have learned. I have noticed, however, that even if a student can *show* me, they often do not have command of the language required to explain their thinking or their process. These observations led me to wonder how I can better support my students in their ability to communicate mathematical processes and reasoning, especially for those who are simultaneously developing proficiency in English as an additional language.

Over my last five years as a teacher for multilingual learners in a primary school, I have been exposed to teachers and teaching methods that make me wish I could be transported back to fourth grade, before I internalized the message that I am not a mathematician. I have observed and learned a great deal from colleagues who focus on math pedagogy that teaches flexibility in thinking, use of multiple strategies, manipulatives, real-world examples and connections to students' experiences. I have recognized classroom cultures that emphasize the message that all students are capable, and that different strategies and ways of thinking are not only to be encouraged, but celebrated within the learning community. I have also experienced collaboration with colleagues who have very traditional approaches to mathematics instruction, where the focus is on teaching and modeling strategies, then providing students with opportunities to practice and apply, with little room for interaction or discussion of reasoning. From my perspective, the former of these two approaches cultivates potential for a language-rich environment for ELs that is more inclusive, engaging and equitable than the latter.

The EL program model at my school puts an emphasis on co-teaching as a preferred strategy for language support and instruction. I spend about 90 minutes of my day in three small-group language interventions, and the rest of my day is spent in the mainstream classroom, co-teaching all students with their content teacher. I work in a public charter school in St. Paul and about 60% of our student population are non-native speakers of English who qualify for EL services. My role as a co-teacher is dynamic and fluid. At times, I am working with individual students who need modified materials, often re-teaching with a small group of students, and sometimes teaching to the heterogenous group. The fundamental goal of the co-teaching model is to provide all students in the mainstream classroom with access to content standards and instruction through appropriate language supports and scaffolds.

As a teacher of multilingual learners, I approach academic content with a language lens. Historically, I have partnered with classroom teachers in co-planning and co-teaching in the content of English/Language Arts, because the language load is heavy and the academic demands for productive domains of speaking and writing are significant. Students are expected to have academic discussions and extensive written responses, so teachers on my team have always preferred the support of a language teacher during those instructional periods. Over the past few years, however, I have come to realize that our neglect to collaborate and co-teach in mathematics instruction has been an oversight. The lack of attention to the language demands of this content area have been a detriment to our students in their development of the language of mathematics and their ability to meet increasingly rigorous math standards.

I would like to note here that throughout this paper I will refer to the target language of instruction as *academic language*, as is the terminology most frequently used in the research explored for the purposes of this project. I must acknowledge, however, that in the context of the social and political uprisings that have occured this year, in the wake of the murders at the hands of the police of George Floyd, Breonna Taylor, Ahmaud Arbery, Tony McDade and many more, there is heightened, albeit long overdue, awareness and active critique of the racist language used in our institutions, including academic institutions. As educators and researchers in the field of linguistics, we must recognize that the racist language used in institutions of learning can be equally as harmful as the racist violence that exists in our society.

In July of 2020, the Conference on College Compositions and Communication (CCCC) Special Committee on Composing a Statement on Anti-Black Racism and Black Linguistic Justice published a list of demands, including a call to re-examine the role of educators in perpetuating the marginalization of language-minoritized youth. The demand is that "Teachers and researchers acknowledge that socially constructed terms such as academic and standard English are false and entrenched in notions of white supremacy and whiteness that contribute to anti-Black linguistic racism" (CCCC, 2020). We are in the midst of a massive sociopolitical and cultural movement that is forcing us to recognize the ways in which racism permeates our society. This paper was written in the nascent stages of this national reckoning. My hope is that the inclusion of this language dates this paper to a less-evolved time in our education system and that future research reflects actively anti-racist language and pedagogy. For now, there is not yet an alternative term agreed upon and used throughout the field, so I will include the term *academic language* for the purposes of continuity and clarity, with this disclaimer.

Rationale

I earned my K-12 ESL license five years ago at Hamline University. My coursework and field experiences prepared me well for my role as a teacher of multilingual learners in many ways. I have realized, however, over my last few years of teaching, that there is a gap in my knowledge and experience with the pedagogy of mathematics. As an EL teacher, it is my responsibility to co-plan with classroom teachers and to identify and extract the key language components of individual lessons and the unit as a whole. Then I work with the classroom teacher to infuse language instruction into their lessons and create opportunities for students to practice and interact, using specific features of the language identified.

As stated earlier, I have little experience collaborating with teachers in their mathematics instruction, so we currently do not assess and collect data about the students' language production in the context of mathematics. This project immersed me in the mathematics curriculum that I was interested in exploring with a fresh perspective. It also allowed me to employ my language lens to enhance the curriculum with interaction strategies that support students' development in the language of mathematics.

It is important to me, as a language teacher, to ensure that all students are provided ample opportunities for language support and meaningful language production throughout the day. With our population of students, teachers cannot expect students to engage in content-specific interactions, even when modeled by teachers and native English-speaking peers, if there is not some element of explicit instruction and support of language expectations. Therefore, content-specific student interactions must be scaffolded according to students' proficiency levels in English.

For most of our scholars, the language of mathematics is not a language they are exposed to at home, nor is it a language explicitly taught in school. When I ask students to explain their thinking in math, the most frequent response is a shrugged shoulder or, “I just did it in my head”. These experiences have led me to wonder how to best integrate language instruction into math classes in a way that would provide opportunities for productive language and interaction, while also supporting students' development of number sense and mathematical reasoning. I eventually landed with the promising instructional strategy of Number Talks, created by Ruth Parker and Kathy Richardson in the early 1990s (Humphreys & Parker, 2015). This project will integrate the routines and principles of Number Talks into the fourth grade math curriculum, enhanced with language support strategies geared toward ELs.

Additionally, I am in my second consecutive year of English Learners in the Mainstream (ELM) training, a program through Hamline University that positions EL teachers as coaches for their mainstream teacher colleagues, in order to better serve all language learners, not just those served directly by EL teachers. Through the ELM initiative, EL teachers not only coach their colleagues in instructional strategies that support EL students, we also lead all-staff professional development, with the goal of empowering all teachers to become language teachers. We prioritize culturally responsive practices that recognize the language assets our students bring to the classroom, and we prioritize strategies for increasing opportunities for students to produce academic language. These school-wide goals tie in nicely with my research goals for this project, and could potentially lead to application of my final product as a school-wide initiative for improving engagement and interaction in the context of the mathematics classroom.

Conclusion

Throughout Chapter Two, I will explore the benefits of student interactions within the context and language of the mathematics classroom, using relevant theories of second language acquisition. I will review pertinent literature on the topics of student interaction strategies, the language of mathematics, and how to make the language demands of mathematics accessible to all learners, specifically multilingual learners. In Chapter Three, I will describe the setting and context for my project and detail plans for implementation. Finally, in Chapter Four, I will conclude with reflections and the future implications of my capstone project.

CHAPTER TWO

Literature Review

Overview

The research presented here will explore the question, *How can Number Talks affect academic achievement and language development of fourth grade multilingual learners?* The first theme in the research will shine a light on the math achievement of ELs, or lack thereof, through the lens of equity. The following section will look to answer the question of why mathematical instruction must be analyzed through a language lens, when considering equitable access for multilingual learners. This section explores various aspects of the mathematics curriculum that are presented with linguistic barriers and how instructors can anticipate and plan for students' equitable access to content. The next section will explore the literature on the importance of student interaction for second language acquisition, and subsequently, the role of interaction strategies for language learners, specifically in the context of math instruction. Finally, this paper will explore the positive relationship between content-focused interactions and the agency and identity formation that comes from positive academic experiences for multilingual learners.

