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English Language Learners Acquiring Tier 3 Mathematical Vocabulary in Upper Elementary Grades

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English Language Learners Acquiring Tier 3 Mathematical Vocabulary in Upper Elementary Grades

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A capstone submitted in partial fulfillment of the requirements for the degree of Master of Arts in Education

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To my family and friends for your continuous encouragement and support. Your guidance helped me to complete this project. To all of my students, I will never call you average because that is a mean thing to say. Finally, a special thanks to my wife who was unfailing in her support during my journey.
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CHAPTER ONE

Introduction

Rationale

The focus of my research is: How can educators support English Language Learners as they work to acquire Tier 3 mathematical language in 5th grade? I am a Minnesota certified K-6 educator who began my teaching career in Sweden for the first two years and am now working in a charter school in Minnesota. Having taught English Language Learners (ELL) in my classes, I witnessed a lot of the same struggles in Sweden as I do in the U.S. In Sweden, I taught only mathematics, and in the U.S. I teach all major subjects. I have found in both cases that mathematical language can be very challenging for students learning English and having moved abroad I can empathize with the struggles that come with learning a new language.

Personal experience

Learning a new language can be very challenging. When I moved to a new country, I got to experience learning a new language firsthand. Prior to moving, I had very little introduction to the Swedish language other than what I had learned using a free language-learning program called Duolingo. The application on my phone mainly focused on colors, numbers, and common greetings. Though some of this can help a traveler get by on a week-long vacation, it does not equip a person with the tools to thrive in a country with a different language.
In my experience, learning a new language takes time, energy, and exposure. I was very fortunate to have all three. I was financially able to take classes at a university at night. I surrounded myself with educated adults that were happy to assist me in my journey to learn the national language. I continued using Duolingo and tried out new language software including Rosetta Stone and Babbel. I listened to podcasts in Swedish and watched television shows. Most importantly, I had a job that forced me to learn the language to be able to teach my students effectively.

The population I taught at my school was mainly immigrants. There were over 40 different languages spoken at my school. Most knew Swedish as a second language and English as their third or fourth language. My ability to communicate in Swedish was critical to the day-to-day success of my students’ understanding of expectations.

By the end of my second year of teaching mathematics in Sweden, I was finally able to teach all basic arithmetic in Swedish. I was able to switch back and forth from Swedish to English as needed. I was very proud of my ability to teach basic levels of mathematics in two languages. However, even with all this integration and exposure, it did not mean I was as fluent as I wanted to be or thought I was.

I have a very clear memory of going shopping one afternoon and telling a cashier that I was a mathematics teacher. She began talking to me in Swedish about coordinate planes and I became frazzled. I apologized and said that I did not understand what she was talking about, then she began apologizing right back. At this point, I felt what so many of my ELLs can feel: pride with one's growth, then a feeling of inadequacy. This was not my first time feeling overwhelmed, but it was a reminder of the challenges that
our students face when learning Tier 3 vocabulary. The content-specific vocabulary is low in frequency but incredibly important as one progresses in formal education. The need to learn new vocabulary is not just left to academic life. Teaching abroad is not the only time a person can relate to a student having to learn new and challenging vocabulary.

One can relate to the challenges of learning new vocabulary without moving across the world. As one enters different vocations and work industries, the language one uses can change. As I left university I did not go directly into teaching, but I was able to learn about the challenges of going into a new work environment. This is the same feeling that many students may experience when starting a new academic unit, be it in mathematics, science, or language arts.

**Professional experience**

The school where I taught in Sweden was located in a lower-income neighborhood, and the majority of students were refugees from Middle Eastern countries. The school served approximately 700 students where over 40 different first languages were spoken. Many of my students spoke a Mother Tongue, the language from the country from which they originated. Once they learned their mother tongue they would learn to speak Swedish, which was often broken, and finally, they learned English. Instructions were spoken in English in all subjects except Swedish and their history class. The English program began in 4th grade and I taught 4th and 5th grade classes.

What I encountered immediately was that my students often came in with no English skills beyond what they learned from American entertainment, such as YouTube
and American Television. These types of platforms were not teaching my students mathematical vocabulary. In my two years, I worked tirelessly to learn as much Swedish as I could in order to help my newcomer students. Simultaneously, I had to ensure that they were keeping up with their peers in other Swedish schools in mathematics. I leaned heavily on having all my lessons on slides that had both English and Swedish on them, something I was taught in my classes at Hamline University. I had no other formal training in working with ELLs. The translations sometimes led to humorously bad translations that my students were quick and happy to point out. Fortunately, the Swedish language did offer one very helpful steppingstone for me and my students.

As both English and Swedish share the same Germanic root, in some of the words it was easier to see similarities. For example, *odd* and *udda*; other times there was very little in common, an example being *mode* and *typvärde*. This presented some challenges as my students were able to grasp some words faster than others. The ability to rely on cognates was therefore hit or miss. As I was completing my second year teaching in Sweden and planning my return to teaching in the U.S., I assumed I was moving away from teaching with a language barrier.

When I began teaching back in the U.S., I found an opportunity at a charter school in a suburban area. This school has approximately 650 students with a capacity of 700. These students come from nine different cities from around the metro area. This charter school has moved three times and is now in a building they hope will be their permanent site. Although the diversity in my school in Minnesota is not what I worked with in Sweden, I do believe it is closer to what a typical school in the U.S. is experiencing.
The charter school where I teach is not an immersion school, but it has two major pieces that it uses to help differentiate itself. It is a school that mandates that the students wear uniforms every day. Also, the students are in Spanish class for 40 minutes every school day. The students are adjusted into classes to fit their Spanish skill set once they get into 6th grade. Even though the students have Spanish class every day, we are not expected to incorporate Spanish into our classrooms or lessons.

In my class of 28 students, there are three students that receive English language services twice a week for 30 minutes. As a school, we have 42 students currently receiving services (although that number tends to fluctuate), and approximately 60 students total, including those who are designated as English learners in the Minnesota Automated Reporting Student System (MARSS) but have opted out. Approximately 10 former ELLs are being monitored right now as they have exited within the last two years. I have two other students in my class who have tested out of the services because of their WIDA scores. WIDA is a company that provides testing material to gauge my students’ English language proficiency.

Of my five ELL students, three speak Spanish as a first language, one speaks Somali, and one speaks Russian. This proved to be both a challenge and an opportunity for me as an educator. It was a challenge as I was not able to rely on just two languages such as Spanish to English translations in class, but also an opportunity as I needed to think beyond one language to English learners. Although the diversity of my ELL classroom had changed drastically, I still found a major opportunity to help my students.
As I moved back and settled into helping my new students grow, I realized that a lot of the same issues that burdened my ELLs in the U.S. were the same troubles I recognized while teaching in Sweden. In my current school, we began the year focusing on word problems and effective strategies to find the correct problem to answer. I found my ELLs really struggled with any terminology that was outside the most basic arithmetic vocabulary. Examples of basic arithmetic vocabulary include: add, subtract, multiply, and divide. This issue seemed to grow as we moved into more complex subjects such as finding common denominators. I soon recognized that this challenge could be an opportunity. I began trying new techniques to start chapters focusing on direct instruction for my students' math vocabulary first before moving into the content.

The strategies were mainly using flashcards that were provided in the mathematical workbooks; this approach was based on what had worked for me and what others suggested to me. In Sweden, I only taught mathematics and incorporated learning English as much as I could throughout lessons. In the U.S., I got to teach all major subjects once again, and in doing so I learned new techniques that I then brought into my math lessons. As I began my research into helping support my students I was excited to discover more opportunities to better my students' experience.

