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The Effects of Daily Math Talks on Number Sense Development in a Kindergarten Clasroom

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Abstract

The purpose of this research was to determine the impact that daily Math Talks have of the number sense development of Kindergartners. The study consisted of 22 Kindergarten students in a midwestern school. The data was collected over the course of four months using pre- and post-intervention self-assessments, observational teacher notes, NWEA standardized test scores, and Seesaw video recordings. Results show a positive correlation between daily Math Talks and increased number sense skills. The data shows positive effects on foundational number sense skills and mathematical ability and can be actively integrated into classrooms to help support student achievement and growth. It is my recommendation that daily Math Talks are implemented over the course of the school year as a part of daily classroom routines.

Keywords: mathematics, number sense, math talks

When looking into the day of a Kindergarten classroom, one subject that most would see being taught is math. Also, it would be expected to observe a large amount of discussion, talking amongst students and teachers. Research has shown the importance of class discussions and conversations, along with the development of math skills in younger grades. What if these two vital life skills are put together? Teachers have been using classroom discussion as a teaching strategy for many years, but it is not frequently associated with mathematics. Talking about math and using mathematical strategies has a positive impact on student achievement.

Math Talks are short whole-group conversations revolving around using various mathematical strategies and concepts. The focus is not on the answer but rather the process, which encourages students to develop the ability to see the relationships between numbers and utilize various strategies. These Math Talks help teachers to promote foundational number sense skills in their students. The focus is on solving problems mentally and then sharing answers and strategies with others. From the age of 5, students learn the importance of the fluidity of numbers and the many different ways that they can solve a problem. Implementing Math Talks gives students the ability to grow their conceptual understanding of mathematics, as opposed to only solving problems using memorized procedures. In the classroom, Math Talks have been shown to help students develop a deeper understanding of how numbers work along with building a greater sense of confidence in their mathematical abilities.

A strong ‘number sense’ is the ability to think fluidly and flexibly with all numbers along with understanding how numbers relate to one another within the number system. People with a good sense of numbers have the ability to see the world in number terms and quantity, and have

the ability to interpret when, for example, 50 is a large amount or when it is not (Shumway, 2011). By promoting the fluidity and relationships between numbers at a young age, students can build confidence in their mathematical abilities along with creating a strong base of knowledge of the multitude of ways a problem can be solved.

Research shows that number sense is a strong predictor of later mathematical success and low number sense in primary grades can lead to later mathematical difficulties (Witzel, Ferguson, & Mink, 2012). In addition, many schools stress the importance of these skills and integrating additional practice to build foundational number sense skills in their elementary students. Number sense is a thought process, and personalized to each individual, with the development being a lifelong process. With number sense development being unique to each student, teachers address these skills in many different ways. It is difficult for teachers to address the need to develop crucial number sense skills while only following the provided curriculum.

According to Parrish (2010), increasing whole-group mathematical discussions within elementary classrooms, while incorporating strategy sharing among students will positively impact the number sense of students. Though there is research showing the importance of number sense skills, many curriculums do not provide and promote adequate development of these skills in Kindergarten students. Many students possess the procedural skills to solve various math problems but lack the knowledge of how and why they are using these procedures. Consequently, there is a need to gather information and data using outside resources to introduce Kindergarten students to various mathematical strategies and learning to verbally share their ideas and thoughts with others. Through these daily discussions and problem solving, students will develop an understanding of the fluidity of numbers, by being able to compose, decompose,

subitize, and represent numbers in several ways. By using these strategies, students will be able to solve mathematical problems in a multitude of ways, building a strong foundational sense of numbers to be used for in their future mathematics. Therefore, the purpose of this action research project is to explore the impact of math talks on the number sense skills of Kindergarten students.

Theoretical Framework

Cognitivism, as a learning theory, states that learning is an active cognitive process that focuses on the internal processes and mental connections that take place during learning. Cognitive learning maintains that prior knowledge and mental processes play a large role in overall learning (Yilmaz, 2011). This theory places emphasis on what learners know and how they acquire the information instead of what they do with the learning/the external outcome. Cognitivism highlights the idea of making known information meaningful and using a learner's schema to help organize new learning and relating new learning to prior knowledge (Yilmaz, 2011).

Math Talks allow a teacher to use cognitivism to help students refine their thinking process. By challenging students to mentally recall and use different mathematical strategies, students are activating their prior knowledge while also building upon their schema to learn and observe additional strategies. As a whole, Math Talks focus on the internal thinking process of students, which is a key aspect of cognitivism. Cognitive learning theory helps shape the overall development of this study through utilizing students' prior knowledge, along with verbally explaining students' internal problem solving skills and thinking processes.

With using students' prior knowledge and schema, they are able to further their overall number sense development, a skill essential to mathematical success. Throughout this study, many aspects of cognitive learning theory were utilized with a focus on students verbalizing their thinking. Daily Math Talks concentrate on providing students with the ability to explain their ideas and thought processes, a key aspect of cognitivism. By explaining their ideas and strategies, students have the opportunity to further develop the foundational number sense skills at a young age.

Literature Review

Number sense is a complex but essential skill for young children to develop (Witze et al., 2012). Without a proper foundation in number sense, it becomes increasingly difficult for students to make computations and identify the relationships between numbers (Pittalis et al., 2018). As students build foundational number sense skills, mathematics take on more meaning and understanding (Shumway, 2011). When mathematics becomes more than rote memorization and numbers, students can actively apply these skills in their lives outside of the classroom. As students develop further understanding of how numbers relate to each other, number sense deepens and mathematical achievement rises. According to Witzel et al. (2012), number sense in primary grades is a reliable predictor of mathematical achievement in upper grades. The development of a young child's number sense is linked to mathematical achievement in a similar way that phonological awareness has been linked to reading proficiency. Mathematical achievement is necessary to succeed in many current and future career paths and daily activities, as society's focus on technology and mathematical reasoning grows (Lago & DiPerna, 2010).

Components of Number Sense

Number sense encompasses several larger foundational mathematical concepts. When put together, these components make up the essential skills of mathematics that students will build on in their future years of education. According to Jordan, Kaplan, Olah, & Locuniak (2006), there are six key components that makeup number sense as a whole. These components are: 1) counting, 2) number knowledge/identification, 3) number relationships and patterns, 4) estimation, 5) quantity/magnitude discrimination, and 6) fluency with numbers.

Counting is one of the first skills developed in early mathematics. When children are young, counting aloud is similar to singing a memorized song. While they know the names of the numbers, they likely do not understand the full meaning behind the counting principle. Although many students enter Kindergarten being able to count to ten, this does not encompass all aspects of counting in early elementary grades. There are several different variables of counting. To develop proper number sense, students need to master all principles of counting (Linder & Powers-Costello, 2011). One-to-one correspondence is the ability to be able to count objects individually, along with attaching a counting/number word to each object. This is attained when students realize the stable order of numbers, which means that no matter what number they start counting at, they know the order will remain the same. Another aspect of counting is the order irrelevant principle. This attribute explains that the number of objects will not change, no matter what order they are counted in and how they are counted. Cardinality is another essential element of counting. This is achieved when a child can identify how many objects are in a group without individually counting them.