English Language Learners and Math Achievement

The Equity Principle

This section addresses the Equity Principle, the first of six principles published by the National Council for Teachers of Mathematics (NCTM) in their 2000 revision of *Principles and Standards for School Mathematics*. The revision of this document called for reform in the teaching of mathematics, with an emphasis on equity as a cornerstone of excellence in mathematics education (Bartell et al, 2008). Twenty years later, there is an abundance of research that illustrates the lingering existence of substantial obstacles to academic achievement in mathematics for ELs. This section will explore various theories and explanations for the existing achievement gap in mathematics, between native and non-native English speakers.

The National Assessment of Educational Progress (NAEP, 2015) provides data going back to 1996. The collected data shows that consistently, every year since 1996, the mathematics scores of fourth and eighth grade ELs are significantly lower than their native English-speaking peers (NAEP, 2015). According to the National Center for Education Statistics in 2017, the achievement gap between white and Latinx students in 2017 was not measurably reduced from the corresponding gap 27 years earlier, in 1990 (Martin & Fuchs, 2019). This data is discouraging to say the least, and begs for further analysis of educational policy and professional development requirements for educators in order to address this disparity.

The National Council for Teachers of Mathematics (NCTM) attempted to address this disparity by prioritizing the first of its six principles as the Equity Principle: “Excellence in mathematics education requires equity - high expectations and strong support for all students” (NCTM, 2000, p.12). Bartell et al. (2008) identified four areas of equity in the context of the mathematics classroom: equity in instruction; equity in classroom environment; equity in opportunity; and equity in appropriate curriculum.

Equitable instruction requires teachers to cater their instruction to the diverse needs, experiences and learning styles of their students. Equity in the environment focuses on cultivating a safe learning environment in which every student is expected to succeed. The concept of equity in opportunity varies from the previous concept in that it extends to the greater school community and sees equity as the availability for all students, regardless of race, gender, native language, etc., to access particular mathematical courses and receive quality instruction. Equity in curriculum focuses on math materials that are relevant and engaging to students' experiences (Bartell, et al., 2008). These four areas of equity can also be realized as areas of inequity, when examining the obstacles ELs face in their journey through academia in American schools.

Inequity of Math Assessments

A study published by Brown in 2005 examines the inequity of math assessments of ELs, specifically, literacy-based performance assessments (LPBAs). LPBAs were created largely in response to increasing demands to not only assess students' ability to demonstrate mathematical concepts, but also their ability to communicate and rationalize problem-solving strategies in mathematical terms and subject-specific discourse. In contrast to multiple choice or linguistically minimal formats, these types of assessments, which have been widely accepted as superior to multiple choice assessments, are characterized by real world situations, higher order thinking questions and literacy-based, open-ended questions that require written response and explanation (Brown, 2005).

Brown (2005) examined the success in mathematics assessments of both ELs and non-ELs, looking at socioeconomic status (SES) in relation to English proficiency. This study suggested that LPBAs are not necessarily appropriate for measuring the math achievement of ELs, due to the receptive and productive literacy demands of these questions, which interfere with the validity of a content assessment for ELs (Brown, 2005). The study found that ELs with higher SES did not perform as well as their fully English proficient peers with higher SES, meaning that language was an obstacle, even when SES was not. Additionally, both native and non-native English speakers with higher SES outperformed ELs and native English speakers with lower SES. Brown (2005) concluded that exposure to print-rich environments and cognitive academic language proficiency (CALP) were advantages that led to success in these assessments. Conversely, ELs with lower SES were disadvantaged in that their lack of access to academic English was a barrier in their performance on language-heavy assessments.

This study applies to the context and setting of my capstone project, as will be described in Chapter Three. The student population focused on in this project are roughly 60% ELs, and 95% of their families live below the federal poverty guidelines and qualify for the school lunch program. This population faces multiple obstacles to ever-increasing demands and rigor of mathematical standards for achievement.

Solano-Flores (2013) furthered this critique on the validity of assessments for ELs, using a semiotic perspective to examine ELs' performance on math tests. A semiotic perspective recognizes the importance of signs and symbols as key aspects of language; accordingly, meaning can be communicated through multiple ways of representing information. The field of mathematics is now widely recognized and examined from a semiotic perspective (Chapman, 1993). From this perspective, Solano-Flores (2013), found that limited proficiency in the language of an academic assessment is a primary threat to the validity of assessments of ELs.

Furthermore, Martiniello (2008) and Abedi and Lord (2001) conducted studies that examined the linguistic complexity of math questions and found that linguistically modified questions significantly reduced the disparity between ELs' and native English-speaking learners' academic performance. Both studies scrutinize the validity and appropriateness of assessments in math that neglect to account for language proficiency and language demands of the mathematical tasks required for achievement. These findings support the use of accommodations for ELs, such as native language support, use of visuals or manipulatives to express concepts, and simplification of language that obstructs students' access to mathematical concepts.

Implications for ELs

Fuchs et al. (2002) highlighted the urgency of reforming mathematics instruction to meet the needs of all learners in the warning that, "by the end of kindergarten, the distribution of mathematical development in typical public school classrooms spans more than four grade levels with many children, especially those from high-poverty backgrounds, demonstrating large deficits in their mathematical thinking and skills" (p. 569). Such significant deficits in one's first years of schooling are strongly linked to long-term academic deficits. Furthermore, Rivera-Batiz (1992) determined that statistical analysis of academic deficits in mathematics, specifically, are correlated with income and employment, even when reading skills and IQ are explained (as cited in Fuchs et al., 2002). These are significant findings considering the growing populations of ELs in our schools who are experiencing these significant learning deficits.

Culturally Relevant Pedagogy

Ladson-Billings (1995) is renowned in the field of education for analysis of classroom environments and curriculum through a lens of culturally relevant pedagogy. ELs are often perceived by peers and teachers as members of a subordinate group within the mainstream classroom. Students eventually internalize these perceptions, affecting positive identity formation in academic environments (Yoon, 2007). Culturally relevant pedagogy demands that educators consider and understand ELs' cultural and social positioning in the mainstream classroom, and work to meet the cultural and social needs of these students.

Ladson-Billings (1995) noted that the concept of multicultural education is not new. She recognized that the work of Thomas Kuhn in 1970 paved the way in mainstream educational scholarship by recognizing the implicit bias and cultural assumptions that are embedded in the formation of knowledge in all sciences. Less frequently recognized are African American scholars many decades earlier, such as Dubois (1935) and Woodson (1919), who challenged Western empiricism in academia (as cited in Ladson-Billings, 1995). These scholars have long challenged that the typical classroom rarely positions students to be active participants and inquirers in the construction of knowledge.

Ladson-Billings (1995) recognized that, in the field of mathematics, "the curriculum has long been seen as neutral, objective, and immune to discussions concerning multicultural education" (p.131). The concerns highlighted here reinforced this author's convictions that in order to engage learners in the language and content of mathematics, there would need to be a focus on cultivating an environment of active participants and inquirers in the construction of knowledge. The ideal classroom environment provides space and structures for students' voices, experiences, and perspectives to be at the forefront. This leads to the question of how to ensure that every voice is heard or represented, considering the wide range of abilities present in the classroom.