**Conclusion**

This project opened up new possibilities for me to consider how to best help my ELLs approach Tier 3 vocabulary in mathematics. As the population in the U.S. and in Minnesota changes, it is important to remain ready to adjust to the needs of our students. I have had multiple people say that numbers are a universal language, so teaching math
should be easier. Too often we forget the terminology that accompanies mathematics and how quickly complexity can change. Strong language foundations go a long way in opening up pathways instead of pushing out students because they do not have the language to keep up with their peers.

Students come in with multiple different factors that influence their development (i.e. classroom experience, maturity, age, and motivation). These factors can have a direct impact on how ready the students are as they attempt to meet the academic standards of mathematical vocabulary in 5th grade. If the students do not understand the terminology, that means they could misunderstand the instructions, problems, lessons, and conversations with their peers.

Educators need to consider not just one approach to helping their students grow and take on new Tier 3 vocabulary. They should be considering how to engage their students in direct instruction of new vocabulary through graphic organizers (Reed, Jemison, Sidler-Folsom, & Weber, 2018), word walls (Graves et al., 2014), regular open discussion (Kamil & Hiebert, 2005), and implementation of technology (Cummins, 2000) to help bridge the academic gaps. Many ELLs will face years of academic struggle to catch up with their peers’ English skills in the fast-paced American education system. Scott and Asselin (2003) magnify the need for more content-specific vocabulary exposure in addition to meaningful activities to help ELLs gain comfort while learning new vocabulary.

In the next three chapters will be going into How can educators support English Language Learners as they work to acquire Tier 3 mathematical language in 5th grade?
Chapter two goes over the review of relevant literature. This reviews relevant research and materials to best support educators. Chapter three is the rationale for the vocabulary guide project that has been created. Chapter four is the reflection of the research and the project that has been created.
CHAPTER TWO

Review of Relevant Literature

Introduction

The focus of the research is: *How can educators support English Language Learners as they work to acquire Tier 3 mathematical language in 5th grade?* English Language Learners (ELLs) face many challenges as they step into the average U.S. classroom. As students progress into upper elementary years, the rigor of the classroom, and the vocabulary used in each subject becomes more specific. Generally, ELLs are not getting mathematical word problems correct because the mathematical operations are too difficult. The vocabulary tends to become Tier 3 vocabulary and they struggle to understand how to approach the problems. ELLs not only have limited vocabulary in English but also limited depth in vocabulary (August, Carlo, Dressler, & Snow, 2005). Tier 3 vocabulary consists of low-frequency words that are domain-specific, i.e. *integers*, *quotient*, and *acute*.

The literature on acquiring mathematical vocabulary is not common, but fortunately, many of the techniques for acquiring vocabulary for ELLs are transferable into the mathematics classroom. This chapter reviews the best practices that can be brought into the upper-level mathematical classroom to assist ELLs in acquiring Tier 3 mathematical vocabulary. The main points of inquiry are:

- What are effective approaches to teaching vocabulary?
- What suggestions do the leading experts suggest?
What strategies are recommended in teaching mathematical vocabulary to ELLs in upper-level elementary grades?

What are potential opportunities for ELLs to learn new vocabulary?

**Effective Approaches to Teaching Vocabulary**

The typical age of a 5th grader is ten to eleven years old. According to Chip Wood, an educator, and author of many books on childhood development, ten-year-olds read voraciously (Wood, 2017). Some students like to explore new genres, while others tend to read very similar series. Reading can be an excellent place for students to grow their vocabulary. Unfortunately, the words they begin to experience in schools can be content-specific and they do not encounter them in the series they are reading.

According to Beck, McKeown, and Kucan, this content-specific vocabulary is generally considered Tier 3; a set of words that has a frequency of use that is quite low and often limited to specific topics and domains. These words are best learned when a specific need arises (2013). As the students begin to encounter these content-specific vocabulary words it is important to have strategies in place that students can rely on to learn the vocabulary as needed.

**Growth of Understanding**

As students work to acquire new vocabulary, they sometimes come in with no knowledge of the word, and sometimes they may have some understanding. According to Edgar Dale, knowing a word is not an all or nothing spectrum. Dale breaks it into four different stages:
1. No knowledge of the word - never heard or saw it
2. May have heard the word, but don’t really know what it means
3. Can make general associations with the word and recognize it within context
4. Has a rich understanding of the word and can use it while speaking or writing (as cited in Peery, 2016, retrieved April 9th, 2020)

When one considers the abilities of their students it is not all or nothing. Often the students come in with different points of knowledge. It is up to the teacher to find what those other points of knowledge are and how to connect them with new information. Dale’s stages of knowing a word are a great point of reference for a teacher that is struggling where to figure out what a student knows prior to the unit (Peery, 2016). A potential strategy for teachers and their students, ELL or general education, is to have them complete a pre-unit test and not only look at what the students know but more importantly, what they do not know. A teacher could have the students circle or underline words that confuse them on the pretest. That would give a teacher better insight into the words they need to focus on and where they are on Dale’s stages (Peery, 2016).

Educators should find out what their students know about the Tier 3 vocabulary to help build on it. ELLs have the additional burden of having had less exposure and teachers often assume they are at stage one. A teacher is able to get a better insight into students' understanding of the vocabulary through math talks, small group discussions, or vocabulary assessments (Kamil & Hiebert, 2005).

As students grow their vocabulary they need to take on the responsibility of working to gain new words. Students should be taking on an active role and not just
assuming language will be gained without effort. Students need to develop an interest in and awareness of words in order to adequately build their vocabulary (Beck et al, 2013). Ideally, teachers find ways to keep the students engaged and interested in the lessons. ELLs may benefit from working with sentences that contain a blank to be filled in. Vocabulary words that they can use to fill in the blank can be found in a word bank. Scaffolding is a powerful tool to help students understand and connect.

Repeated exposure to the vocabulary

The expansion and elaboration of vocabularies is something that extends across a lifetime (Kamil & Hiebert, 2005). Students are often asked to learn new words for different subjects and units quickly, with sometimes very little exposure. This lack of exposure to the vocabulary is an additional burden on ELLs in the classroom. There is no established method for teaching vocabulary. The National Reading Panel identified the 5 methods of vocabulary instruction:

1. Explicit Instruction: Students are given definitions or other attributes of words to be learned.
2. Implicit Instruction: Students are exposed to words or given opportunities to do a great deal of reading.
3. Multimedia Methods: Vocabulary is taught by going beyond text to include other media such as graphic representations, hypertext, or American Sign Language that uses a haptic medium.
4. Capacity Methods: Practice is emphasized to increase capacity through making reading automatic.
5. Association Methods: Learners are encouraged to draw connections between what they do know and words they encounter that they do not know. (as cited from National Reading Panel (2000), pages 4-3)

The National Reading Panel encourages repetitive exposure when it comes to learning vocabulary. Teachers will have varying approaches to how they feel the
vocabulary should be taught, but students need to be exposed to the vocabulary directly, with the acknowledgment that they are working to learn the new terminology. Often when teachers teach math they provide the key vocabulary in passive ways, possibly because they are not comfortable with the terminology or they are focused on teaching the content. Educators need to consider the importance of direct instruction, especially for the ELLs that need information brought to them (Goldstein 2013). The National Reading Panel’s list is a great place for teachers to consider how to incorporate more vocabulary instructions into their math class. Students come in with different abilities and histories in education. Trying different methods could be the key to success as one works to meet their students where they are in their education journey.