Shumway (2011) enumerated three major areas of numeracy. One of these areas is basic number knowledge and identification. This means that a student knows what a number represents

and is able to correctly name and write the number. Recognizing relationships between numbers and the overall pattern to numbers is an equally important aspect of number sense. Students understand that there is a pattern to all numbers that never changes. This component of number sense builds overall number combination fluency and automaticity.

The third component of number sense is estimation. Students use their number knowledge every time they make an accurate estimate. Along with being able to estimate, students need to understand the concepts of quantity and magnitude. Quantity is the knowledge that mathematics is not just about an individual number but about the amount/quantity that the number represents. Magnitude is the ability to make comparisons between two numbers. With strong number sense, a student sees the number 50 and knows that 50 students in a classroom is a large amount while 50 grains of rice is a small amount (Shumway, 2011). Strong number sense allows students to use numbers to make comparisons and formulate a mental number line.

Lastly, fluency with numbers is a critical aspect of number sense. This is the ability to compose and decompose numbers without thinking, with automaticity. In order to be on track with developing a strong number sense, students should be able to compose and decompose numbers 1-10 in the early elementary years, before 3rd grade (Kline, 1998). This ability allows students to be flexible and effective in their problem-solving skills.

Development of Number Sense

How can teachers best support students, when number sense encomasses many foundational skills? The teaching of number sense requires a conscious, well-planned effort by a teacher (Tsao, 2011). Every student's number sense is unique and a direct by-product of teaching for understanding (Pittalis et al., 2018). Teachers need to go beyond flashcards and simple

visuals. To best support their students' learning, teachers must guide and model thinking, language, mathematical strategies, and number representations (Parrish, 2010). There are three mathematical interventions that are research-based and proven to support and guide number sense development in Kindergarten students. These three interventions include intentional subitizing practice, a number of the day routine, and daily math talks.

Subitizing is the ability to quickly name the quantity of objects/dots without having to count. Concrete subitizing skills are linked to later mathematical achievement along with being a strong predictor of mathematical abilities (Newbury, Wooldridge, Peet, & Bertelsen, 2015). One way to teach subitizing skills in the classroom is through the use of quick images. These can be dot pattern cards, dominoes, or ten frames. Teachers show students the picture for a few seconds and challenge the students to name the quantity that they saw. By only showing an image for a short time, it diminishes the tendency to count objects by ones and encouraging students to recognize groups of numbers (Shumway, 2011). By fostering subitizing skills within the classroom, students are encouraged to find different ways to picture a number and describe what they see. This intervention promotes collaboration and discussion of ideas. Through this practice, students dramatically increase their number fluency and recognize the flexibility of numbers (Kline, 1998).

In addition to incorporating subitizing into a classroom, teachers can also integrate a number of the day routine into their lessons. Having a number of the day is an opportunity for students to recognize that there is not one right way to express a number. Students are challenged to represent a number with pictures, words, different equations/combinations, and any additional was that they discover (Burton, 2010). Through this daily activity, students can practice, model,

and reinforce various math skills and mathematical language. This intervention supports and encourages students to think of a number in a variety of ways along with how it can be composed and decomposed into other numbers.

Along with representing a number in many ways, this intervention also allows teachers to enhance mathematical vocabulary and conversations. Teachers can expand their students' thinking through questions such as "When is ____ big?" and "When is _____very little?" By incorporating these questions, students are encouraged to relate these numbers to different scenarios in their own lives (Shumway, 2011). The Number of the Day intervention gives students the opportunity to relate a number to their own lives and identify how quantities are composed. With thorough modeling, students can represent a number with coins, tally marks, pictures, equations, and any additional ways to make a number. When utilizing this strategy, teachers encourage students to think about a number in various situations and meanings. Students can expand their thinking beyond the number itself and look at its magnitude, size, and relationships with other numbers. Students are able to realize that a number can mean different things in many different situations (Shumway, 2011).

Another useful number sense intervention is the implementation of daily math talks in the classroom. Teachers can guide mathematical discussions and understandings through math talks. Through thinking aloud and posing specific questions, teachers can model how many different ways and strategies there are to solve a problem (Newbury et al., 2015). Some of the benefits of Math Talks include 1) giving students the ability to clarify and explain their own thinking 2) providing students with a multitude of effective problem solving strategies 3) demonstrating the relationships between numbers in a meaningful way 4) being exposed to and testing different

strategies, then deciding if they are logical in a mathematical sense and 5) gaining the ability to choose which strategy would be most logical for specific problems (Parrish, 2010). By being actively engaged in mathematical thought and language, students will develop higher competencies—classroom lecture is exchanged for learners talking, sharing ideas, and learning from one another. Through these conversations, students are encouraged to express their views using mathematical vocabulary and accurately justify their thoughts to others (Walshaw & Anthony, 2008). By verbalizing mathematical reasoning, students can identify their thinking, which discourages impulsive math problem-solving skills (Witzel et al., 2012).

Mathematical Difficulties with Poor Number Sense

Given the benefits of developing a strong number sense, what happens when a student does not learn these foundational skills? Students with poor number sense have difficulties and are at a higher risk for struggles and mathematical failure. Some of the identifiers of poor number sense include the inability to subitize, and struggling to identify relationships between numbers. Many mathematical learning difficulties can be related to number comparisons, relationships, and counting skills (Sood & Jitendra, 2011). Number sense is a skill that develops over the course of several years and matures and strengthens with practice and experience. If a student is missing critical aspects of foundational number sense, they are less likely to achieve the same level of success and understanding of later, more advanced mathematical skills (Pittalis et al., 2018). Studies have indicated that number sense development is a strong predictor of mathematical achievement and difficulties in higher grades ex: especially 3rd grade, with more advance number computation and problem-solving skills (Yilmaz, 2017). With gaps forming without number sense skills, Jordan et al. (2006) study shows that early intervention in

Kindergarten and 1st grade is an ideal time. Studies by Sood and Jitendra (2011) have also shown that students with number sense interventions in Kindergarten outperform students in mathematical tasks and number identification skills.

Through intensive research and finding peer-reviewed articles relating to number sense, there were several key findings that emerged. Giving students the support and opportunity to build a strong background in their number sense skills sets them up for further mathematical success and the ability to build upon these skills (Yilmaz, 2017). According to Lago and DiPerna (2010), it is best to intervene before any mathematical problems arise. The sooner an issue is identified, the fewer gaps will form. There are several interventions that teachers can use to foster number sense in their students. Some of these strategies include developing subitizing skills, setting up a number of the day routine in the classroom, and incorporating math talks into each day.