Culturally relevant teaching focuses on the power and influence of teachers to either act as constraints or as supports; to be inclusive or exclusive. With a focus on ELs' participatory behaviors and interactions with teachers and peers, Yoon (2007) drew on the work of Ladson-Billings (1995) to discuss how approaches to teaching can either offer or limit opportunities for active participation of EL students in the mainstream classroom. Recognizing that ELs perceive themselves as members of subordinate groups in the mainstream classroom, Yoon (2007) stresses that it is essential for teachers to carefully consider and understand ELs' cultural and social positioning and work to create a classroom dynamic that empowers and emboldens these students. Through observations and interviews, Yoon (2007) concluded that individuals need to be recognized and accepted as group members in order for them to become active participants in their learning communities. Teaching approaches that carefully consider students' language abilities and recognize the native languages of students, in addition to the target language of instruction, can be powerful instructional tools for engaging participation of all learners present. This investigation into ELs' participation in English dominant settings led to further interest in the relationship between mechanisms that support students' agentive participation and how these experiences may shift social positionings and positively affect identity development.

Turner et al. (2013) investigated how educators who were able to facilitate agentive problem-solving roles in group mathematical discussions contributed to positive identity development of Latinx English learners in academic settings. Their findings suggested that specific discursive positioning moves of the educator were successful in facilitating ELs' active participation and that recurrent experiences of active participation led to dynamic shifts in identity formation. Examples of these instructional strategies included: the use of explicit statements that validate a student's reasoning; invitations to share, justify, and clarify their thinking; and inviting peers to respond and evaluate ELs' contributions, positioning them as mathematically sound and valid. These discursive positionings employed by teachers can include sociolinguistic considerations such as the availability of tools or supports that are available as a set of norms established in the classroom. The research explored by Turner et al. (2013) demonstrated the power of instructional strategies that actively engage linguistically and culturally marginalized students. Recurrent experiences in an academic environment that is inclusive and validating, not only invites engaged participation, but positively affects identity formation of students who are often marginalized in academic contexts.

Math as a Second Language

Without consideration of the linguistic obstacles to students' effective communication in mathematics, educators may be at a loss for how to support the ELs in their classroom. A linguistic perspective of the discourse of mathematics reveals complexities that cannot be merely intuited by students through exposure. Language acquisition theory supports that best practice is when instructors embed explicit language teaching into their content instruction, in this case, teaching academic English and math in tandem (WIDA, 2019).

There seems to be a common misconception that the content area of math has a lighter language load than other content areas, and that it is more accessible to ELs because numbers are universal. Language teachers are often requested for support in the content of Language Arts or Science, and in my own career, that has historically been where I have focused my co-teaching. The abundance of research that exists on the importance of language in the field of mathematics education has highlighted the detrimental effects of neglecting to address the language demands of mathematics.

Math Acquisition and Language Acquisition

Wakefield (2000) drew comparisons between what he calls “math-acquisition devices” and “language acquisition devices”, exploring possibilities for language acquisition applications in math education. One of the maxims of language learning highlighted here is that students learn to speak before learning to write. Wakefield (2000) cited Richards and Roberts (1986) when he stated that first languages are acquired first through hearing and speaking. Similarly, verbal math is foundational to written math. If instructors are rushing students to produce written math before establishing confidence in verbal math, it could be stifling to learners and have adverse effects on their confidence in this content area.

Additionally, Richards and Rogers (1986) noted that second language acquisition theory stresses that language must be taught in meaningful contexts, not in isolation (Wakefield, 2000). If the language is not taught to be used, or necessary for “survival” in that context, it will not be practiced and will not be learned. Wakefield described how this translates to language used in the setting of a mathematical classroom:

> A student’s failure to become fluent in math in an environment where math is rarely spoken is obvious: he or she, apparently, can live well enough without it. The reverse is true of math learning in an environment where math is commonly spoken. (Wakefield, 2000, p.278)

Another maxim of language learning is that the target language must be explicitly taught and modeled consistently by teachers. According to Beebe's (1988) research in second language acquisition, new languages are learned best when students and teachers understand and are able to teach the distinctions between the native language and additional language being taught (as cited in Wakefield, 2000). However, simply using and modeling the language is not sufficient if students are expected to produce the target language themselves. Second language acquisition theory states that explicit teaching of language features and negotiation of meaning through interaction are important aspects of language learning, due to the activation of metalinguistic awareness that occurs when language is made explicit (Gass & Selinker, 2008). According to Bialystock (1988), "The ability to *think* about language is often associated with an increased ability to *learn* a language" (as cited in Gass & Selinker, 2008). Therefore, using knowledge of students' native language and contrasting features with the target language increases the metalinguistic awareness of learners, and is just as powerful a tool for learning as modeling and instructional feedback (Gass & Selinker, 2008).

Linguistic Analysis of Mathematical English

The linguistic analysis of Carter and Quinnell (2012) scrutinized the complexities of mathematical English presented in classroom instruction and assessments. They exemplified the linguistic lens that a language teacher brings to the table, in collaboration with the content teacher, in preparation for instruction. While the content teacher brings their expertise in mathematics, they may not recognize these linguistic complexities on their own and therefore neglect to anticipate the accessibility, or lack thereof, that ELs experience in relation to instruction.

According to Bevhervaise (1992), "Mathematics is a unique language with its own symbols (grapho-phonics), vocabulary (lexicon), grammar (syntax), semantics and literature" (as cited in Carter & Quinnell, 2012, p. 3). Munro's (1974) analysis of the lexical features of mathematical English demonstrated that particular words may not follow expected or learned parts of speech. Cardinal numbers, for example, are used as adjectives in most circumstances (*there are six bottles of water)*. In the context of math, however, cardinal numbers can function as nouns in a sentence, such as *the answer is six.*

As in any other language, to make meaning of mathematic text, the student must learn: signs and symbols (+, =, *x*); lexicon (vocabulary such as *coefficient, square, similar*); syntax (for example, multiplication precedes addition in order of operations); and semantics (for example, variables in some situations are likely to be rational, whereas in other situations they are irrational) (Carter & Quinnell, 2012).

Long before students encounter algebraic expressions, they are, quite simply, naming and identifying numbers. But even the foundational skills of naming and verbalizing numbers in the first years of school can be confusing for ELs. The order in which numbers are read, from left to right, have exceptions to the rule in English. For example, numbers in the teens are not read the way they are represented in symbols, as noted by Park (2003) and Perso (2005) (as cited in Carter & Quinnell, 2012). The number in the ones place is read before the number in the tens place, whereas all other numbers are read from left to right. For example, a student might begin writing the number *thirteen* with the number *3,* because it is the initial morpheme, or meaningful linguistic unit, in the word *thirteen* (Carter & Quinnell, 2012).

When students advance into naming higher numbers, the rules for naming can seem illogical. The prefixes used to describe numbers such as *milli-, bi-, tri-,* etc., have little relation to the size of the numbers described as millions, billions and trillions (Carter & Quinnell, 2012). To make things more confusing for native Spanish speakers, although many math terms in English are cognates of math terms in Spanish and therefore easily translated (for example, *millions* and *millones),* there are many exceptions, such as the word *mil,* in Spanish, meaning *thousand* in English. This can add an extra layer of confusion for students who are utilizing cognates as a strategy in language transfer.

Another exception to the rule that students encounter when voicing numbers in English is differentiating between ordinal and cardinal numbers. Ordinal numbers are generally formed by adding the suffix *-th* to the cardinal word (for example, *four* and *fourth).* There are exceptions, however, if the number ends in 1, 2, 3, or 5. The ordinal number then becomes *first, second, third* or *fifth.* Furthermore, in the ordinal number system, *first* is higher than *second,* but in the cardinal system, *two* is higher than *one* (Carter & Quinnell, 2012). As if the language of whole numbers isn't enough, the language of fractions and decimals, which are introduced in fourth grade, complicate matters further. For example, when articulating a fraction, the numerator is described using patterns of cardinal numbers, but the denominator is expressed following rules of ordinal numbers, such as *two-fifths,* or *three-eighths.* It is also common for teachers to substitute, without explanation, words like *quarters* for *fourths,* or to neglect to explain that we don't express ½ as *one-second,* but rather, *one-half.*

The language of decimals can also be used inconsistently, causing confusion for students who are new to the language of math and to the language of English. Although decimals are taught to be read using place value charts, and the language of place value, such as 3.045 read as *three and forty-five hundredths,* I have also observed decimals being read from native English speakers as *three point zero four five,* or *three point oh four five.* The word *oh* is often used to express the number zero in English, whether in the language of decimals, or in listing a phone number or address. This is yet another exception to the rules of English that cause confusion and delay for students who are not explicitly taught the ways in which native speakers of English break these rules every day.