Teachers must consider bringing the vocabulary into the lesson with purpose. Instruction includes lessons and activities where students apply their vocabulary knowledge and strategies to reading and writing (Kamil, & Hiebert, 2005). In mathematics, ‘math talks’ are a great opportunity where discussion can be held, and teachers and students can discuss their mathematical understanding and misconceptions while incorporating and revisiting the key vocabulary. The more often the discussions occur and the more the students are exposed and use the Tier 3 vocabulary in discussion, the more they will be able to repeatedly expose themselves and their peers (Kamil & Hiebert, 2005).

**Direct learning instructions**

As students come to school they come with largely varying levels of exposure to language. It is estimated that children who come from low-income homes possess
approximately 6,000 fewer words than their middle-class peers (Goldstein et al, 2017). One would hope that once the students enter a school, their instruction would be the same and the gap would reduce. Unfortunately, this tends to not be the case. There is not a specific method of teaching vocabulary and educators work toward vocabulary development in different ways depending on their own training, experience, expectations from their school, and curriculum.

Educators have opportunities to accommodate work to best fit the students in their class. According to Goldstein et al. some guiding principles include directly explaining words in child-friendly formats, encouraging active engagement in learning, presenting the words in a rich language context with examples, and restructuring words and tasks as needed (2017). Educators need to consider the importance of being flexible to meet students where they are as they grow. Other opportunities would be to incorporate technology and extend group discussions with the consideration of being equitable.

Goldstein et al (2013) created Figure 1 to model the logic behind explicit vocabulary instruction, located in Appendix A. As Figure 1 shows, in the Basic Vocabulary Instruction the educator would only provide brief or basic definitions for unknown words, focusing on Tier 1 vocabulary, and providing students with limited opportunities for children to respond and practice. Oral language is not encouraged. In this basic vocabulary instruction, the child’s outcome is limited for receptive, expressive, and comprehensive. ELLs are already coming in with the additional burden of learning a new language and then having to take on Tier 3 vocabulary as they progress through mathematical units (Colorin Colorado, n.d.).
Figure 1 - Visual representation of change with explicit vocabulary instruction by Goldstein et al, 2017.

According to Goldstein's (2013) model, Direct Vocabulary Instruction (DVI) changes the child's outcome. DVI includes creating word awareness, delivering explicit instructions with child-friendly definitions and explanations, proving multiple examples, putting the word into multiple contexts, and creating meaningful connections to that vocabulary with other words. Connecting the words for ELLs can be finding potential cognates from the student’s native language. DVI also includes providing modeling and feedback, encouraging oral development, and having students use the desired vocabulary in and out of the classroom. The outcome from direct instruction is growth in language skills, acquisition of vocabulary words, and the ability to use the vocabulary in different tasks. ELLs need opportunities to take on the vocabulary, as they do not just hear it
during instruction but rely on knowing the words in every aspect of the lesson (Kamil & Hiebert, 2005).

DVI does not expect educators to rely on one method. Educators should be working to provide the instruction that meets their students where they are, using approaches that make sense for the subject they are teaching.

Suggestions of Leading Experts

Benjamin Whorf, a noted linguist, theorized that language is required for higher levels of thinking and that an individual’s language structure molds his or her understanding of the world (as cited in Monroe, 1997). Jim Cummins’ contemporaries to the field of educational linguistics from the 1970s to the late 1990s describe him as one of the world's greatest experts on minority languages (Taylor & Sakamoto, 2009).

According to Jim Cummins, students on average require five to seven years to acquire academic language (1979). Language acquisition takes time and not just one tool or lesson will catch up the ELLs.

Integrating technology

For some educators, bringing informational technology (IT) into the classroom is taking power from the teacher and for others, it is opening new paths to have their students connect with quick feedback.

According to Cummins “there is not a shred of empirical evidence that the massive investment in computer hardware and software has improved achievement levels” (Cummins, 2000, p. 538). Teachers giving students time to read in and out of school has been proven to increase students' ability to read. This information should
incentivize school districts to invest in libraries and schedule daily reading time.

Unfortunately, families and times have changed with technology. When IT is being left out of the classroom, it can leave some families and teachers feeling that they are not exposing students to the tool they need once they leave formal education. According to Jim Cummins, middle-class families and many educators have been convinced that computer literacy is the key to their children’s social and economic advancement (2000). Though middle-class people may recognize the need for technology depending on the school district, the ability or desire to bring IT into the classroom can vary. Schools that are prioritizing funds in other places or lack funding can be leaving students behind peers in other schools by not integrating technology into the classroom. Teachers and schools need to find ways to integrate IT into student education especially as technology and applications advance and students come in better equipped to use a smartphone than to know their alphabet (Cummins, 2000).

Language educators should examine the potential of IT not only to increase the linguistic power of the individual student but also to harness that power in critical and constructive ways to strengthen the social fabric of our local and global communities (Cummins, 2000). Students used to write to pen pals, but this could be updated to emailing others and including specific information about what they are learning in school to use the vocabulary. This would promote language education, connect students, and challenge them to use content-specific vocabulary in context.

In order to develop students’ access to and mastery of academic registers, instruction must focus on meaning, language, and use (Cummins, 2000). Learning
vocabulary must be accompanied by other practices that stimulate students’ thinking and reasoning (Reed, Jemison, Sidler-Folsom, & Weber, 2018). According to the authors, for the best results, the learning environment should be blended. Blended learning can be characterized by the interweaving of teacher-delivered, hands-on, and electronic instructional activities (Staker & Horn, 2012). This is distinguished from distance learning in which teachers and students only interact electronically.

Completing electronic activities and participating in online discussions would be common in blended learning environments at any grade level (Reed, Jemison, Sidler-Folsom, & Weber, 2018). By 2010, 70% of K-12 teachers reportedly were using computer-assisted learning to some degree (Gray, Thomas, & Lewis, 2010). As this group grows and more schools work to be one to one with technology with students, teachers must be ready to use technology to assist all students. With technology comes more opportunities for ELL students to connect their education of vocabulary in and out of school.

ELLs could have the opportunity to take more time to process their thoughts in a blended classroom. That would allow them to potentially collaborate with others in a written form before having discussions in class. One potential option for ELLs learning Tier 3 vocabulary in upper-level elementary classes would be graphic organizers. Graphic organizers can have a bit of variation, but they tend to have a visual display aspect of the words and their relationships to other words and concepts (Reed, Jemison, Sidler-Folsom, & Weber, 2018). These could be assembled on a computer to allow ELLs to research in their home language and use translation software as needed.
**Multilingualism in the classroom**

As ELLs work to keep up or to catch up with the growing vocabulary expectations in upper elementary classes, different educators take on different approaches to help their students grow. Many teachers in the U.S. may only speak one language with confidence. This will lead those educators to lead their classrooms with monolingual principles. The monolingual approach may not be the best approach for our ELLs.

According to Jim Cummins, bilingual instructional strategies may more adequately address the challenges of English Language and academic development (2009). Teaching in a multilingual classroom would challenge teachers to prepare and practice other languages to best help students take on the academic challenges they face as they develop. Languages such as English and Spanish have many cognate connections that would allow students and educators to focus on the connections between the languages.