Through this research, teachers can discover the importance of developing number sense skills in our students. When engaged in meaningful, intentional mathematical learning experiences in early grades, students are much more likely to participate and excel in mathematical learning in the upper grades. Through these mathematical experiences, students will learn vital skills that are crucial for not only navigating higher education but for navigating through life's demands (Linder & Powers-Costello, 2011).

Methodology

This study was conducted in a regular education Kindergarten classroom with 22 students. Several pieces of data were gathered during, before, and after the research. The Kindergarten students were assessed using the Northwest Evaluation Association (NWEA) K-2

Math test. This test is designed to assess mathematical abilities of students, while being able to highlight key skills that students need additional support with along with focusing of the areas where they excel. Students took a baseline NWEA test at the beginning of the school year and then took the NWEA test again in the spring. This is a standardized and required test that assesses students overall abilities and their growth over the course of the school year. Teacher observational notes were taken during Math Talks that recorded: overall student participation, strategies used to solve problems, willingness to share ideas, and the problem posed to students. In addition, a self-assessment was given to students prior and after the study to compare any shifts in their overall attitudes towards math, and their confidence and interest in using different strategies along with sharing them with the class.

The population for this action research study was Kindergarten students at a small K-8 parochial school in the Twin Cities area. The sample included 22 Kindergarten students from the end of January to April. In this sample, there were 14 females students and 8 male students. Of these 22 students, there were 5 ELL students and no special education students. The study was integrated into regular class time, as a supplement to the mandated mathematics curriculum.

The first method of collecting data for this study was pre- and post- self-assessments. The students were asked to record their thoughts and perceptions about their math skills by answering five specific questions. These questions were designed to gather information about each student's feelings towards math and how comfortable they are with sharing and talking about mathematical strategies. The Kindergarten students circled their feelings using 1-5 picture scale with 1 being not at all/a negative response to 5 being very positive/a strong response. The statements included: "I can solve math problems," "I am good at math," "I can explain how I

solve math problems," "I can use different strategies to solve math problems," and "I like to share how I solve math problems with others." (see Appendix A). The researcher read all questions aloud to ensure that all students heard the question and answered the correct statement. The same self-assessment was administered both pre- and post- research to gauge students' beliefs and attitudes about mathematics and to track any possible shifts in responses.

Once the pre-self-assessment was administered, it was time to start the Math Talks. Each Math Talk coincided with mathematical strategies from Sherry Parrish's (2010) *Number Talks: Whole Number Computation.* This text was used throughout planning to align problems and to introduce students to a variety of mathematical strategies. Math Talks were implemented as a warm-up for our daily math lesson and are designed to last anywhere from 10-15 minutes. Math Talks were done with students sitting on a carpet, with the teacher in front of them.

Math Talks began with the teacher and students reviewing the procedure and naming off possible strategies that can be used to solve problems. After the quick review, a problem was written on a Clevertouch board, it was read aloud by the teacher, and then, students were given time to solve the problem, along with thinking about which strategies they used to solve the problem. Students were given think time and once they had come up with an answer, they would hold up his/her thumb at their chest. If students quickly came up with a strategy they used/an answer, they were challenged to try solving the problem using another strategy. This allowed think time for students along with giving advanced math students an additional challenge. By using a silent thumbs up, the students were able to indicate that they had come up with an answer/strategy and it did not distract or overwhelm other students.

Once students had sufficient time to work through the problem independently, usually around 2 minutes, the teacher called on students to share the strategy that they used to solve the given question. Students were challenged to not only give an answer but share how they got to their answer. Prior to starting Math Talks, students learned about the importance of not only the answer but, more importantly, their ideas and ways that they solved the problem. It was important that students shared their thinking process with their classmates. Students were then invited up to the Clevertouch board to share their strategy. Some students wrote their strategy on the board while other students verbally explained their process. For each Math Talk, 4-5 students shared their strategies. After students shared, the teacher concluded the Math Talk by focusing on one specific target strategy. Some of these strategies included: making doubles, counting on, counting back, using a number line, making 10, using fingers, and skip counting.

Throughout the Math Talks, the teacher recorded observations including: student participation, strategies used, patterns noticed, misconceptions that needed to be retaught, along with any other relevant information observed. All recorded information was logged in a Math Talk Teacher Log (see Appendix B) and kept for later reflection and data analysis.

Throughout the study, students also recorded themselves solving math problems using Seesaw. Students were recorded once the first week of the study, once during the 4th week of the study, and once during the final week of the study. Students were given a math problem, and then recorded themselves and their thinking process using the Seesaw app. Students recorded themselves verbally explaining their thinking process along with identifying the math strategy that they chose to use and why they chose to use that strategy. The teacher was able to then

watch their response, gauge their strategy use, compare their verbal responses pre- and post-Math Talk intervention, and identify any similarities/differences with other students' responses. A fourth piece of data that was collected and compared were NWEA K-2 math test scores. These standardized tests are mandatory and measure student growth in several key areas of mathematics. Kindergarten students took this test in their 5th week of school in the fall, in late September. The Spring testing was completed the last week of April. Once Spring testing was completed, all data was collected and analyzed. Using this data, the teacher was able to compare and contrast the measurable growth and change in students' mathematical abilities along with observe strategy use during the test. Throughout the Fall and Spring tests, students had the opportunity to use scratch paper to help them solve all problems. Any scratch paper was saved for record of problem solving skills and mathematical strategy use.

The overall goal was to improve students' use of mathematical strategies and increase their comfort in verbalizing their ideas and methods to solve problems to increase overall number sense. Over the course of the next section, data will be analyzed to help understand if the use of daily Math Talks were beneficial to students' number sense.

Analysis of Data

The raw data for this study was in many different forms including: standardized testing scores, student self-assessment responses, teacher logs of short statements/notes, along with logs containing mathematical strategies used. Pre- and post- self-assessment response data was logged by student number, so that responses could be compared. Class responses for self-assessment questions were averaged, in order to see the overall shift in student response, if there was one.

Data gathered from Seesaw recordings was noted in a Google form, marking what specific strategies used by each student. Strategy use was categorized by topics and target strategy used. While recording and organizing data, common themes and strategies were noted as categories. Data was categorized into several different strategies such as: making tens, counting on/back, subitizing, using fingers etc.

Throughout the Math Talks, notes were taken by the teacher, recording participation and strategy use. The teacher analyzed these notes, totaling how often each student participated, along with noting which strategies were used the most and/if mathematical strategies were used more effectively over the course of the intervention. Lastly, the NWEA standardized K-2 Math test was given at the end of this study. Results of this test were logged and compared to Fall results, focusing on the overall growth of students, if there was any.

The purpose of this study was to identify the effects of Math Talks on student number sense development at a Kindergarten level. For this study, data was collected using a wide variety of ways, making sure that both quantitative and qualitative data were accumulated. The four primary sources of data were comprised of a pre- and post- self-assessment, 3 Seesaw recordings of students solving problems and verbalizing their strategy use, NWEA standardized testing results from Fall and Spring, and teacher observations, recorded in a teacher log.