Three Tiers of Vocabulary

Math curricula are never completely devoid of language instruction, but they are often limited to content-specific vocabulary, or what Beck et al. (2013) described as Tier 3 words. In the first tier are ordinary English words, used in everyday speech and in various contexts inside and outside of the classroom. These are the first words that language learners acquire because they are most essential to survival and belonging in any given community. Tier 1 words in math would be words such as *above, dollar, more,* and are words that are less likely to need explicit explanation, or explanation can be limited to an image or direct translation.

Tier 3 words are words that are specific to a field of study, and not likely to be used outside of that specific domain. Tier 3 words in mathematics would be words such as *denominator, quadrilateral, quotient.* These words are also important to teach in the context of the unit where they are most applicable, but students will likely not be producing these words on a daily basis. Munro (1979) stated that Tier 3 vocabulary is likely to amass the most instructional time because teachers don't expect students to be familiar with terms such as *quadrilateral.*

Teachers will provide images, definitions, simulated examples and real-life examples to help students acquire these new terms into their schema.

Often neglected, however, are the Tier 2 words, which students may be familiar with in everyday usage, but are not able to comprehend or apply its mathematical connotations without explanation. These are the vocabulary terms which are also more commonly overlooked and more likely to lead to confusion in students' comprehension of math statements (Munro, 1979). Tier 2 words are words that are commonly used in various academic contexts and are essential for students' engagement in academic content. These are the most important words for teachers to focus on in direct instruction because they are words that can function in many contexts, but also may shift slightly in meaning, depending on the academic subject. These are words such as *power, equality, similar, rational, factor.* The way these words are used in a language arts class may be different from how they are used in math, but they are essential to sophisticated communication in both content areas.

Mathematical Grammar

In addition to complex lexical features of mathematical language are the sentence-level language patterns and grammatical structures present. Comparative structures such as *greater than, less than, two times more, equal to,* are structures that may be obstacles when students are attempting to verbalize or interpret a math text. Prepositions, such as differentiating between *dividing by* and *dividing into,* can also pose problems for students, unless these features are identified and de-mystified through instruction (Slavit & Ernst-Slavit, 2007).

Academic Language Development

It has been established that students who are minority language speakers face substantial obstacles in academic achievement because "they lack the valued skills of school literacy and language use" (Zwiers, 2008, p.xv). A distinguished contributor to the field of language acquisition, Cummins, cited in Zwiers (2008), defined academic language using the terms *basic interpersonal communicative skills* (BICS) and *cognitive academic language proficiency* (CALP). BICS encompasses the social language used in conversations and everyday interactions and includes helpful comprehensible input to support new vocabulary, such as real objects, picture clues, gestures, facial expressions, or shared background knowledge (Zwiers, 2008). Regardless of their native language, most students acquire BICS with relative ease over the course of a few years because BICS is the language that facilitates social interactions with peers, which is highly motivating. CALP, on the other hand, is the language of academics and usually lacks the same support as is provided in the comprehensible input of BICS. Zwiers (2008) defines the more complex and formal language of CALP as the "set of words, grammar, and organizational strategies used to describe complex ideas, higher-order thinking processes, and abstract concepts" (p. 20).

In order to be successful in academic environments, students must learn and utilize academic language. It is the language needed to access the content, and the language required for assessment of learning. This is significantly easier for students whose home language and culture is aligned with the mainstream language and culture of schools, or rather, that of the staff and educators delivering instruction. For linguistically and culturally diverse students, acquisition of academic language requires "rich classroom experiences that accelerate the language that supports their content knowledge, thinking skills and literacy skills" (Zwiers, 2008, p.xiv).

The Role of Interaction in Second Language Acquisition

Meaningful Interaction

For second-language learners, the benefits of peer interaction have long been established, and research indicates that content learning is enhanced by peer interaction (Moschkovich, 1999). A sociocultural approach to language development, grounded in the work of Bruner (1978) and Vygotsky (1978), described learning as a natural consequence and benefit of interaction with others (as cited in Gámez, 2015). The more opportunities for meaningful input and production of language, the more conducive the environment is for language acquisition. Gámez (2015) noted, "Optimal learning occurs through children's scaffolded interactions with more knowledgeable persons (adults, peers), who build and expand on what children already know" (p.136). Furthermore, an interactionist perspective on language development, as explored by Snow (1994) and Tomasello (2000), emphasizes the influence of a child's social interactions, with special attention toward the language they are exposed to, or the language *input* (as cited in Gámez, 2015).

The interactionist perspective was formed in opposition to the perspective of Noam Chomsky (1981), who determined that language structures are innately formed through exposure (as cited in Gámez, 2015) . In contrast, interactionist theory emphasizes "the joint contribution of childrens' capacities for learning language and their language input, establishing a connection between the inherent features [and frequency] of the input and the features in the output" (Gámez, 2015, p.136).

Gámez (2015) made an important distinction between the quantity and quality of language input for ELs. According to Gámez (2015), the research that currently exists on the quality of ELs' language input is fairly limited to studies on the teacher's language production, which indicates “there is an optimal amount of teacher talk that serves to improve language skills, whereas children do not benefit from a disproportionate amount of total talk devoted to teachers’ talk” (Gámez, 2014, p.138). Gámez (2015) proceeded to cite a study by Palermo et al. (2014) which found that ELs’ exposure to English through their peers was positively associated with their development in English. This finding supports the interactionist perspective that transactional conversations are a critical factor in the development of an additional language.

Second language acquisition experts know that second language development requires a language-rich instructional environment that actively involves students in using academic registers in both receptive and expressive ways (Moschkovich, 2012). In order to have command of the language, words and linguistic patterns must be used in multiple ways, from multiple voices and over extended periods of time.

Martin-Beltran (2017) stated that research on best practices with culturally and linguistically diverse students is often focused on teacher-dominated language and instruction. Based on this research, Gámez (2015) determined that a higher ratio of teacher-to-student words was associated with smaller language gains for the student. This is indicative that a focus on teacher talk as a means to model academic language, without considerable space for students to interact with the language being modeled, will not be effective in increasing language proficiency. Interactionist theories of SLA have found positive relationships between peer interactions and language outcomes, championing student interactions as a meaningful component of best practices for ELs (Martin-Beltran, 2017). However, there remains to be a great demand for continued research in the field that addresses student-led language interactions and the opportunities they provide for experimentation and risk-taking, which inevitably enhance linguistic awareness and content learning.

Scaffolding

DeOliveira (2016), a proponent of systemic functional linguistics, argued that it is a disservice to water-down academic content language for ELs, once they are beyond the initial stages of language development. Contrary to advocates of reducing the linguistic complexity of instruction and assessments (e.g., Abedi & Lord, 2001; Martiniello, 2008; and Solano-Flores, 2013), systemic functional linguistics focuses simultaneously on “the meanings that are made (the ‘content’) and the language through which the meanings are expressed” (DeOliveira, 2016, p. 219). This perspective keeps the focus on the content and teaches strategies for tackling complex texts, sometimes clause by clause, to examine how language is used in various disciplines to present content. It requires a metalinguistic approach to language in that it recognizes the various ways language functions as a means of presenting information.