Teaching in a multilingual setting would allow students to grow based on what they already have knowledge of in their first language. A fundamental principle of learning states that learners’ pre-existing knowledge is the foundation for all future learning (Bransford, Brown, & Cocking, 2000). Educators should work to build on the information and knowledge all students bring into our classroom. As classroom demographics change educators need to be working much harder to meet the needs of ELLs.

**Teaching Mathematical Vocabulary Strategies to ELLs in Upper-Level Elementary Grades**
Some like to think that numbers are their own type of language and, because of that, mathematics can be done as long as students understand the numbers’ value and basic arithmetic. Unfortunately, the power of language gives students a much better grip on understanding how and why math operations work and how to move them around and manipulate them. According to Colorin Colorado “The average native English speaker enters kindergarten knowing at least 5,000 words. The average ELL may know 5,000 words in his or her native language, but very few words in English. While native speakers continue to learn new words, ELLs face the double challenge of building that foundation and then closing the gap” (Colorin Colorado, n.d., para. 2). Elementary teachers need to keep this in mind as they consider the power of conversations in their mathematics class.

**Number talks**

Early differences in children’s mathematical knowledge can have a long-lasting impact on their future success in mathematics (Duncan et al, 2007). ELLs need to practice using the language in their speech. Teachers can ask students to restate the definition in their own words and provide opportunities for students to use academic vocabulary in discussions (Barrow, 2014). Students need to engage early on in mathematics, as engagement can have a lasting impact on their development as the subject matter gets more complicated. Students learn in different ways and can benefit from getting taught with varying styles. From a socio-cultural stance, learning is viewed as a consequence of collaboration in social activity. The belief is that all higher-order functions, such as learning, grow out of social interaction (Moffett & Eaton, 2017).
Educators need to find ways to build in social interaction into all subjects, especially mathematics.

Number talk has been developed to support teachers as their students develop an understanding of numbers and their association with vocabulary. Moffett and Eaton have organized number talks into three core sections. 1) Numbers and Counting; 2) Number Relationship and 3) Number Operation (2017). They suggested that each section still begins with an overview of the mathematical concepts. Students then should be shown a varying group of examples to help promote a greater range of thinking (Moffett & Eaton, 2017).

As the students interact in conversations, teachers are not idly sitting by. They should work as knowledge participants in the conversations by moving it forward and clarifying misconceptions while allowing for discussion to grow and move as students work to use key vocabulary. Students should be working toward having a secure vocabulary base to help them explain, justify, and communicate mathematically. Without having the necessary vocabulary, students will consistently be unable to understand instruction, word problems, and textbooks. Their ability to engage in meaningful discussions with peers will suffer as well (Kamil & Hiebert, 2005).

Often educators rely on indirect vocabulary instruction instead of direct instruction in mathematics. There is evidence to suggest that many pupils, particularly those who experience difficulty in mathematics, benefit from explicit vocabulary instruction (Andersson, 2010). Students benefit from direct instruction of content-specific vocabulary. Teachers can support their students' progression in mathematics and the
building of Tier 3 vocabulary by having students use technical vocabulary early on and not relying on everyday vocabulary.

Number talks offer an opportunity for ELL students to engage in using the Tier 3 vocabulary as teachers guide and provide feedback in classroom discussions. These talks should be happening regularly to give students as much exposure to key vocabulary to help them understand expectations in instruction, textbooks, and word problems.

**Frayer Model graphic organizer**

The graphic organizer can be a powerful tool for students to use in different subjects in school. Graphic organizers can be in the form of concept maps, flow charts, Venn diagrams, and timelines. They have long been used to support learning from text due to their ability to spatially depict relationships between key concepts (Kim & Cha, 2010). The Frayer Model is a type of graphic organizer that is used to help students learn new vocabulary. The Frayer Model is broken into different sections to help students build an understanding and connections to the new terminology. As educators use the Frayer Model with students to help build their vocabulary the suggested approach by Richardson is to provide direct instruction in 5 steps:

1. Explain the Frayer model chart to the class by using a common word to demonstrate the various components. Model the type and quality of desired answers when giving examples. Think out loud when trying to come up with examples and non-examples, etc. Pictures/symbols can also be used.
2. Then review a pre-selected list of key concept words with the class before reading about the topic in the textbook. Read the text selection.

3. Pass out blank copies of the Frayer Model or have students create a chart in their copies.

4. Students practice the strategy in pairs or in small groups with the key concepts and key vocabulary from the topic. (Each group could also be given different key concept words).

5. Groups share their completed charts with each other. Students can then add additional words/images/symbols to the Frayer chart until all four categories are substantially represented. (Richardson, 2012, p. 1)

For any teacher new to the Frayer Model, Richardsons’ (2012) step by step list is a great place to begin as one considers how to use the Frayer Model with your ELLs. Educators and students can alter these steps to best meet the needs of their class and the subject matter. Figure 2 is a blank Frayer model that could be used in one’s classroom for different subjects as new vocabulary is being taught.
Frayer Models are able to come with variations and can be edited as needed to meet students where they are academically. Figure 3 is an example of a completed Frayer Model. Commonly, a Frayer Model always has a place for definitions, and the keyword in the middle. From that point, this example is a place for characteristics. This would give the students more opportunities to go beyond the definitions. It also has an example and nonexample. The nonexample is a great place to have students place common misconceptions. ELLs can use these to build up information without just looking at definitions over and over or attempting to grasp their understanding of words by reading straight from the text (Kim & Cha, 2010).
The Frayer Model is a graphic organizer that allows more flexibility and once students and educators begin to understand how the Frayer Model is set up, educators can modify them for their students' needs (Richards, 2012). Figure 3 in the Appendix B is a modified Frayer Model as it no longer has a Facts/Characteristics section. This same place could be modified to help ELLs with either translations or with cognates when available. Educators are able to continue modifying the Frayer Model to meet students' needs to include scaffolding as needed too. This would allow ELLs to quickly work to identify the word as they attempt to learn challenging vocabulary with their peers.

**Word wall**

Teaching is more complex in this decade than ever before, as educators adapt to new curricular reforms and assessments, implement social and emotional learning
programs, and plan learning for an increasingly diverse student population (Merritt, 2016). The more one is able to create opportunities for students to view key vocabulary the more often educators are working to welcome it into their classroom discussions. It is important in all subjects but especially mathematics and ELL. Having a place that they know where they can go to for keywords is a powerful tool as they build confidence in using Tier 3 vocabulary. Effective vocabulary instruction includes “both a definition of a word and the word in context, provides multiple exposures to the word, involves students in discussion and active processing of the word’s meaning, and helps them review the words in various contexts over time” (Graves et al., 2014).

Educators need to make sure that they are not just putting words up in a static sense but finding ways to go further with the words, provide pictures, find ways to connect the words to the overarching concepts, and for ELLs in the class consider having the words translated into their first language for them to find even stronger connections. Different subject units can come with a varying amount of necessary vocabulary. As educators, we need to work to find the more important vocabulary. To do this Julie Jackson (2018) suggested using figure 4 as a planning tool to help.

Educators have opportunities to create word walls that best fit the needs and abilities of their students. It relies on the teacher having potentially provided direct instruction of the key terminology definitions and working with students to go over how to use the word wall effectively (Richardson, 2012). Other teachers that have ELLs could make sure to include translations or any potential cognates.
Educators can often be expected to have their students learn an incredible amount of new words a year. Educators need to plan accordingly to be ready to support their students. According to Merritt, a productive day of teaching requires substantial planning time to choose effective strategies, design lessons, prepare materials, and collaborate with others (2016). This is not an easy task. Teachers, just like their students, need tools to help them plan to meet their students' needs.