The first research question that this study addressed examined the degree that daily Math Talks and strategy use affect students' number sense skills. This question was answered in two different ways. One way that this question was answered was through the use of an observational log, which kept track of student participation, strategies used, and any misconceptions that students had throughout the Math Talks. The teacher noticed a trend of student engagement and

participation throughout the use of daily Math Talks. Prior to the study, math period began with a math warm-up such as choral counting, counting on, or skip counting with a neighbor. The higher achieving students were not actively engaged, since they had mastered the material. The Math Talk routine showed a high level of participation, at first from the higher achieving students and as students became more confident in their ability to share ideas, lower achieving students shared their ideas.

Prior to the study, students were often hesitant to share their answer and idea unless they were positive that they had the correct answer. Through the use of Math Talks, students became more willing to share their ideas and takes risks, even if they were not correct. The teacher and class focused on how a problem was solved opposed to the correct answer. The teacher also observed that throughout the study, many more students were actively participating and sharing ideas. When the teacher asked for volunteers to share their ideas and strategies, there were often only two or three volunteers at the start of the study. At the end of the study, the teacher found that nearly every student wanted to share their strategy uses and ideas. Due to the high levels of participation, the teacher would draw names of students to share their ideas, opposed to calling on individual students. Students were encouraged to try solving the problem in different ways, to show the uses of several different strategies. At the start of the study, students were consistently using basic strategies such as counting on or using their fingers. By the end of the study, students frequently used strategies such as skip counting and making groups of ten, which involve a more complex understanding of numbers, along with greater number sense skills.

The researcher also used a pre- and post- self-assessment of students, which focused on their attitudes and confidence in math, using strategies, and assessing student views on math. All

five questions were rated using the Likert Scale (strongly agree to strongly disagree.) Once a pre- and post- self-assessment were completed, all the results were averaged and charted in Figure 1 to compare the overall difference.

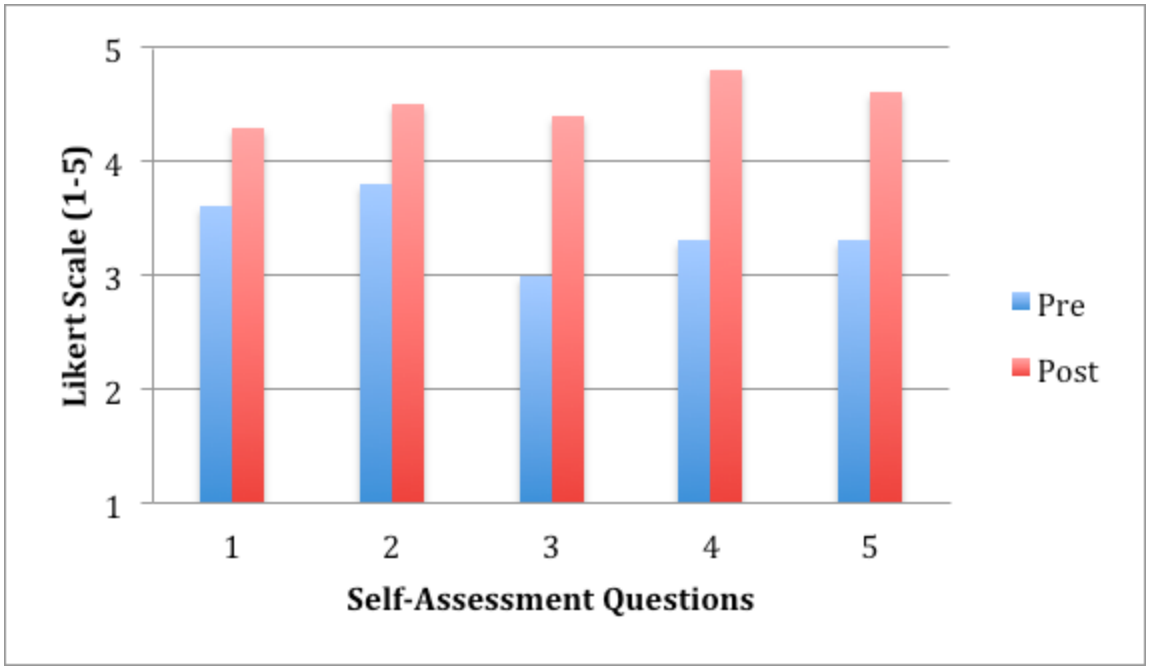

Figure 1. Classroom pre- and post- self-assessment results.

All five questions saw an increase in overall attitude and confidence in the use of mathematical strategies, talking about math, along with students' confidence in their own mathematical abilities. When looking at the individual responses, there were no students that saw decreases in any areas. Many students increased in at least 2 questions, while students who ranked their feelings towards math as lower on the pre- self-assessment saw large gains. The average ranking for all questions was a 4, which translates to agree. The two questions that correlated to the research question the most where question #2 and #4.

Question #2 stated "I am good at math." This question directly relates to student confidence and attitude toward mathematics in general. Figure 2 highlights the responses of

students to this question prior to the Math Talks intervention. 41% of students agreed that they were good at math prior to the intervention while 37% of students were neutral or disagreed. With 22 students surveyed, this means that there were 8 students that did not think they were good at math prior to the intervention. Through this study, one focus was to boost overall confidence in students, in terms of mathematical ability and problem solving skills.

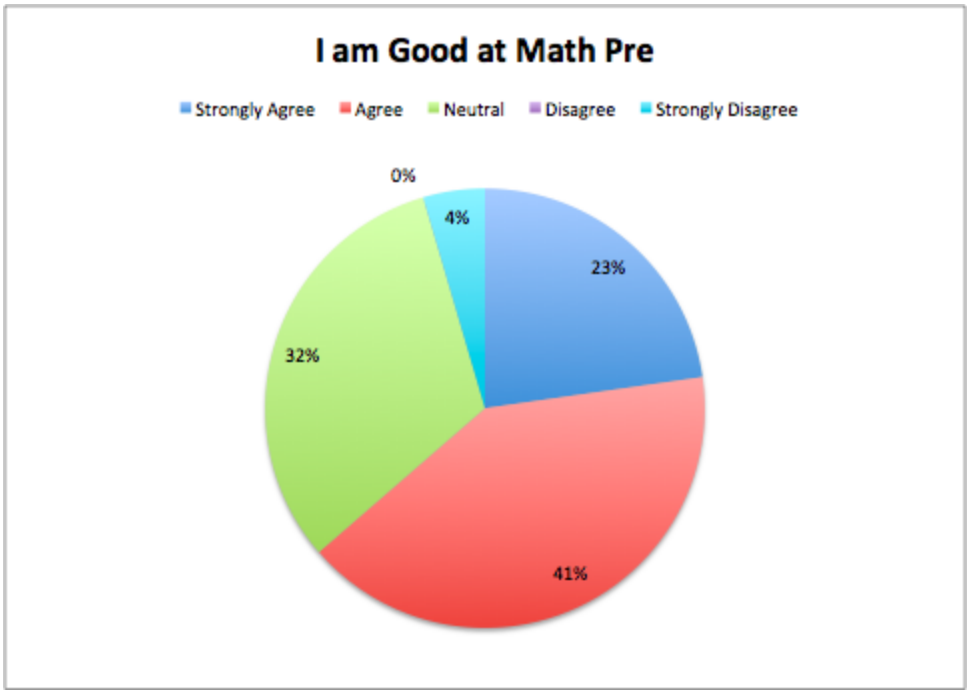

Figure 2. Question #2 Results Pre-Intervention.