DeOliveira (2016) outlines several components of this functional approach to language that are relevant to an interactionist approach to academic language development. The principle of code-breaking involves explicitly teaching the linguistic and cultural “codes" of content learning in school (DeOliveira, 2016). Proponents of functional linguistics and code-breaking assert that students do not acquire academic language, in all its complexities, simply through exposure and comprehensible input. Rather, instructional practices must actively build bridges between the everyday language that students produce and the target language of academic discourse (DeOliveira, 2016). In this instructional model, high academic standards are maintained for ELs in the mainstream classroom.

The principle of interactional scaffolding is particularly relevant to the research question, *How can Number Talks affect academic achievement and language development of fourth grade multilingual learners?* DeOliveira (2016) outlines the three main elements of interactional scaffolding: linking to prior experience; appropriating and recasting students' contribution; and initiation, response, feedback (IRF) sequence.

Based on knowledge of students' English language abilities and prior experiences, teachers reference home and school experiences as links to the broader concepts that will follow in the curriculum. The second technique that is used to scaffold learning is the way in which teachers can facilitate students' contributions to academic discussion by recasting their words with additional context-specific academic language. The third element, the IRF sequence, is a way in which teachers support students' interactions with strong verbal or gestural hints for specific students. Teachers can ask for clarification and guide students' toward an expected response using visual clues and scaffolds, facilitating contributions from all learners.

Expecting students to engage in academic, content-specific discourse without significant modeling and scaffolding will significantly limit contributions and diversity of voices. The goal should be a classroom community where all students actively engage and participate in social processes that co-construct knowledge.

Interactionist Interventions in Math

The reform-oriented standards in mathematics that equally emphasize procedural fluency, conceptual understanding and mathematics practices are rigorous to say the least. Mathematics teachers of ELs are simultaneously encouraged to elicit mathematical content knowledge and mathematical communication from students as a means of developing students' conceptual understanding (NCTM, 2000).

A growing body of research addresses the ways in which ELs can be engaged participants in mathematical discussions in classrooms where English is the language of instruction (Banes et al., 2018; Banse et al., 2017; Moschkovich, 2007; Orosco et al., 2013; Slavit & Ernst-Slavit 2007; Sun et al. 2018; Turner et al., 2013). This section will focus on the importance of embedding meaningful communication with mathematical tasks, in order to adequately support and challenge ELs in the mainstream classroom.

Banes at al. (2018) cited several researchers (Adler, 1997; Gorgorio & Planas, 2001; Secada & De La Cruz, 1996) exploring the participation of ELs in mathematics classrooms. They found that ELs' engagement in discussion was limited and production of meaningful explanations of their mathematical thinking were limited as well. Low-performing students may tend to avoid whole class discussions due to their lack of confidence. If the language demands are too high and feel inaccessible, students will likely tune out or avoid participation. Furthermore, if the pace of verbal questions and responses are too rapid and students lack appropriate processing time, they will likely disengage from the conversation (Banes et al., 2018). This trend is significant in terms of equitable access to instruction, but also correlates negatively with the likelihood that students will develop a positive disposition toward mathematics (Boaler, 2016).

Although still minimal, there is a growing body of research that aims to capture effective strategies for ELs to productively engage in the language of math in mainstream classrooms (e.g., Banes, et. al., 2018; Moschkovich, 2007; Turner, et al. 2013). Encouragingly, Chapin et al.

(2003) found that benefits of mathematical discussion include "building a deeper understanding of concepts and improving motivation" (as cited in Banes et al., 2018, p.417). Regardless of questions about how interactive strategies impact performance on assessments, the benefits to students' engagement, confidence and language development are difficult to ignore.

Moschkovich (2013) advocates broadening the definition of participation to include both verbal and nonverbal communication. Multimodal expressions include gestures such as hand signals or pictorial representations that contribute to the classroom discussion. Students don't need to give a definition or explain a procedure to participate or to demonstrate conceptual understanding. Students can contribute by drawing a model or showing a tangible representation of equivalent fractions. These classroom contributions coming from students with limited proficiency in English are effective ways of communicating reasoning and participating in the collective effort to make meaning.

Moschkovich (2013) also calls on educators to support ELs to use emerging and imperfect language in their mathematical contributions, maintaining the focus on engaging students in mathematical practices. Teachers should focus on promoting and privileging meaning, no matter the students' chosen mode of communication, to build confidence and build support that meets students where they are. This is an important tenet of building an equitable learning environment.

Number Talks

A research focus on student-centered interaction strategies that promote diverse perspectives, engagement and opportunities for productive language led to several references to the practice of Number Talks. Originally created by Ruth Parker and Kathy Richardson, Number

Talks are commonly focused on students' first years of primary school (Humphreys &Parker, 2015), but Sun et al. (2018) explored and shared their success with this interactive model in high school classrooms, proving it beneficial at any age.

Number Talks consist of 10-15 minutes in the beginning of a lesson, beginning with a math problem presented by the teacher. Students are given time to solve the problem mentally, using any strategy they can think of, and as many different strategies as are available to them. Once students have silently communicated that they have found a solution, the teacher records as many different answers as are shared from students. The focus is on different ways of approaching problems, not whether an answer is correct or not. Then, students are given the opportunity to share their approach and explain their thinking to the class, while the teacher records on the board. This process offers a routine that can be very powerful, in that students shift into the role of teacher, and teacher shifts into the role of facilitator and recorder (Humphreys & Parker, 2015). The routine creates a space and audience for students to practice explaining their reasoning, and critique or build upon the ideas of their peers. Number Talks are designed to promote flexible thinking and strong number sense, but they can also facilitate communicative competence in academic language and help students build a more confident disposition toward the academic environment of the classroom.

Sun et al. (2018) highlighted the procedure of Number Talks as a strategy for supporting engagement and language development in the process of making sense of math. These outcomes became especially compelling, considering the population and culture of the students for whom this project is intended. Through the practice of Number Talks, Sun et al. (2018) observed that students shift their approaches to math from a focus on *what* the solution is, to a focus on *how* and *why* a solution is. Students learn about different approaches to the same problem, get more comfortable with mistakes and persevere through confusion. They also develop skills that help them not only express and evaluate their own ideas (getting feedback in recordings, revoicing and expansion of verbal expressions), but also to listen and critique the ideas of others (Sun et al., 2018). These practices intertwine the language and the content of mathematics and provide structured opportunities for students to interact and experiment with that language (Moschkovich, 2013). As a first step into incorporating an interactional approach to instruction, it is an encouraging model.

In addition to shifting the focus in math to the process rather than the solution, the routine of Number Talks also provides an instructional strategy that answers Turner et al.'s (2013) suggested mechanisms for positioning ELs as active participants in mainstream mathematical discussions. The strategies highlighted in their research included: explicit statements of validation for EL's contributions; invitations for ELs to share, clarify and justify their thinking; and opportunities for respectful peer responses that position ELs' contributions as valid, valued and important to the learning community. Number Talks incorporate all of these culturally relevant instructional approaches and provide a structure for recurrent opportunities that position all participants as mathematical thinkers and problem solvers.

Conclusion

This chapter began with the research question: *How can Number Talks affect academic achievement and language development of fourth grade multilingual learners?* Extensive research in the field of mathematics education, second language acquisition and interactionist approaches to learning, all point to Number Talks as an instructional strategy that may begin to transform a traditional, teacher-led classroom into a space where students become teachers; a space where the classroom community as a whole, navigates content as a common endeavor, with a common language. Chapter Three will apply the research accumulated in Chapter Two to design a project that is tailored specifically to the research question and learning site of the author. The following chapter provides an overview of the project, a description of the context and setting where the project will be implemented, and the instructional frameworks that supported the development and rationale of the project.