Figure 4 is a type of tool that teachers are able to rely on to help decide if an educator is giving their students the extra connections in the lesson. According to Julie Jackson (2018), the word wall helps provide a rich and varied experience that students need. An example of a word wall is to give students with varying reading abilities a chance to see the vocabulary with examples in action for students to reflect on. This type of word wall goes beyond providing the same textbook definition and creates a rich space for ELLs to go when needed.

![Vocabulary planning tool](image)

Figure 4 - Vocabulary planning tool for word walls by Julie Jackson, 2018
Opportunities for ELLs Learning New Vocabulary

Students come into the classroom with all types of abilities and opportunities for them to grow. It is crucial that educators build relationships to best understand their students’ strengths and opportunities. Some students come in with the additional hurdle of having to learn English in an academic setting. ELLs are defined by not yet being proficient in listening, speaking, reading, or writing English, and their language skills impact their performance on content-based assessments administered in English (Hopkins et al., 2013). Educators have an opportunity to learn about their ELLs’ strengths with English to help them learn the Tier 3 vocabulary necessary in upper elementary levels of mathematics.

Using native language cognates

As ELLs work toward proficiency in English reading, speaking, writing, and listening it is important for educators to consider opportunities to bridge language when possible for the students. One method to help ELLs bridge language is by using cognates when possible. Cognates are words with ancestral roots that are similar in appearance and meaning (Garcia & Godina, 2017), such as *circumference* (English) and *la circunferencia* (Spanish). ELLs may have the opportunity to activate the knowledge they have from their native language to help bridge connections with Tier 3 vocabulary.

Students may not realize the cognates that are available to them, such as *circle* (English) and *circulo* (Spanish). Students may not realize the connections so educators may consider putting up anchor charts with lists of cognates for students to rely on or include on graphic organizers such as Frayer models (Richardson, 2012). Educators may
need to use direct instruction for ELLs as they may need assistance making the initial connections between their native language and the content-specific vocabulary. Educators have to consider if they are more concerned with the students learning English or having a deeper understanding of the word.

According to Barrow’s Response to Intervention (RTI), he offered ideas for educators when considering ELLs while pre-teaching them vocabulary. This includes the strategic use of the child’s native language when possible (2014). Educators working with ELLs can use cognates that allow students to begin to deepen their comprehension of the Tier 3 vocabulary as they learn the necessary academic language in English. However, teachers must beware of false cognates. These are words that appear to be cognates yet have different meanings in their respective languages (Barrow, 2014).

**Scaffolding**

ELLs come into the classroom with all types of abilities and prior knowledge. It is important for educators to work to evaluate the students to get a better idea of what the students know and where they need a bit more help. Scaffolding is a term commonly used to characterize how a skilled individual, typically older, can help a less skilled one to manage a performance by supporting the learner’s efforts at points where the learner is at a loss while hanging back wherever the learner proves able (Greenfield, 1984). Greenfield believed that scaffolding has five characteristics:

1. it provides a support;
2. it functions as a tool;
3. it extends the range of the workers;
4. it allows the workers to accomplish a task not otherwise possible; and

5. it is used selectively to aid the worker. (Greenfield, 1984)

Scaffolding is a great tool to bridge work to meet the abilities of ELLs. Educators should work to help create assignments that students are able to approach and work through with confidence. According to Tan Huynh (2017), the three main forms of scaffolding are sensory, interactive, and graphic. Figure 5 is a breakdown of the forms of scaffolding. Depending on your students' needs they may benefit from sensory scaffolding like videos and films, or physical activities. They may need interactive opportunities like stations, pair work, discussions, or graphics like number lines, charts, or tables. Different students will benefit from different types of scaffolding (Barrow, 2014).

Figure 5 - Graphic that describes scaffolding options by Tan Huynh, 2017
As educators consider the scaffolding needs of their ELLs it is important to work to meet the students’ needs as they progress and content changes. Barrow offered different sentence structures as examples depending on the students’ level of comfortability (2014):

- Beginner: The pattern has________.
- Intermediate: The first pattern has_____, but the second pattern has. Both have____.
- Advanced: While the first and second pattern both have ____, both are different because ____. (Barrow, 2014, p. 38)

These examples of scaffolding would be ready for ELLs to use. Depending on the students’ needs having various scaffolds will help meet the ELLs where they are in their development.

**Summary**

Mathematics involves an astounding amount of reading (Smith & Angotti, 2012). Before educators expect students to be able to master the reading necessary in upper elementary mathematics, educators need to make sure they are giving their ELLs the tools to be successful. Language acquisition takes time, and the vocabulary we expect students to learn can be daunting. Educators need to put the steps into place and provide a setting to create the best opportunity for their students to be successful.

All students begin somewhere on the Edgar Dale (Peery, 2016) stages of vocabulary knowledge. It is up to the teacher and working with the English Language Services in your school to understand where your ELLs are to help them move forward.
Growth of new vocabulary, especially Tier 3 vocabulary, over time with repetition and direct instruction. According to Kamil and Hiebert, expansive vocabularies extend over a lifetime (2005).

Students grow not just from reading in books social interaction can play a key role in students feeling open and confident with new vocabulary. According to Moffett and Eaton (2018), social interaction can help students grow higher-order function. Math discussions in class give students a chance to practice using new vocabulary in a safe area where the educator can guide and correct misconceptions along the way.

Educators can give tools that they can take beyond a single lesson. Graphic organizers can come in many different shapes and offer different benefits. The Frayer Model is a tool that has sections that can be modified to assist students with different needs (Richardson, 2012). The Frayer Model is something students would be able to recreate with ease as they progress into different subjects and into later years of education.

Educators often create a room that is pleasing to the eye as their students enter but also can display useful information. Word walls can offer an interactive display that goes beyond simple words and their definitions. Educators have the opportunity to display interactive and engaging material that students are able to refer back to as they work and discuss new concepts. Depending on the class demographics cognates, when available, are a great part to include to help ELLs engage with Tier 3 vocabulary.

Different students will find motivation in different activities. Integrating technology as suggested by Jim Cummins (2000) gave students modern tools for student
interaction. Giving students tools like computers can help guide students to consider math beyond a workbook and a pencil.

Through direct instruction, classroom discussions, giving ELLs tools that they can rely on and recreate, placing meaningful information around the classroom, and integrating technology educators have a chance to engage with their ELLs at a much greater level than before.

Chapter 3 provides insight into the vocabulary instructional guide to help guide educators and ELLs as they work to acquire Tier 3 mathematical vocabulary in upper elementary grades. Chapter 3 reviews the supporting information, the intended setting, and the timeline the instructional guide will take for an educator to use.
CHAPTER THREE

Rationale

Introduction

The focus of the research is: How can educators support English Language Learners as they work to acquire Tier 3 mathematical language in 5th grade? Tier 3 vocabulary is low frequency and consists of content-specific words. English Language Learners (ELLs) in school come into mathematics facing multiple challenges. They are not only facing the obstacles of learning the necessary content in the math unit, but they are facing the burden that learning new English vocabulary can cause. In the modern classroom, educators are not only expected to teach the concepts in the math unit but are also expected to teach English. As students progress into the upper elementary grades, the vocabulary becomes significantly more challenging especially for students that are working toward English proficiency in reading, writing, speaking, and listening.