Question #2 post-intervention results showed a large amount of growth for the 22 students. By the end of the intervention, all students agreed or strongly agreed that they were good at math. This data shows overall growth in student confidence and belief in their abilities. By the end of the intervention, 45% of students strongly agreed that they were good at math, while the remaining 55% of students agreed that they were good at math.

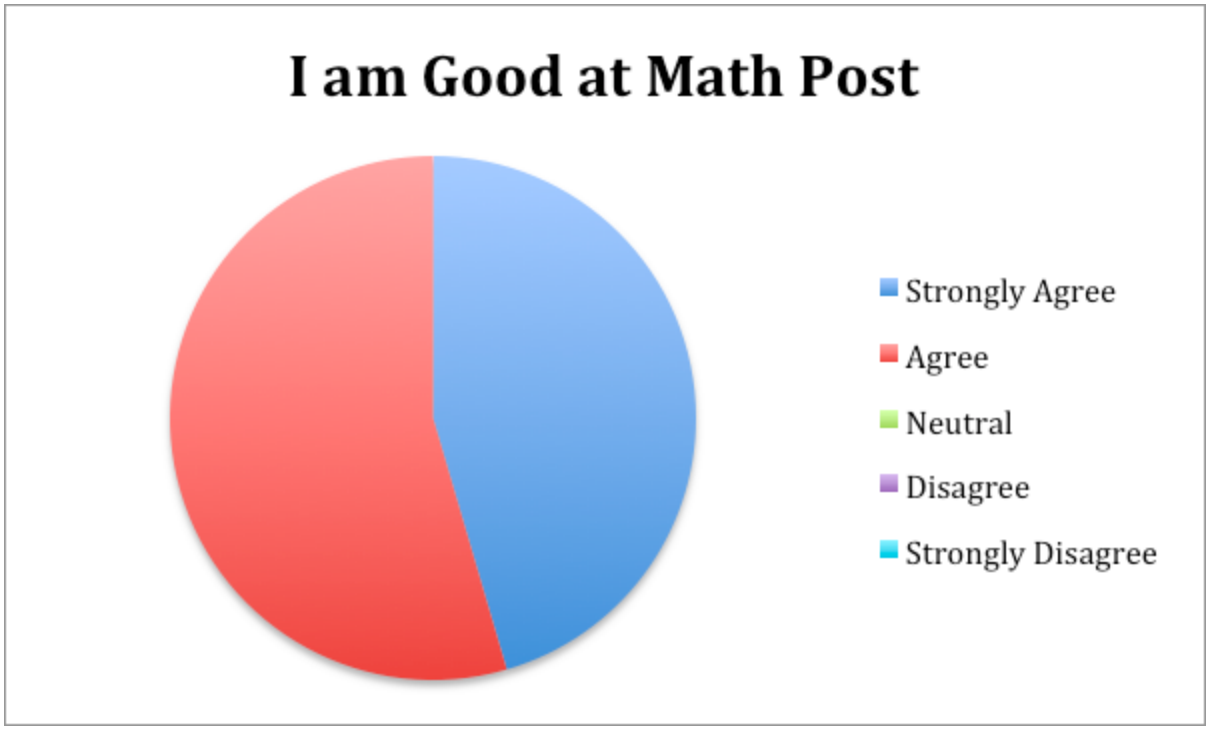

Figure 3. Question #2 Post-Intervention.

The second question that showed a large amount of growth was questions #4 "I can use different strategies to solve math problems." As seen in Figure 4, the majority of students, 41%, were neutral on their ability to use different mathematical strategies to solve problems. Pre-Math Talk intervention, students had not been taught many different strategies, and the data showed that a low 9% of students strongly agreed that they are able to use different mathematical strategies, along with 14% of students strongly disagreed that they were able to use different mathematical strategies.

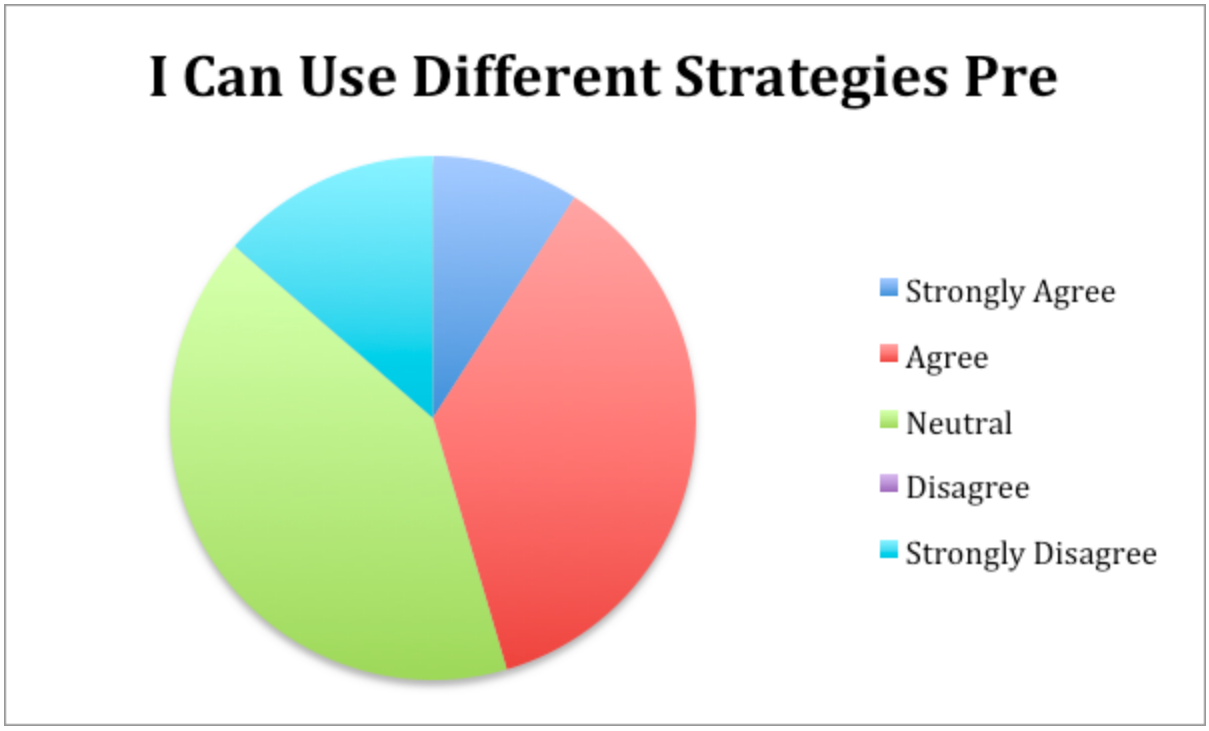

Figure 4. Question #4 Pre-Intervention.