CHAPTER THREE

Project Description

Overview

Chapter One described the personal and professional motivations for this project and Chapter Two laid out a review of relevant studies and theories that support the project. Chapter Three outlines the plans for creation and implementation of Number Talks into the fourth grade math curriculum in order to address the research question: *How can Number Talks affect academic achievement and language development of fourth grade multilingual learners?* The outline begins with a description of the project, the instructional frameworks used to guide the project, and a review of the research that supports it. This is be followed by a description of the setting and participants who will be involved and affected by the project and the chapter concludes with a timeline and summary of the project.

Project Description

The purpose of this project is to incorporate Number Talks into the fourth grade math curriculum in order to develop number sense and promote student interaction and engagement in the language of mathematics. The literature review of the previous chapter led to the conclusion that Number Talks are an appropriate strategy to address concerns about participation of ELs in the mainstream mathematics classroom and the lack of opportunities that currently exist for structured interactions in the academic language of mathematics.

Number Talks can take many forms and can be applied to any subject or level of mathematics, from Pre-K to the collegiate level. In order to introduce the routine in a way that will optimize engagement and participation, the Number Talks routine is introduced with a focus on subitizing skills, as recommended by Sun et al. (2018) and Humphreys and Parker (2015). Subitizing refers to the ability to identify the number of things in a set simply by looking at them quickly, rather than counting individual items. After a few weeks, once the routine is established, the Number Talks will move on to operations with whole numbers, demonstrating properties of addition and subtraction and later multiplication and division, and eventually address decimals and fractions, in alignment with the progression of the fourth grade curriculum.

There are several benefits to starting with subitizing skills with a fourth grade classroom. Most students have not experienced Number Talks, so teaching the routine will be new, as is the level of participation expected of students. The math should be easily accessible to all students in the room and can increase in rigor throughout the year. If the math is accessible, participation will be increased because the stakes will be low. Another benefit is that both the visual nature of the subitizing strategies and limited language required to participate are more likely to keep ELs engaged and confident in their ability to participate. The emphasis is on equity and accessibility.

There are many innate strategies to counting that are accessible even for students with limited or interrupted formal education (SLIFE) and these students will be able to share their strategies visually, drawing lines or circling clusters, lessening the cognitive load of language and increasing the likelihood of participation. The idea is to establish the expectations for participation and build on linguistic and mathematical strategies from this baseline. Number Talks that begin with subitizing provide opportunities for students to build recognition of numbers and their parts with low stakes prompts that build confidence and inclusion (Parrish, 2010).

With engagement as my focus, each Number Talk includes language supports that can provide structure for those who are less than proficient in grade level academic discourse. These structures will be taught to the whole class and reinforced in small groups, using explicit instruction and modeling of correct use. Supports will be posted for students to reference, but not required in student contributions. The focus should remain on students' ideas and the mathematical concepts being explored, according to Orosco et al. (2013).

Instructional Frameworks

This curriculum project uses the framework of Number Talks, created by Humphreys and Parker (2015). Additionally, Sun et al. (2018) outlined the procedure of Number Talks as a strategy for supporting engagement and language development in the process of making sense of math. Wiggins and McTighe's (2015) curriculum model of *Understanding By Design* guided the curriculum development. This model requires that the instructional team (the mathematics teacher and myself) clarify the shared goal of what students will be able to do by the end of the unit, how they will be assessed and how they will receive feedback on their progress throughout.

Number Talks provide opportunities for authentic performance tasks on a daily basis, so there will be daily opportunities for students to demonstrate knowledge, self-assess and reflect on their growth. According to this model, it is imperative that desired goals and plans for assessment are created before initiating plans for instruction, so that the teachers and students alike are aware and mindful of the purpose and progression of learning that will take place.

My instructional plans are also guided by the World-Class Instructional Design and Assessment (WIDA) standards framework, which is used to plan for goals toward target language, according to EL proficiency level. Figure 1 is an example of how I will use the WIDA standards framework to plan for students' language goals, as well as content goals. The first component of the WIDA Standards Framework identifies the English Language Development Standard, which states, "English language learners communicate information, ideas and concepts necessary for academic success in the content area of Mathematics" ("WIDA ELD Standards", p. 3). The second component of the framework lists the connection to the Minnesota State Standards in Mathematics. This framework is used to make strategic decisions regarding the various language supports, instructional strategies, and language objectives that guide student achievement in both language and content knowledge and skills ("WIDA ELD Standards").

It is important to note that all students, even those at the most limited language proficiency in the language of instruction, can think and process at the highest cognitive levels. This framework is used to plan appropriate tasks for what students at each language proficiency level can do, enabling students to construct meaning and express complex ideas within each content-specific cognitive task. The Model Performance Indicator (MPI) is written as an example of how language is produced or processed within the identified academic context. The MPI consists of three elements: language function, content stem, and instructional support. Displaying the MPIs together in a table can help to plan for differentiation for individuals or groups of students, according to their proficiency level, and can be used as a tool to challenge students with language just beyond their current proficiency level. Figure 1 shows the components of the WIDA Standards Framework and MPIs created in my planning for language goals of Number Talks, according to proficiency levels in the domain of speaking.

Figure 1

Model Performance Indicators for Number Talks

Grade 4; English Language Development Standard 3 English language learners communicate information, ideas and concepts necessary for academic success in the content area of Mathematics.
Content Connection: Minnesota State Standards in Mathematics Benchmark 4.1.1.5: Solve multi-step real-world and mathematical problems requiring the use of addition, subtraction, and multiplication of multi-digit whole numbers.
EXAMPLE CONTEXT FOR LANGUAGE USE: Students will **DEFEND** an answer for a problem by explaining their mathematical process and **EVALUATE** the most effective and efficient strategies.

Cognitive Function: All students will **DEFEND** their answers and **EVALUATE** effective strategies.						
	Level 1 **Entering**	**Level 2** **Emerging**	**Level 3** **Developing**	**Level 4** **Expanding**	**Level 5** **Bridging**	

Domain: Speaking	Use nonverbal signals to respectfully agree/ disagree with answers and strategies, using nonverbal posters and native language support.	Use language of agreement such as, "I agree with ___" or "I respectfully disagree with ___" to defend answers, using nonverbal posters, sentence frames, native language support and teacher-modeled language.	Defend an answer by explaining the process for solving, "I agree/disagree with ___ because..." and "First, I...then I…", using sentence frames, native language support and teacher-modeled language.	Defend and evaluate effective and efficient strategies, using sentence frames, vocabulary posters, and teacher- modeled language.	Defend and evaluate effective and efficient strategies using teacher-modeled language.	
TOPIC-RELATED LANGUAGE: efficient, effective, defend, evaluate, operation, added, subtracted, multiplied, divided, factor, sum, product.						

Additional MPI strands can be developed according to various Minnesota State Standards in Mathematics as they apply throughout the Number Talks routine.

The Number Talks routine emphasizes interaction and language development, and always reinforces fourth grade Minnesota math standards. Standard 4.1.1.1 is the demonstration of fluency with multiplication and division facts, with factors one through nine. The illustrations used to accompany many of the Number Talks will demonstrate the concept of using arrays to solve simple math facts. Standard 4.1.1.3 is the multiplication of multi-digit numbers using efficient and generalizable procedures, based on knowledge of place value, including standard algorithms. Though not immediately, Number Talks that are presented later in the year can address the standard of multiplication of multi-digit numbers, and the concept of efficient procedures ties in nicely with the goal of evaluating the most efficient strategies presented. The most frequently practiced standard will be 4.1.1.5, in which students solve multi-step real-world and mathematical problems requiring the use of addition, subtraction, and multiplication of multi-digit whole numbers. There will also be opportunities to practice mastery of standard 4.2.2.1, understanding how to interpret number sentences involving multiplication, division and unknowns and using real-world situations involving multiplication or division to represent number sentences.