Without an understanding of the vocabulary, ELLs have the potential of not just missing out on classroom discussion and instructions, but also misunderstanding textbooks and math problems. The content-specific vocabulary does not just impact one part of a lesson, it can impact an entire math unit. ELLs need the opportunity to have the tools in place for early success to practice the vocabulary throughout the unit. Educators, in turn, need to consider beyond the specific subject or content in the lessons. ELLs come in with different language needs and educators need to consider many options in order to guide them on a path of success.
As ELLs require multiple tools in order to succeed, I believe a specific vocabulary instruction guide must be created for educators to follow to help their students grow, not just in one lesson but throughout a unit. Students need direct instruction with math vocabulary, and not just passively. They need the key vocabulary put up in places where they can regularly see and interact with it. They should have a safe place to use the vocabulary with their peers and they should find ways of integrating it into their use of technology.

**Supporting Research**

Often educators, especially in mathematics, do not expect to consider the need for direct instruction when it comes to mathematics vocabulary. They are so focused on making sure they are teaching math in the correct order, or worried about common misconceptions, that they stop thinking about all the extra language needs that students come into the class with. Math is a vocabulary-rich subject that needs to be supported by educators and given direct explanation in kid-friendly ways in order to give the students insight into the importance of the vocabulary (Goldstein et al, 2013).

A great tool that educators rely on to help students acquire new vocabulary is the Frayer Model. The Frayer Model is a type of graphic organizer that allows students to move information into predictable sections for students to refer back to as needed (Kim & Cha, 2010). These can be modified to meet the students' needs and levels of abilities. Educators are able to help scaffold the organizers with partially written sentences, and they can also add in cognates when possible or direct translations for students. With
direct instruction on how to use the organizer, students are able to bring that tool into other subjects and into later years of education.

Educators do not just need to consider what they give to their students but also what they put up in their room. Students do not just rely on what they remember or what has been handed to them. Often educators fill their walls with useful and inspiring materials. It is important that educators also think beyond inspirational quotes and put material up that students can use and engage with while in class. A great option is to create a word wall. Word walls provide essential words in informational texts that are necessary for understanding the concept of the text and key concepts in the content area (Graves et al, 2013). The vocabulary in mathematics opens up the understanding of lesson discussion, instructions, in textbooks, and in math problems. Word walls provide a consistent place for students to turn for information as they work to master the content and vocabulary in mathematics.

As schools rely more on technology in their classrooms, it is important for educators to find ways to integrate it into the lessons effectively. The use of technology can be a powerful motivator for students especially when coupled with the concept of it being used for project-based learning (Cummins, 2000). Students getting the chance to create word problems using technology and sharing with classmates is using technology to engage students while also allowing them to use content-specific vocabulary in a safe way.

ELLs need not just one pathway into the vocabulary but consistent and fruitful opportunities to use it in the classroom. Getting as many opportunities to engage with the
vocabulary through classroom discussions, direct instruction, word walls, and technology is important.

**Setting**

The average classroom in the U.S. is changing. The classroom is getting more diverse. Teachers’ responsibilities are increasing as state standards grow to meet the increasing changes in our society. To meet those needs and the increasing standards, educators need to think beyond one subject at a time and consider cross-curricular opportunities. Integrating vocabulary instruction into math not only fulfills the needs of ELLs but also other students that need to find more connections in their education.

Different states follow different guidelines when identifying ELLs. These regulations are changing, so make sure you are up to date on how your school and state are identifying your ELL population. According to the WIDA website (May 6, 2020), students in Minnesota begin with an identification survey that is followed by a English Language Proficiency Screener. This would be completed by the school and the English Language (EL) Team at the school. Students are being screened on their proficiency in reading, writing, speaking, and listening. Depending on how they did on their screener they would either qualify for service, test out, or their families could opt out for receiving additional services. Even if the students opt out or test out of EL services, a teacher should still consider the students’ ELL needs as they prepare material and instructions for Tier 3 mathematical vocabulary (Richardson, 2012).

A common misconception of educators is that the only students that need EL services are new immigrants (WIDA, April 2020). This is not always the case. Often
second and third generation immigrants can still qualify for services. Students that are second and third generation immigrants can often speak socially at a high level with their peers and instructors. As some of those students go home they speak in a native/home language. This would lead to a lack of exposure to academic terminology at home. These conversations can be at times that are not always academic based, like cooking, that have transferable language. This puts these students at an unknown disadvantage. Educators should not just rely on the social conversations they have with the students to consider if they would benefit from ELL instructional vocabulary guidance. By going through EL services at one's school and getting to know one's students and their families, one may gain the information that will guide their students to greater success (Kamil, & Hiebert, 2005).

A diverse classroom allows conversations and growth, not just for one student but for many. The vocabulary instructional guide that I am proposing is for classroom use for upper elementary grades. Math Talks using the Tier 3 vocabulary would be best for use in a classroom that has a mix of native English language speakers and some that are progressing to meet the language standards at their individual schools (Kamil, & Hiebert, 2005). Classrooms that have both types of students allow ELLs to hear classmates use content vocabulary in discussions to ease their own understanding and practice. The benefit to native English speakers comes when the ELLs are creating word problems and sharing them with classmates, so they can benefit from the peer-to-peer feedback.

The average classroom size varies across the U.S., which means a teacher may have varying sizes throughout their teaching career. The maximum and minimum number
of students for this classroom vocabulary instruction guide does not have hard lines. However, it would be beneficial to remember that when too many students are involved in Math Talks it may result in some students being left out. If classroom size is a concern, shifting from whole-classroom discussions to small groups or talking with a partner will help increase the amount of sharing each student gets to do.

Staffing availability is another factor that changes over time for teachers. Where additional assistants may be in the room some years, other years the teacher may be the only adult. This vocabulary instructional guide is meant for one teacher to be able to manage the needs of the group depending on the individual needs of the students. Educators should be able to prepare necessary graphic organizers and word walls, facilitate classroom discussions, and guide students on technology to create and share word problems.

**Timeline**

Learning new information, especially new content-specific vocabulary, can be challenging. Unless students are predisposed to the vocabulary, they are not likely to remember it after the first lesson. Students need the opportunity to engage and practice new vocabulary over an extended period of time (Kamil & Hiebert, 2005).

New math units in upper elementary can take weeks and sometimes over a month to get through. With that time frame in mind, an educator needs to start units off with vocabulary instruction followed by regular classroom discussion that is ideally student-led. Once the educator feels that the students have a grasp of both the content and the vocabulary, they could then introduce technology nearing the end of the unit. This
would be a great opportunity for teachers to allow students to review the unit by creating problems containing the unit’s vocabulary to share with their peers (Cummins, 2000).

**Personal Timeline**

In February of 2020 this capstone began with reflecting on what has challenged me in my teaching profession. With consideration of where and who I have taught I have realized the importance of teaching vocabulary in mathematics to upper elementary students, especially those that are learning English as a second language. The project that was created was to be a guide to assist educators. It was important to research the best practices in place as one strategy would not be enough to effectively educate students on Tier 3 vocabulary.

Through the research I was fortunate enough to read about great strategies and important people in the field of vocabulary acquisition. The literature review also provided great insight into the project that I created for myself and others. The project grew as peers content experts provided feedback on what they thought it could include and what it left them wanting to know more about. The project came together as a guide that provides educators with a checklist to go through prior to the math units and materials that provide examples and blank templates for others to use.