The results of Question #4 post-intervention were largely different from the pre-intervention results. All 22 students agreed or strongly agreed that they could use different strategies to solve mathematical problems. 77% of students strongly agreed that they could use mathematical strategies opposed to the 9% that strongly agreed in the pre-intervention self-assessment. It could be deduced that through the implementation of daily Math Talks and reviewing different mathematical strategies, students became more confident in their abilities and more aware of different mathematical strategies through the repeated practice.

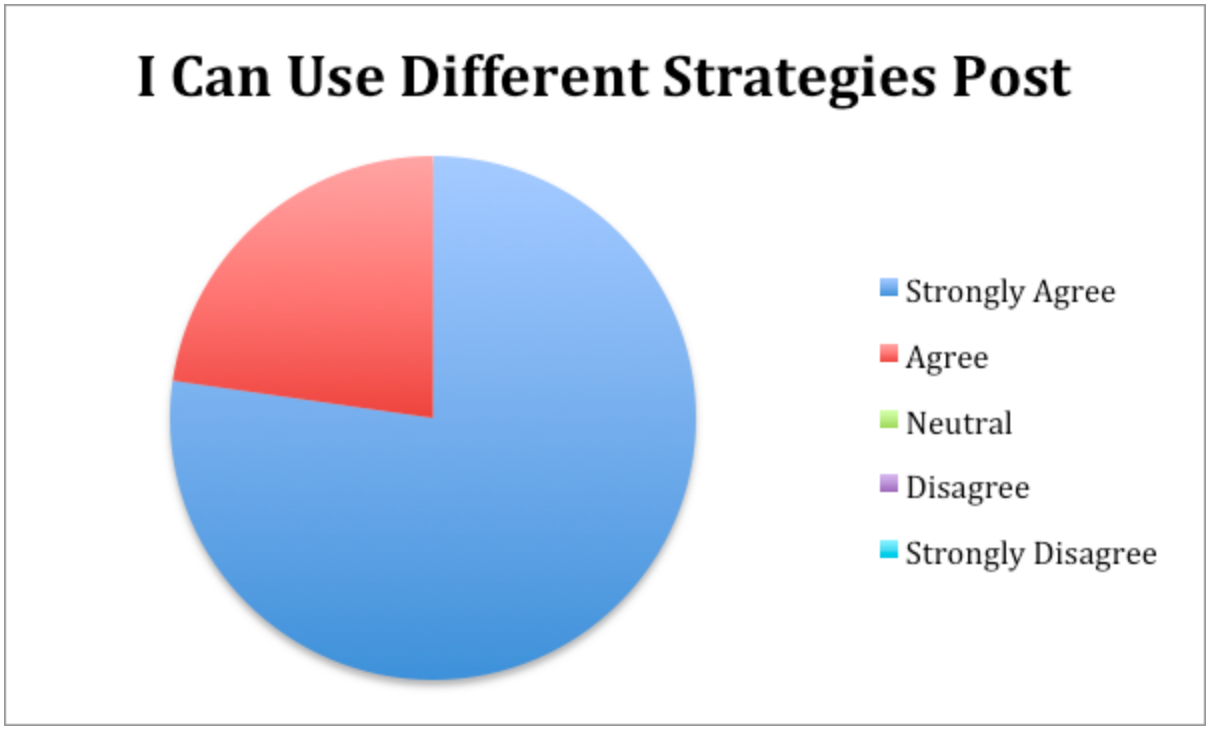

Figure 5. Question #4 Post- Intervention

The last research question that this study addressed was if there was a direct correlation between students' ability to discuss how they solved a math problem and the outcomes on mathematical assessments. To answer this question, the researcher compared standardized test scores from Fall to Spring, which was taken directly after the Math Talk intervention. In addition, the researcher also utilized Seesaw recordings of students solving math problems, to track mathematical strategy use, problem solving skills, and overall outcomes of the assessment.

NWEA standardized test results offered information into the overall gains and growth in mathematical skills over the course of the school year. This study was ongoing over four months of the school year. When comparing the results of NWEA tests, there were no students that scores went down and all students showed overall growth. The national average NWEA math score at the end of the year in Kindergarten is 159.1, which the majority of students surpassed.

19 out of 22 students scored higher than the national average score, which highlights the gains made by students.

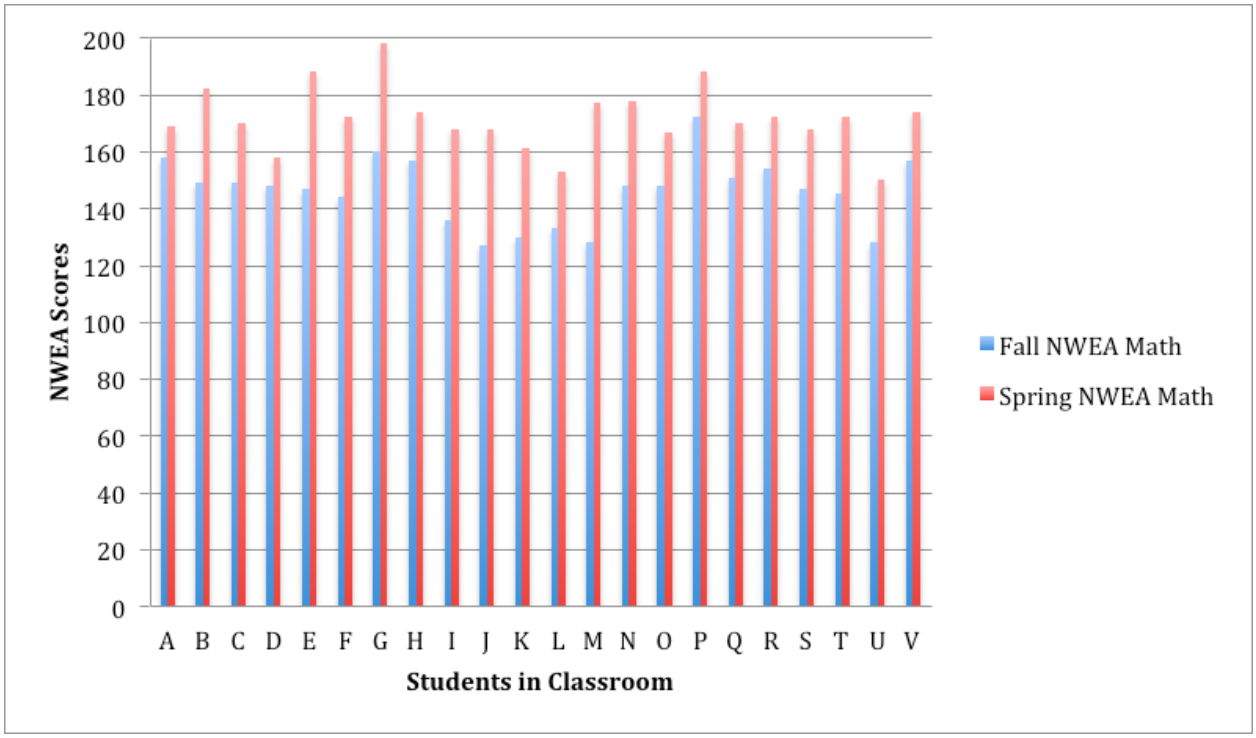

Figure 6. Classroom Fall and Spring NWEA scores

Another aspect of the NWEA math test scores that the researcher focused on was the overall growth of students. The national average amount of growth was 19.1 points. When averaging overall growth of this class, their average growth was 25.5 points. Figure 7 highlights the breakdown of NWEA growth throughout the course of the year.