Rationale

The development of this project is grounded in the interactionist approaches of language acquisition, which find positive associations between peer interaction and language outcomes (Martin-Beltran, 2017). More specifically, interactions with content-specific academic language between all members of the classroom community create dynamic language environments, ripe for engagement and learning (Gamez, 2015; Moschkovich, 1999, 2013; Sun et al., 2018; Zwiers, 2015). Additionally, Turner et al. (2013) addresses mechanisms that support the development of positive identity formation in connection with students' positionings as active participants in a collective learning environment.

The selection of Number Talks as an appropriate choice for this particular setting and the needs of the student population are supported by nascent research on the relationship between productive academic language interactions and achievement in mathematics for ELs (Banes et al., 2018; Banse et al., 2017; Chu & Hamburger, 2019; Gamez, 2014; Gutstein, 2003; Martin-Beltran, 2017; Moschkovich, 2013; Slavit & Ernst-Slavit, 2007; Turner et al., 2013; Yoon, 2007). These studies all advocate for imbedding language instruction into the content and employing instructional strategies that support ELs' participation and engagement in the academic language of mathematics.

Setting

The setting for this project is a primary school, one of three sites in a PreK-12 public charter school district in the Frogtown neighborhood of St. Paul, Minnesota. In 2019, the percentage of ELs in the K-12 program was 35% of nearly 600 total students. When grouped according to composite proficiency level in English (according to WIDA ACCESS scores), 15.3% are Level 1 (Entering); 27.6% are Level 2 (Emerging); 46.5% are Level 3 (Developing); and 10.6% are Level 4 (Expanding). When considering home languages of our ELs, 64.5% speak Spanish at home; 30.2% speak Hmong; 2.5% speak Somali; 1.5% speak English, 1% speaks Vietnamese and 0.5% speaks Amharic. Due to the majority of our population having English proficiency at Level 3, our program model focuses on a push-in model of language instruction with EL teachers and classroom teachers participating in a co-teaching model.

The ESL team consists of four licensed teachers and a program coordinator. Each ESL teacher in the primary school collaborates with two grades and the middle school teacher works with grades 6-8. The high school recently merged with the district and currently has zero ELs enrolled. The EL program model features English instruction through co-teaching and collaboration between content teachers and EL teachers, as well as limited pull-out language interventions. Instructional collaboration through co-teaching and limited pull-out helps all ELs acquire proficiency in English within content-specific contexts, while also providing explicit language instruction when necessary. EL specialists align language instruction using the Minnesota state content standards and the WIDA English Language Development (ELD) standards in our instructional design. ELD instruction primarily occurs through co-teaching and small group language interventions. The fundamental goal in having EL and mainstream educators co-teach is to provide all students access to content standards and activities through appropriate language supports and scaffolds, while also ensuring that language learners have opportunities to interact with their English proficient peers.

The collaborative nature of this teaching environment indicates that the content teachers on this team will be participants in the project. While the planning and implementation of Number Talks will not be led by content teachers, the routine should ultimately be something that either instructor in the classroom could eventually lead. A benefit of having two teachers in the room is that there is potential for Number Talks to occur in the style of parallel teaching, in which two smaller groups of students are engaged in identical problem-solving discussions on either side of the room, led by two different instructors. This may allow for more student participation, as students are more likely to produce language in smaller groups and twice as many students would be able to share strategies as with the larger group.

One aspect of working in a small district is that professional development is often led by teachers, rather than outside experts. This school is in its second consecutive year of the ELM Project (English Learners in the Mainstream) through Hamline University, funded by a grant from the United States Department of Education. For the second year, The EL team has developed into the role of teacher coaches, with the goal of bringing best practices in Teaching English as a Second Language to our in-service teachers. In addition to coaching individual teachers throughout the year, the EL team also plans and leads three all staff professional development seminars throughout the year, each between two and three hours long. There is potential for an entire session on the benefits of Number Talks for ELs, who make up 35% of the student population, and are the shared responsibility of all staff in the district.

Timeline

The capstone project was completed in November of 2020. While my intention was to test my materials on the current fourth grade class at the start of this school year, the global pandemic forced our school to continue with the full distance learning model for the start of the 2020-2021 school year. Due to limitations in preparation time, synchronous learning time and equitable access to technology resources, I decided to wait until in-person learning resumes, hopefully in the fall of 2021. As the project focuses on establishing and practicing a routine that will be used for the rest of the academic year, I would begin teaching within the first few weeks of the new academic year.

Summary

Throughout the reflections and research on instructional methods that would address engagement and interaction of ELs in the context of the mathematics classroom, this project has landed on the framework of Number Talks as a promising strategy for ELs in the mainstream. This chapter summarized the project description, the rationale based on research and professional experience, and the specific setting and timeline for the project. Chapter Four will share reflections on the outcomes of this project, what has been learned, and possible implications for future research and practice.

CHAPTER FOUR

Reflection

Introduction

The preceding chapters have explored the research question: *How can Number Talks affect academic achievement and language development of fourth grade multilingual learners?* Chapter Four will reflect on the process of researching, planning and creating this project. This chapter will also acknowledge the shortcomings of the final project, and explore possible future implications for research.

Chapter Four covers what I've learned throughout the process of researching, designing and completing the project. I will reference the research done in Chapter Two and highlight the aspects of my literature review that became the most relevant to my project. I will lay out my plans moving forward for how my research and materials will be applied to my specific teaching site and how results will be collected and documented. The chapter will conclude with a summary of my learnings and reflections.

Creating the Number Talks

My research began with my own observations that students at my school site either enjoyed math or did not, participated in math or did not, identified as mathematicians or did not. I noticed a disconnect between the instructional approaches used in other content areas, such as ELA, and those applied in the context of mathematics. I became concerned that our math classroom was not fostering an academic environment that was accessible for all students and not recognizing and acknowledging the existing disparities in achievement.

The project that emerged from my research on interaction strategies that support ELs in mathematics resulted in instructional materials to support establishing the routine of Number Talks in the fourth grade classroom. These materials took the form of a Google slideshow presentation that includes printable posters of sentence frames and nonverbal signals, meant to be posted in the classroom near the board where students are faced for the Number Talks. My project goals were clarified once I received input from colleagues at my site who requested that I, as the EL teacher, provide the materials and lead the first 21 days of the Number Talks routine for their students. This request emerged out of my colleagues' honest concern that the new strategy, appealing as it was, would not as likely be implemented if they were asked to create the materials or teach the routine for themselves. This feedback helped me to realize that in order to see the benefits of the research I'd done, it made more sense to create the materials and teach the routine, rather than deliver a professional development session, create a coaching framework, or any other number of ideas I had at the beginning of the capstone process. The 21-day framework is one that our school has used for several other project initiatives in recent years, and is familiar for staff and students, although not supported by any specific research indicating that 21 days is a magic number for habit-formation. Still, my team and I agreed that it was sufficient time to familiarize teachers and students alike with the process and expectations of this new instructional practice.

Plenty of resources already exist as frameworks and formats for Number Talks. My research process led me to a resource that I found very engaging for the purpose of this project, because it includes a language component in the form of a rhyming riddle, and a visual component, which appealed to my goal of making the math engaging and accessible for all students. I am aware that students with a history of feeling unsuccessful in math will shut down or disengage the minute an equation is put on the board. My hope is to reduce that response to anxiety or negative self-talk by offering math in the form of pictures and riddles. I found a book entitled, *Grapes of Math*, by Greg Tang (2001) which uses a visual approach to mathematics and a riddle accompanies each vibrant illustration with clues on how to solve the problem. I found this book to be an engaging and age-appropriate resource for teaching subitizing skills, or ways to group numbers in sets rather than counting them individually. The challenges included in the book lead naturally into developing strategies for multiplicative thinking, which are a key focus in fourth grade math.