**Assessment**

The goal of this capstone project is to consider: *How can educators support English Language Learners as they work to acquire Tier 3 mathematical language in 5th grade?* The effectiveness of the project is founded by using information from experts and the best practices in places for assisting ELLs as they acquire new content-specific
vocabulary. The guide provides educators with a checklist that they can use to assist themselves in preparing for upcoming units. Along with the checklist educators have tools and resources available they can use to create an environment that promotes students learning new mathematical vocabulary.

**Summary**

ELLs require not just one lesson to successfully learn new vocabulary. They need to have repeated exposure after they have been introduced to the words with graphic organizers. Educators need to create a classroom environment that has opportunities for students to return to the vocabulary as needed. Classroom discussions, whether they are with the whole class or in small groups, give students the opportunity to engage with the new vocabulary in a manner that allows them to feel safe to use it. Students should use technology to engage with the vocabulary while creating problems to share with their peers. Educators need to be flexible through the instructional guide.

Often, educators hope that everything will fall into place based on how they set up their classrooms and lessons. Educators need to be flexible to meet their students’ needs and abilities. That flexibility can be over a lesson or over weeks. Classrooms change over time and educators need to meet their students where they are to help them get to where they need to be. Assisting ELLs is not up to just one department but should be the responsibility of all teachers to help meet the needs of their students.
CHAPTER FOUR

Conclusion

Introduction

The focus of my capstone is: How can educators support English Language Learners as they work to acquire Tier 3 mathematical language in 5th grade? As students move into upper elementary classes, the complexity of the subjects increases, and with that, so does the language. Content-specific language can cause ELLs additional challenges that other students may not face. The content-specific language is not just part of the introduction of new material, it is woven throughout the unit in the math questions, the instructions, both written and often spoken by the teacher, and in assessments. Educators more often need to consider the importance of direct instruction of vocabulary for ELLs (Goldstein, 2013) and not just teaching the math instruction.

In chapter one, I discussed my own personal experience of moving to a new country and having to learn a new language. While teaching abroad I worked with students from all over the world who are not just trying to learn English but also learn Swedish while maintaining their home languages. That experience helped shape my understanding of what ELLs go through every day as they work to progress through formal education. In those years of teaching, I was able to try different strategies to help engage my students as they learned not just the expected math for their grade, but also help them work towards mastering the necessary vocabulary. I found that being able to teach bilingually to my students opened up a different level of success, showing to me
that often my students did not fail my assessments due to a lack of understanding of the content but, instead a lack of understanding of the language.

In chapter two, I reviewed the relevant literature of helping ELLs learn new content-specific vocabulary, particularly in mathematics for students in upper elementary grades. This literature review focused on exposing students to new vocabulary with direct instructions, images, classroom discussions, the necessity of repetition, and specific adjustments for ELLs. In my review, educators should not rely on one tool; educators should work to expand the experiences students have in class to engage them with the new vocabulary.

In chapter three, I described the project I created for educators to work with their classes specifically for classes that have ELLs. This chapter included supporting research, the ideal setting, and a timeline that educators should consider when going into a new math unit.

**Capstone Literature Review Highlights**

As I consider the path of completing the research in the second chapter, I recall going in hoping to find the one tool or lesson that would be the key to my ELLs’ success in learning new content-specific vocabulary in mathematics. What I found instead were many different approaches that could be considered and blended together to create the best environment while focusing on taking time in lessons for vocabulary and giving students tools they can use beyond one lesson.

I initially struggled to find specific research on building vocabulary in upper elementary math classes for ELLs. I shifted and began to focus more on what experts
were suggesting to help support ELLs and considered options that have been implemented already in other subjects and worked to find ways to bring it into the math class.

Through completing the literature review I realized how often mathematical vocabulary was put to the side in math lessons. Often educators focus on the content and hoping the vocabulary development would be learned through just hearing the teacher use it. My review of the literature led me to understand the opportunities educators have to help connect students with the content-specific vocabulary on a deeper level.

**Limitations of the Project**

As this project came together, I realized that what I wanted to create would be limited to how it could be used initially and would depend on educators to adjust it and apply it as they saw fit. The vocabulary guide is a supplemental tool for educators to use as a reference point as they begin their math units, as they move through the unit and in preparation for the completion of the unit. As I created the guide, I considered just putting together a math curriculum that had a focus on the vocabulary. I did not consider that as useful as a tool to give to teachers as they help their ELLs progress. I did put in multiple explanations to assist educators to gain a better understanding.

Realizing the limitations of creating a vocabulary guide, I was not able to provide a strict timeframe. Much of the timeframe will depend on the math unit. I did provide a one-month overview of how to approach a generic unit, as some math units may take a couple of weeks while others may stretch well beyond a month. Educators will need to consider and plan their math units in conjunction with my vocabulary guide.
The initial page of the guide is a checklist an educator can use as they plan and go through the unit, allowing for them a chance to reflect if they have taken all the steps and are preparing their students for success. I attempted to leave the checklist to a single page to not overwhelm those using it. On the initial page, I also included brief definitions of items that others may not initially understand if they have not used them before in the classroom.

The limited examples that I included mainly focused on fractions. Ideally, educators do not think of this as a tool only to help in fraction use. This vocabulary guide should be considered going into all math units for the benefit of ELLs.

Application to the Profession

One of the most significant successes of the vocabulary guide was creating something tangible that educators are able to use to reflect and plan for new math units. I consider this project a guide to help educators that need more practice incorporating vocabulary development directly into math lessons to benefit all students but especially ELLs. In my experience, it is important to reflect on the vocabulary that is required in the math unit, not just what is suggested in the curriculum but by going through the unit’s lesson plans, worksheets, assessments, and any potential group work to see what students will be experiencing day to day in the math unit.

ELLs need to be considered as an educator prepares for a new unit. The vocabulary should be taught with purpose and not just passively in the lesson, hoping students will catch on along the way. This tool will help me slow down and consider if I am being as considerate as I should be, and making sure I am giving my students time
each day to practice the new vocabulary, not just in the assignments, but through discussions with classmates.

As I consider my own history as an educator that has worked with hundreds of students attempting to learn English in my math classes, this guide is something that I could have used since my first day as a teacher. As I move forward I will be using this vocabulary guide to help my ELLs with the new and challenging Tier 3 vocabulary and not assume that they will learn through a passive experience.

**Summary**

Overall, this guide is to help educators create a rich environment that allows students to engage with new vocabulary in meaningful ways. Students will be able to use graphic organizers that they will be able to use for years to come, along with having a safe space to work to practice the new vocabulary with classmates. With this guide, educators will be able to challenge themselves if they are giving their ELLs the experience they deserve to be successful in mathematics.

Chapter Four has provided an opportunity for me to reflect on the project for my capstone and also upon my own growth through the process of creating it. Educators know reflection is critical in one’s development and this chapter has provided me with it. This chapter has reminded me of how much I have learned through creating this capstone project. It has provided me with more realization of how much more we all can be doing for our students and that every lesson is another chance to help our students grow.
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Appendix A

Direct Instructions

Figure 1 - Visual representation of change with explicit vocabulary instruction by Goldstein et al, 2017.
Appendix B

Frayer Models

**Definition:**
- The perimeter of a shape is the distance around the edge of the object.
- The perimeter of a circle is called the circumference.
- Common units: cm, m, km,

**Examples:**
The perimeter of this rectangle is $3+7+3+7 = 20$
Rectangle perimeter $= 2(l+b)$

An example of a perimeter is the line where your wall goes on the border of your garden.