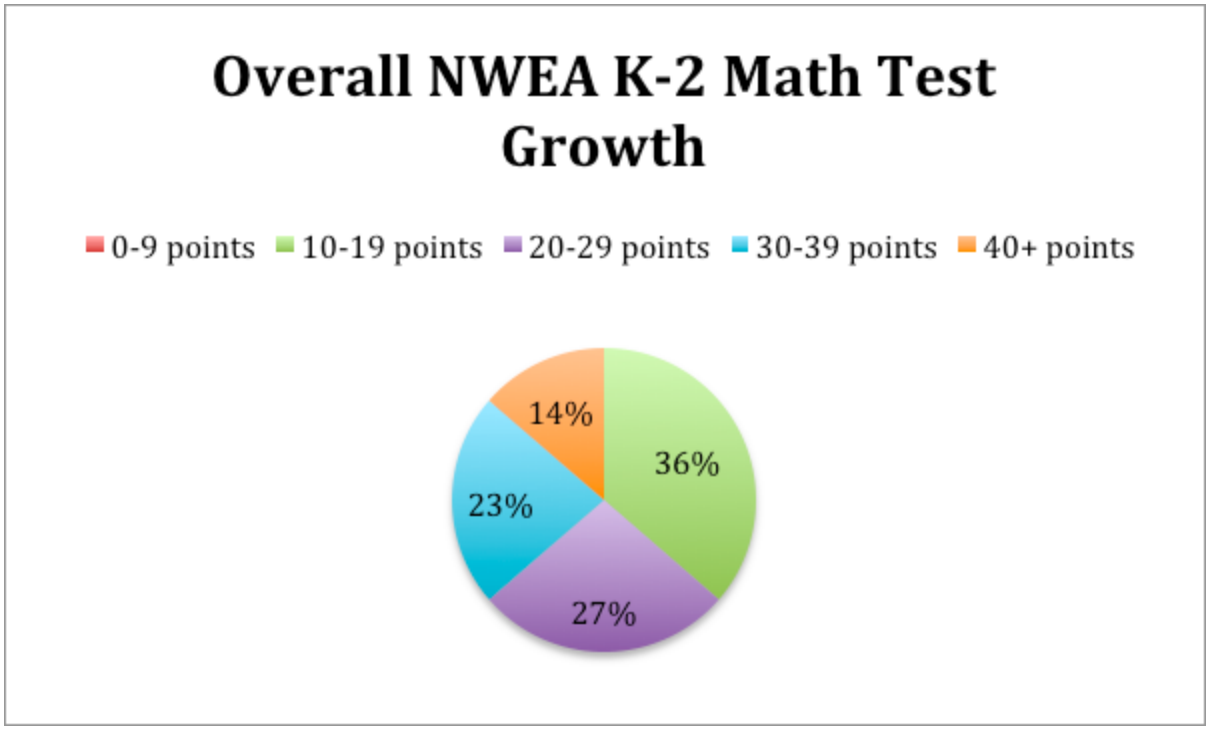

Figure 7. Overall NWEA Growth from Fall to Spring

With the average growth being 19.1 points, there were 36% of students that fell within that range. There were 37% of students (8 students) that grew by over 30 points. These students were a combination of those that were low achieving in the Fall, along with higher achieving students that scored in the 99% percentile in the Spring.

The fourth aspect of data that was used to report findings was Seesaw recordings of students solving math problems given to them. Each problem was based on subitizing skills, which is a prominent aspect of number sense development. Students were given a group of objects and asked to identify the amount of objects that were there. Figure 8 shows the

progression of strategies used by students.

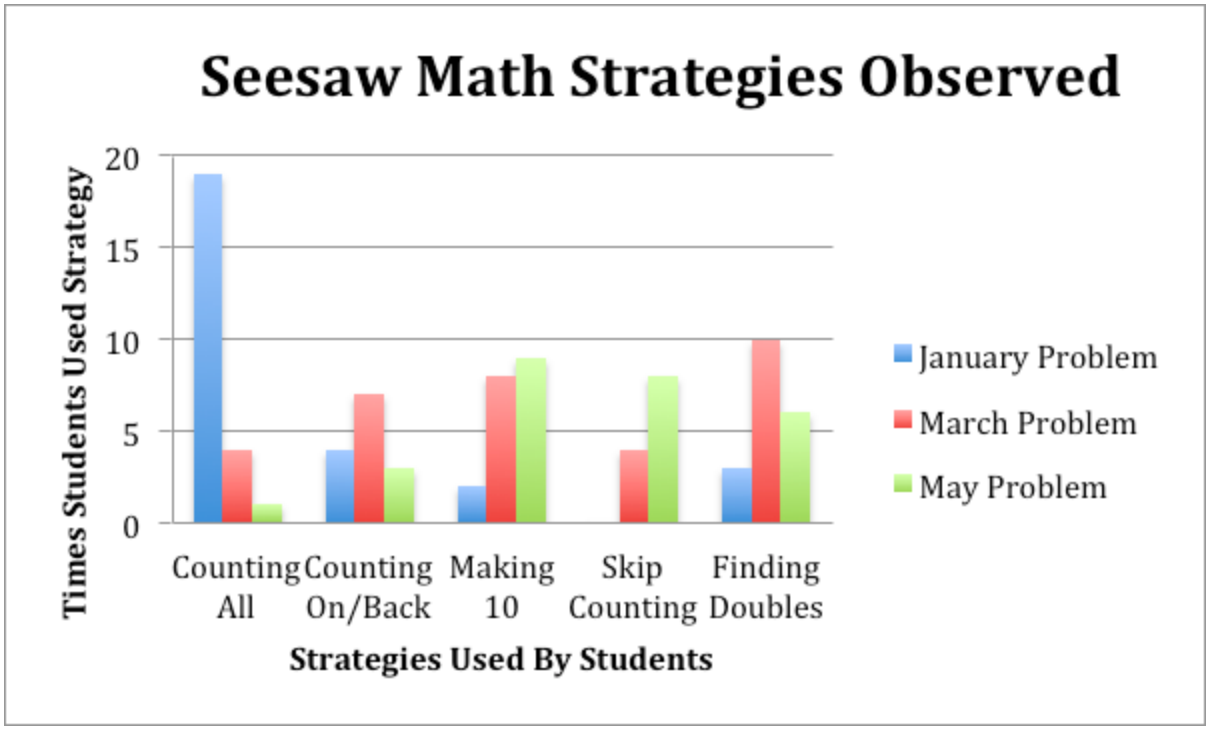

Figure 8. Seesaw math strategies Observed from January to May

When comparing the mathematical strategies used in January compared to the mathematical strategies used in May, it can be seen that there is a significant change between the months. In January, nearly all students used counting all objects as their main strategy. Over the course of the study, students shifted from using a basic strategy of counting all to more complex strategies such as making groups of ten and skip counting.