As I created the slides for the first 21 days, I also created plans for thoughtful and thorough instruction and implementation of the routine. The first 20 slides are an introduction to Number Talks for students and include posters for nonverbal signals and sentence frames that will be used throughout the routine. In the first week or so, more time will be allotted for Number Talks, because I will be teaching the routine, the sentence frames, the vocabulary and nonverbal gestures. I expect that these mini lessons will be closer to 30 minutes in the beginning, but will eventually be shortened to 10 or 15 minutes once the process becomes more familiar. I will explain the process and define key terms such as *defend, evaluate, effective,* and *efficient.* These terms will be posted on the wall for reference and repeated practice. I will also introduce the nonverbal signals we will be using for the first part of the Number Talks, before strategies are shared and defended verbally. These signals will also be posted near the board. Finally, I will introduce sentence frames that students can reference for strategy sharing, also posted near the board. These will not all be introduced at once on the first day, as that may result in an overload of language input for some students. I will prioritize the nonverbal signals on the first few days and gradually add the other language supports for more complex language output as the routine gets more established. Time spent on providing clarity about student expectations and providing immediate feedback in regards to those expectations will be time well spent and time, as this routine will be continued throughout the school year.

Connections to Research

As I set out to create plans and materials for the Number Talks routine, several key pieces of research from Chapter Two stuck out to me as the most influential. I found myself comparing the similarities between the acquisition of mathematical strategies and the acquisition of language strategies, as highlighted by Wakefield (2000). The concept of verbal math being foundational to written math was one that I had not considered before, but makes sense, considering what I know about language acquisition theory. This confirmed and validated my efforts to incorporate opportunities for productive language and interaction into the mathematics classroom.

In the new context of the distance learning model that is required this school year, I have also been reflecting on the issues of inequity that exist in our schools, now intensely magnified by the global pandemic. Access to resources, information, and services are all significantly compromised for the families we serve. It is more important than ever that we, as educators, create safe spaces, even when they are virtual spaces, where all students are recognized, valued and heard. The work of Yoon (2007) on inclusion of ELs and the power of educators to dramatically affect cultural positionings within the classroom has been influential in framing and focusing my instructional goals for this school year.

Finally, the work of Turner et al. (2013), which looked specifically at Latinx English learners and their social positionings in the mathematics classroom, was the most encouraging piece of research whenever I became discouraged or conflicted about the direction of my project. It was a reminder that all of the time and work that goes into inviting and elevating the voices and ideas of culturally and linguistically marginalized students is well worth the rewards of a students' recognition from peers, inclusion and positive identity formation.

Project Findings

I reflected quite a bit throughout this process on the differences between my experience doing research for this project and the research projects I did in the process of earning my teaching license five years ago. My years of teaching experience and familiarity with my particular teaching site were extremely advantageous when it came time to select a focus and a goal for my completion of the capstone project. I tend to get carried away with endless possibilities when I open my eyes to all of the fascinating work being done around the world in the field of education, but the context of my current role, my current colleagues and my current students were grounding for me throughout every stage of this work. I saw my students in every article that I read and knowing that my project would inevitably come back to them made it possible for me to narrow down the possibilities and envision the possible outcomes. I found myself very grateful for my years of experience and reflective about all that I've learned in the field, as they say. I also found myself grateful to my colleagues, who supported me in the process of completing this work during one of the most tumultuous and stressful years I can remember. This process also helped me appreciate that I work with teachers who trust me, who share their classrooms with me, who speak of our students as *our students*, not *their students*. I am grateful that they trust me to reimagine the way math is being taught now and attempt to make it better for all of our students.

While this process led to appreciation of my experiences, it was also a potent reminder of how valuable opportunities for professional learning and development are for educators. As I stated in the first chapter, through my years of graduate coursework in preparation for my ESL license, I had very little exposure to the pedagogy of mathematics. This opportunity to immerse myself in the world of math instruction was both daunting and exciting because it was all new to me. I learned a great deal, and I learned how much more there is to learn. In my efforts to remain focused on what was relevant to my project, I developed a large collection of articles that would be filed away and read at a later time. Once I dipped my proverbial toe into the Hamline databases, I was inundated, and often distracted, by fascinating research being done in the field of education. It caused me to reflect that engaging in academic research is an aspect of my work that has been neglected and I would like to make more time in my life for the practice of continued education. I also hope to find myself in a school system that demonstrates value in this aspect of the teaching profession.

I was also reminded of how important it is to take the time to explore new research and challenge our established habits and routines that are carried over from year to year. We as educators are often so overwhelmed, overworked and underfunded that there is precious little time to reflect and examine our practices, to absorb new ideas and to thoughtfully and diligently create better learning opportunities for our students. As difficult and time-consuming as this capstone project was, I am ultimately grateful that it gave me the impetus to focus on an aspect of my teaching that I have been wanting to pursue and improve for a long while.

Limitations

The finished product is not without limitations. My goal was to establish a strong routine that was accessible and engaging for all, but the final product is limited to only the first 21 days of instruction. My intention is to eventually create enough for every school day of the year. Another limitation is one that is universal in this academic year; the issue of translating instructional practices to distance learning. While I was hoping to use these materials with my students this year and make adaptations and edits according to students' engagement and response, I did not have the luxury of in-person instruction or the time allotted to attempt the routine during distance learning. Therefore, the materials created have not been tested out in the classroom, where surely I would notice limitations and oversights in my plans. An additional limitation is that of native language support provided. While I included Spanish translations for the nonverbal signals that will be used, I did not provide translations in other languages such as

Hmong, Vietnamese or Somali. While none of my current fourth graders depend upon native language translation in these languages, it is a possibility that students could join our community with native language literacy in a language other than Spanish, and these translations could be added to the language supports in the future. The following section will explore additional considerations and possibilities for this work in the future.

Future Implications

Ideally, I would like for the two fourth grade classrooms in my school to be a preliminary model for establishing the routines of Number Talks, and if the outcomes are promising, the strategy could be expanded and eventually become a school-wide practice. Our MCA math scores have been disappointing and underwhelming for as long as I've been teaching at this site, but I wonder if a school-wide effort to get students engaged and talking about math could help to cultivate a community-wide practice that builds a strong foundation for students to be confident in their problem - solving abilities. When I let myself dream, I imagine a learning community where all students are empowered to talk about mathematical concepts and to learn from their peers about the unique and different ways our brains make connections and solve problems. I want our mathematical instruction to build students' capacity and tolerance for challenges; to see them as puzzles to solve together, rather than obstacles to avoid.

Summary

This final chapter was a summary of my personal and professional reflections throughout the process of completing the capstone project. This project provided a tremendous learning opportunity as I endeavored to answer the essential question: *How can Number Talks affect academic achievement and language development of fourth grade multilingual learners?* The chapter began with my process for selecting this topic and creating the materials for Number Talks, with a focus on establishing routines that are engaging and inclusive of all learners. Next, I revisited the pieces of research that proved to be the most influential in the process of planning and creating the project. The following section focused on what I have realized about myself as an educator and lifelong learner, followed by the limitations and future implications of my work. In response to the essential question that launched this process, I feel confident in my assertion that Number Talks provide a structure and routine for equitable access to content knowledge, explicit language instruction, engagement in peer interaction and positive identity formation as a result of belonging to a learning community.

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