**Facts/Characteristics:**
Add only the numbers on the outside of the shape.
All the length outside an object added together

**Non Examples:**
Can’t find the perimeter because it’s not a closed figure.

![Diagram of perimeter with examples and non-examples](https://www.nbss.ie/sites/default/files/publications/frayer_model_-_vocabulary_strategy_handout_copy_3.pdf)
Appendix C
Vocabulary Planning Tool

<table>
<thead>
<tr>
<th>Teach a few well-selected words directly</th>
<th>Teach word learning strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior knowledge</td>
<td>Are there any affixes that should be taught?</td>
</tr>
<tr>
<td>Science practices</td>
<td>Words with multiple meanings? Cognates?</td>
</tr>
<tr>
<td>Science tools</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Provide &quot;rich and varied&quot; language experiences</th>
<th>Foster &quot;word consciousness&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word wall, sketch vocabulary strategies, vocabulary games and enrichment ideas</td>
<td>Student awareness of and interest in words and their meanings</td>
</tr>
<tr>
<td></td>
<td>TARGET Vocabulary</td>
</tr>
</tbody>
</table>

Figure 3 - Vocabulary planning tool for word walls by Julie Jackson, 2018
Appendix D

Scaffolding Diagram

Figure 5 - Graphic that describes scaffolding options by Tan Huynh, 2017
Appendix E

Capstone Project

Checklist

- Determining if the term should be included in the vocabulary guide
  - a. Is it part of your state’s curriculum? If yes, then include selected vocabulary in the unit’s guide.
  - b. Review the math coursebook, instructions, assignments, and assessments are the terms selected needed to be understood to successfully understand the expectations of instructions or problems. If certain words are used repeatedly and necessary for understanding, then consider including selected vocabulary in the unit’s guide.
  - c. Have your students been properly exposed to the vocabulary? If yes, then consider not including.

- Create a Word Wall - a literacy tool composed of an organized collection of words that are displayed in large visible letters on a wall or bulletin board.
  - a. Consider beyond the word and basic definition.
  - b. Provide examples to be posted.

- Complete direct instruction of a Frayer Model - graphic organizer for vocabulary building.
  - a. Consider cognates. Educators may consider including translations to be provided to ELLs’ Frayer Models, especially cognates when available.

- Daily Math Talks - Whole class or small group discussions that focus on creating a better understanding of other ideas regarding the math topics. It should be completed every day for 5 to 10 minutes throughout the entire unit. It can be based on opening discussion or following problems. Students should focus on using the key vocabulary in the unit. Reminders:
  - a. Encourage students to have Frayer Models out to rely on using Tier 3 vocabulary correctly and often.
  - b. The teacher should be moving the conversation forward, correcting misconceptions, and providing feedback.
    - i. Examples of questions:
      1. What strategy did you use?
      2. Do you agree?
      3. Do you disagree?
      4. Let’s see if we can break it down. What would the parts be?
      5. How did you reach that conclusion?

- Students create word problems to share with classmates/peers that focus on including the selected vocabulary from the unit.
  - a. Suggestions:
i. Students create word problems on computers to increase their use of technology.
ii. Students provide peer to peer feedback as needed to help finetune the problems.
iii. Students also send the teacher the problems to review.
iv. Students underline the selected vocabulary from the unit.

Example of a month-long timeline:

<table>
<thead>
<tr>
<th>1st - Monday:</th>
<th>2nd - Tuesday:</th>
<th>3rd - Wednesday:</th>
<th>4th - Thursday:</th>
<th>5th - Friday:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● New math unit begins</td>
<td>● Frayer Model completed in class</td>
<td>● Math Talk</td>
<td>● Math Talk</td>
<td>● Math Talk</td>
</tr>
<tr>
<td>● Review Word Wall</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8th - Monday:</th>
<th>9th - Tuesday:</th>
<th>10th - Wednesday:</th>
<th>11th - Thursday:</th>
<th>12th - Friday:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Math Talk</td>
<td>● Math Talk</td>
<td>● Math Talk</td>
<td>● Math Talk</td>
<td>● Math Talk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>15th - Monday:</th>
<th>16th - Tuesday:</th>
<th>17th - Wednesday:</th>
<th>18th - Thursday:</th>
<th>19th - Friday:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Math Talk</td>
<td>● Math Talk</td>
<td>● Math Talk</td>
<td>● Math Talk</td>
<td>● Math Talk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>22nd - Monday:</th>
<th>23rd - Tuesday:</th>
<th>24th - Wednesday:</th>
<th>25th - Thursday:</th>
<th>26th - Friday:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Math Talk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 29th - Monday: | 30th - Tuesday: | | | |
|----------------|---------------|| | |
| ● Math Talk | ● Unit Assessment | | | |
Word Wall Example:

**Word Wall**

**Numerator** (numerador): The number that is written above the line in a fraction. It tells how many of the whole you have or how any parts are being considered.

**Denominator** (denominador): The number below the line in a fraction. It shows how many equal pieces the whole has been divided into.

Frayer Model Example:

**Definition:** The number that is written above the line in a fraction. It tells how many of the whole you have.

**Word:** Numerator

**Example:** 2

**Non-example:** 3

**Synonym/Cognate:** numerador (Spanish)
Frayer Model Blank:

<table>
<thead>
<tr>
<th>Definition:</th>
<th>Synonym/Cognate:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Word:</td>
<td></td>
</tr>
<tr>
<td>Example:</td>
<td>Non-example:</td>
</tr>
</tbody>
</table>

Math Talk Guiding Expectations
1. The classroom should be a safe and accepting environment for students to share their ideas.
2. Daily Steps:
   a. The educator provides a math problem.
   b. The educator allows time for students to solve the problem mentally or on paper as needed. A nonverbal cue can be used to communicate the student has solved the problem. Students use their Frayer Model as needed.
   c. The educator gathers a variety of answers
   d. Students provide insight into the strategies used to solve the problem, beginning with an incorrect answer, followed by a correct answer. Students should focus on using the Tier 3 Vocabulary from the current and prior units.
3. The educator is a facilitator in the process. The educator should be a questioner, a listener, and ready to learn alongside the students.
4. The goal is to build an understanding of vocabulary and the mathematical relationships in the unit.
5. Use math problems are relevant to the lesson and unit to allow students to increase connections and opportunities to practice using key vocabulary to the unit.
Math Talk Example

- Math Problem:
  - **Skip counting by 1/4 starting at 0.**
  - Allow students time to write or consider the answer mentally. Look for students to have written down or indicated completion showing a nonverbal sign.
  - Gather as many students’ responses as possible. Write down all answers giving, correct or incorrect.
  - Engage students to begin discussion and encourage students to use their Frayer Models to use the vocabulary. Engage as many students in the discussion as possible. Consider Turn and Talk strategies as needed. Possibly opening question:
    - **Explain how you got your answer?**
      - Ask another student if they agree or disagree and why.

Writing Word Problem Expectations for students

1. Decide what type of word problem you plan to write (i.e. add, subtract, multiply, divide).
2. Choose numbers that are reasonable.
3. Write at least a statement and a question.
4. Underline the keywords from the unit in your problem.
5. Make sure you can answer the question.