Through analyzing all four of the data instruments, there is evidence that daily Math Talks have a positive impact on Kindergarten mathematical abilities and overall number sense. In the next section, an action plan will be addressed about what was been learned from examining the data. The analysis includes the impact on student participation, confidence, and how Math Talks have impacted student learning, along with how the results of this study will

shift current teaching practices. In the action plan, recommendations of how Math Talks can be integrated into a classroom, improvements to the current study, and what additional action research studies could take place around number sense development and Math Talks.

Action Plan

After reviewing the data and results of the study, it is evident daily Math Talks had a positive impact on Kindergartners' number sense skills and self-efficacy of their capacity to be successful at math. Over the course of this study, students were introduced and became familiar with multiple mathematical strategies that provided them with the ability to improve their overall number sense and further understand the relationships that numbers have with one another. At the foundational Kindergarten level, when students are still learning the building blocks of mathematics, daily Math Talks provide students with the opportunity to discuss their thinking, ideas, and how numbers work with their classmates.

Based on the findings of this study, the following conclusions were drawn:

- Daily Math Talks give students the opportunity to build a repertoire of efficient mathematical strategies, which improve overall number sense skills.
- Classroom conversation surrounding daily Math Talks provides students with the ability to make mistakes and analyze their individual thinking process.
- Math Talks boost student confidence in their mathematical ability and allow students to think flexibly and efficiently when given a problem.

By giving students the ability to verbalize their ideas and thinking process, students gained confidence in their abilities and were able to clarify their own thinking. One benefit of students verbalizing their ideas was the ability to investigate their own thinking and

misconceptions. During Math Talks, wrong answers happened daily. This provided students with the opportunity to find misconceptions in their thinking along with the chance for students to learn from their mistakes. Misconceptions provided the ability to analyze and question thinking. This process helped develop the belief that mistakes happen and that everyone makes them. Students discovered that they had the opportunity to learn from their mistakes. By learning from their own mistakes, students had the ability to dig deeper into their ideas, thoughts, and were guided classmates through similar misconceptions. Students began to play a key role in their own learning, taking initiative and leading the overall conversation and lesson.

As shown in the data instruments provided, daily Math Talks helped to further challenge higher achieving students, while helping the lower achieving students grow and develop their skills. Through the use of daily Math Talks, students were able to direct their own learning, which led to many in depth mathematical conversations. By students analyzing their own/their classmates' ideas, strategy use increased. By learning several key mathematical strategies, students were able to see number in a more complex way, opposed to only seeing them in basic forms. Students began to understand that numbers can be manipulated and represented in many different ways. This discovery led to students developing a stronger foundational number sense, which will help them with further mathematical instruction.

After much examination of the data, the researcher discovered the following recommendations to further the overall number sense development and mathematical achievement:

· Daily Math Talks should be integrated into all primary classrooms, opposed to only one Kindergarten classroom.

· Further implementation of verbalizing mathematical ideas and thoughts should be integrated into mathematics curriculum, in addition to traditional concepts.

· All teachers will need adequate training and materials to properly facilitate Math Talks, using the same method as the other teachers in the building.

· Daily Math Talks should be introduced to students at the beginning of the school year as a part of the daily routine.

By incorporating these changes into my school and classroom, Math Talks have the ability to change the way students understand numbers along with giving teachers the opportunity to provide in depth mathematics instruction. In the future, fellow teachers will be invited into my classroom to participate in and observe Math Talks in action. By providing the tools and the data, it is my hope that fellow primary teachers will want to implement Math Talks into their classroom so that all students may reap the benefits of them. By implementing Math Talks into other classrooms in my school, it is the hope that students will be able to reach their full mathematical potential in the future and be adequately prepared for later mathematical challenges.

Math Talks gave students the opportunity to grow in overall confidence, skill, and problem solving skills. Throughout the course of this study, I observed students struggling one week, discovering a new strategy, and then excitedly sharing a thought the next week. With this growth, students had the chance to share their knowledge with classmates and further increase their confidence. As students began to further strengthen their foundational number sense skills, strategies became more in-depth and complex. With the development of students' foundational

number sense skills linked to later mathematical achievement, Math Talks set students up for later success (Shumway, 2011).

I have developed a further understanding of the importance of developing the number sense skills of my students. Mathematical achievement is a vital part of life for future careers and the daily lives of students. By integrating Math Talks and mathematical reasoning skills into their thought process at a young age, teachers are giving students the opportunity to thrive in mathematics and problem solving. Just as students need to learn letter sounds prior to reading, students need foundational number sense skills prior to learning more complex mathematics.

Throughout the course of preparing this study, implementing Math Talks, and analyzing the data, the overall importance of using research and individual classroom data to help drive instruction was clear. I plan on using the results of this action research project to develop more in depth instruction surrounding mathematics and better supporting beginning number sense skills in my Kindergarten classroom. This action research project provided me with the opportunity as a teacher to further my own education and best practices. By implementing this study, not only did my students have positive results, but I was able to deepen my own understanding of my students' thinking processes. This growth is something that will help my students in all areas of their academics and personal growth for years to come.

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Appendix A

Name: _____

Math Talk Self-Assessment

I can solve math problems.	
I am good at math.	
I can explain how I solve math problems.	
I can use different strategies to solve math problems.	
I like to share how I solve math problems with others.	

Appendix B

Math Talk Teacher Log

Date: Math Talk Focus:	Strategies Observed: ❑ Grouping by 10 ❑ Using a number line ❑ Finding Doubles ❑ Counting On/Back ❑ Counting All ❑ Counting on fingers ❑ Using a 100's chart ❑ Other strategy
Outline of Lesson:	Resources used:

Appendix B

Student Participation:	Student Notes:
❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5 ❑ 6 ❑ 7 ❑ 8 ❑ 9 ❑ 10 ❑ 11 ❑ 12 ❑ 13 ❑ 14 ❑ 15 ❑ 16 ❑ 17 ❑ 18 ❑ 19 ❑ 20 ❑ 21 ❑ 22	

Reteach/Additional notes: