Literature Review

Our number sense journey began in Mrs. Vicki Peterson’s kindergarten classroom at Longfellow Liberal Arts School on Tuesday and Thursday mornings. We originally worked with the students in groups to see if we found any interesting patterns or developments within the students. However, we found after a couple of weeks it was more beneficial to work with the students one-on-one because each student’s individual abilities were more apparent to us when we could focus one at a time. This allowed up to make the instruction more personal based on each student’s skill level and abilities. From here, new questions emerged about the students’ number sense abilities day after day.

A particularly striking aspect of the children’s thinking involved their confusion with the academic language involved with number sense. We were working on the students’ knowledge of number sequence and patterns when we noticed that students were mixing up several concepts that included number sense academic language. By this we mean that through activities involving dominoes, cards, and the iPad application Line ‘Em Up, students were having trouble determining the difference between the academic language greater than, more, after and less than, less, before. We came across this limitation because as the teachers, we were accidentally interchanging these words, thinking that the students knew the difference in meanings. However, we noticed overtime that a student, for example, understood what “greater than” means when comparing two numbers but could not determine a number that came “after” one of those same numbers. Meaning, we presented this student on a number line the numbers 13 thru 20. The student understood that 20 was “greater than” 13 and that 20 represented “more,” but did not know that 20 came “after” 13. This pattern overtime showed us that academic language really comes into play when learning number sequence. This raised our question of how does academic language impact students’ number sense abilities? Even further we became interested in researching different methods, strategies, and approaches as to how teachers can be aware of incorporating the academic language into the students’ development of number sense.

Through our literature reviews, we found very informative and strategic information that will benefit our future lessons with the students struggling with number sense academic language. Miller (1993) states “students’ understanding of mathematics is dependent on their knowledge of both mathematics as a language and the language used to teach mathematics.” This connects directly to Mrs. Peterson’s classroom because there are definitely varying levels of mathematics and number sense abilities. Those abilities are determined by exposure and practice in the students’ lives up until that point in time. Understanding vocabulary, or academic language, is very important because math vocabulary is sometimes unique to the subject and not familiar outside of the classroom. Therefore, if the vocabulary is not understood since it is at times like a foreign language, students are handicapped in their efforts to learn math (Miller 1993). Miller(1993) also emphasizes the role of teachers creating a learning environment that encourages students to make the language connection to concepts outside of math. This is sometimes where teachers fail in the connection of academic language to the math subject because students are only hearing this language in one context, resulting in no actual grasp of the concept . This is why Miller (1993) suggests several strategies within the classroom to ensure better understanding: modeling appropriate language for your students, ask students to define words in their own language, use writing to make the language connection, put together cooperative groups to work together, and encourage students’ use of vocabulary throughout the
classroom. These are all strategies that teachers can use and implement into daily instruction that will benefit the students’ number sense abilities. While we are not the homeroom teacher that is with them all day, there are only a couple of these strategies that will work well with the small amount of time we have with the students.

“Miller (1993) also describes the particular issues that English Language Learners (ELLs) face when learning math. Miller notes that math education cannot be the subject that is ignored in terms of the needs for a multicultural classroom. Within this environment, being sensitive to other cultures and understanding the different cultural expectations for classroom discourse should be studied and implemented within the math classroom. By encouraging a multicultural classroom, the teacher can also encourage students to express their sociocultural understanding of mathematics, which we can in return learn from that as well. Knowing and emphasizing to the students that there is more than one way to interpret math is important. Also, for the ELL students, clearly writing and carefully pronouncing new math vocabulary will help ensure students are understanding accurately in order to place each term within a meaningful context (Miller 1993). There is a range of student needs that must to be taken into consideration when teaching math to young students. The diversity amongst students in a teacher’s classroom is one need to be accounted for when introducing new mathematical language. ELL students may need additional support or resources to ensure that the students understand the math content and are able to participate in classroom discussions (Adams, Thangata, & King, 2005). Oral retellings, pictures, and writing assignments can help support learning as well as provide evidence for the teacher to mark ELL progress in academic language. In the early elementary grade levels, students are learning how to read, write, and are introduced to basic mathematical concepts, such as number sense. An effective approach to teaching mathematical academic language to students is to begin introducing math concepts at the same time students are learning how to read and write (Rothman & Cohen, 1989). This will not only benefit English speaking students who are learning math and reading, but also benefit the ELL students who are learning English in addition to math concepts and reading. The goal is to begin early practice and introducing concepts early on to support further growth. Eventually students will not only learn how to read math problems, but begin comprehension practice so that when students are asked to solve math related problems there is an understanding of what is being asked of the student regardless of the students primary language. Rothman and Cohen (1989) state that learning math symbols should be introduced at the same time students are learning the letter symbols of the alphabet. Early introduction of symbols and mathematical language into the classroom can only help students become more familiar with mathematical concepts. We found this information of the article to be particularly relevant due to the high number of ELL students that are within Mrs. Peterson’s classroom. We have noticed some of the struggles that those students face, and these strategies will allow us to take a different approach in terms of vocabulary and hopefully making those concepts more meaningful for the students.

Thompson and Rubenstein (2000) make the claim by saying, “Unlike common English, the language of mathematics is limited largely to school.” Rarely, students will use mathematic vocabulary outside of the classroom. This backs up Miller’s emphasis that math language is unique and needs to be approached in that manner. As teachers, we often forget that the words and phrases that are familiar to us are foreign to our students until we find a way to make it familiar and understandable. The language of math is important because it is the means of communication of many of the concepts. Students also build their understanding of the math as they process those ideas through the language that is learned. And lastly, we teachers assess students’ math understanding by listening to their oral and written communication of the language (Thompson & Rubenstein 2000), therefore it is important they understand it in order to be assessed. This demonstrates why math academic language is crucial to understand first in
order to understand the rest. Thompson & Rubenstein (2000) also suggest many strategies in order to promote this language development. The strategies were given according to several types of learners: oral, written, visual, and kinesthetic. For oral, they suggest working in groups on problem-solving tasks offers opportunities for students to “talk” about the math. In addition, having students respond in unison or choral response was helpful to find a rhythm with the language. For written strategies, having students keep a journal and each day you provide a prompt for the students to answer about the math concepts learned prior. After this, allowing students to check one another’s writing to determine validity and clarity requires a different level of thinking than just writing for oneself. For visual learners, using picture dictionaries in which pictures are connected with written descriptions in the students’ own words. And lastly, for kinesthetic, using manipulatives to provide concrete examples for students. This allows students to feel why things are different or the same, making the meaning concrete (Thompson & Rubenstein 2000). Looking all together, these are very helpful when it comes to finding the appropriate strategy based on the individual, as at least one of these will work. This was something we struggled to meet the needs of each student because we were not knowledgeable enough in academic language strategies in order to accommodate to each student.

Steele (1999) argues that mathematical language develops through a child’s personal experiences and communication the same way that literacy and language, in general, develops in students. Rudell (2009) states that the more actively involved students and teachers are in meaningful demonstrations of the language, language will be developed to make real life connections. Students will learn new vocabulary in a more meaningful way if students are presented the content with active experiences and tools that connect to the language. Since language and meaning develop together children need to acquire new language in a way that will connect to the student’s current understanding rather than introducing an entire new set of vocabulary words (Steele, 1999). Mathematical language can be puzzling to the students when first being introduced due to it’s limited used outside of school. Therefore students are not practicing mathematical language as much as their native language. However, through social interaction students can assist one another as they organize their thoughts about mathematics. A teacher needs to avoid introducing academic language that may have two meanings or through word and definition memorization (Rubenstein & Thompson, 2002). A better method is for teachers to create classroom activities where the students are using all types of skills, such as reading, writing, and drawing to support a student’s mathematical understanding in a way that is familiar. Even further, teachers can create a print-rich environment where the words are displayed in the classroom. Rudell (2009) suggests because of languages abstract nature, having the words displayed in the classroom are necessary for visualization and making connections.

Rubenstein and Thompson (2002) also examined the difficulties that students have when learning new academic math language. They identified eleven different categories where students have misunderstandings based on the mathematical language that develops in math class. In first grade the common new words introduced to students are square, foot, and odd. These words have different meanings mathematically than when the words are used in everyday English. For instance, students may hear foot for the first time in a math lesson and assimilate with foot as a body part. Or, students may read the word odd on a homework assignment and think odd as being an adjective, which would be incorrect in a mathematical setting. In terms of kindergarteners the categories that are most relevant are those that focus on the connection between mathematical language and everyday English. Since kindergartner age students are still building everyday language, introducing mathematical language needs to be approached correctly to prevent any confusion arising in the future (Rubenstein & Thompson, 2002).

The goal of any strategy used by teachers needs to be connecting new terms and phrases to ideas that children already know and are relatable through previous experience. From there a
teacher can introduce activities that build upon concepts, which begins an informal process of understanding. Eventually the new academic language and concepts introduced to the students will solidify and the teacher can use these words in class discussion without having to stop and restate the meaning of the word (Rubenstein & Thompson, 2002).

One method used to teach mathematical language to kindergartners is through children’s literature. The teacher can provide meaningful learning by using literature, because children’s books foster cognitive growth and productive thinking. One example given in the research was using the story Jim and the Beanstalk to discuss the concept of adding and subtracting. The book created a setting and then manipulatives that connected to the story were used in hands-on activities to develop the understanding adding and taking away. The method of using literature in math lessons resulted in higher math achievement test scores, increases interest in mathematics, and increased the mathematical vocabulary amongst student conversations during free play or recess (Jennings, Jennings, Richey, Dixon-Krauss, 1992).

Keeping all of this literature information in mind, we find that it supports our hypothesis of academic language having an impact on students’ number sense abilities. We found through the literature that without making the mathematics language connection with real life contexts and situations within the classroom, students are likely to fall behind or completely miss the concepts. From here, the next step in our number sense project was to incorporate these strategies we learned from the literature into Mrs. Peterson’s kindergarten classroom during our number sense hours. We believed that these strategies can positively affect our students in a way that we have not been able to reach before.

Ever since we noticed students were not making the connection between the different vocabulary words we began using the words more frequently in daily conversations and math activities. Prior to finding the literature we were interchanging the math vocabulary words, which confused the students. Now when we work with students we are more knowledgable on using words that the students understand and can confidently demonstrate their abilities.

Even though we are not in the classroom daily we did take one approach to teaching students the concepts less than, more than, greater, less, before, and after. In order for students to understand the vocabulary we used manipulatives, technology, and real world context. For example, we used domino chips, shapes, and playing cards as manipulatives to demonstrate and guide student’s understanding of quantity to connect to more than and less than. When using technology we primarily focused on using the iPad application Line ‘Em Up to demonstrate number sequence which connects to understanding the ideas before, after, greater than, and less than. In terms of real-world context we made connections to order, sequence, and the concept before and after by lining the students up in a line with the instructors. Since students are familiar with lining up in a line we were able to use this concept as a way to explain that the student standing in front of you is the student “before” you; the same way a number is before another number on the number line.

After using the strategies, which were modified from the literature, we noticed a difference in students responses to our assessment. Not only were students more confident in stating the answer, but they were more aware of how all the vocabulary terms intertwine. Student A and Student B (Jenna and Noemi) were two students confused by the vocabulary terms used at the beginning of our number sense research. After we started incorporating our strategies into the math lessons we noticed that Students A and B were making a connection to content they were familiar with rather than content they never heard of. Student B understands that a number before a number on the number line will be less than any number that comes after that particular number on the number line. That in itself is an abstract concept when not having a number line to look at as a reference. Our goal is for students to visualize the number line and understand why numbers are located where they are at on the number line. We feel that the strategies we used
helped us reach towards the goal and have seen student improvement in their understanding of mathematical terms along the way.

Because we are not the classroom teachers we are limited to the impact we can make four hours a week with the students. For the future, there are many strategies that we noted in our literature findings that can be implemented on a daily basis throughout the entire school year. Our impact has been since November 2012 to May 2013, twice a week, for a total of over 60 hours. Even though we’ve only spent a small amount of time in the classroom with the students, we can only imagine the impact we could have made if we were there for more hours per week or even being the classroom teacher.

When beginning this research process, it did not occur to us that other teachers were having the same struggles to connect with their students in terms of math academic language as we were. While our situation is on a smaller academic scale since the students are only in kindergarten that we are working with, the same issues still were present in our classroom as in many of the other older grades that we read about.

While we did not find literature that directly related to our specific situation in number sense, we were able to accommodate and adapt these strategies to the individual needs of the students we have been working with. For example after reading an article on ELL students, we now realize a better approach to teaching mathematic academic language to enhance their learning and understanding. Keeping these specific approaches in mind makes us more aware of the environment that we are creating for the students. Another example in the research are strategies to connect to students based on what type of learner they are such as oral, verbal, written, and kinesthetic. This opened our eyes to the ways we can approach teaching mathematic academic language in multiple ways that will benefit the individual learner and not all learners as a group.
**Works Cited**


