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IMPROVING STUDENT LEARNING AND NUMBER SENSE THROUGH THE
COMBINATION OF COOPERATIVE LEARNING AND NUMBER TALKS

By

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

Hamline University

Saint Paul, Minnesota

April 2021

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CHAPTER ONE

Introduction

Overview

Imagine a young boy in second grade who had no confidence in himself or his academic abilities. This young boy was me; I had no confidence in school or myself because the teacher intimidated me. My parents wanted to blame the teacher because it was her last year before retirement, but in fact, it was not the teacher's fault at all. It was my responsibility, because I was not confident in my decision-making, and I was not equipped with the skills necessary to improve my confidence. I was on the verge of being held back. My struggle is one reason I decided to pursue a career in education. The empathy I have for students is driving this Master's degree capstone project which will help teachers help students feel successful.

Chapter one examined the personal accounts and professional accounts, the rationale, and a summary of the project's importance. Through personal accounts, I address the struggles that I had in my youth with mathematical confidence and number sense. I explain the impact that both have had on me as I progressed as a student.

Professionally, chapter one addressed struggles observed in sixth grade students that I faced as a teacher. I describe the areas that have been impactful to me as a teacher as I journey forward in my teaching career. Also described, are the areas of concern I have in my students.

To understand the rationale behind this project, I discussed the importance of addressing number sense with a focus on flexibility and conceptual understanding of numbers through interventions, such as cooperative learning and Number Talks, as well as the reasoning behind blending number talks and cooperative learning. The purpose of this project is to address the essential question; *How do math interventions with a focus on number sense, primarily number*

flexibility and conceptual understanding of numbers, coupled with cooperative learning improve mathematical literacy for elementary students?

Finally a summary of chapter one was provided. The summary covered all that has been addressed in chapter one and the connections that this chapter has moving forward into the rest of the chapters.

Personal Context

This topic is very personal to me, I was a kid who struggled with confidence and lacked the development of number sense. I was held back in second grade, which at the time was devastating; but looking back, it was the best thing that ever happened to me. My second opportunity at second grade gave me the confidence I needed to be successful. My new second grade teacher, Ms. M., did something my first second grade teacher did not, she created cooperative learning groups. Through these groups I started to build my confidence and started to participate and share more with my class. It started to show in school and outside of school; instead of being a shy person with low confidence, I was now becoming a positive leader.

I am a seventies and eighties kid who lost all confidence my first time in second grade, but was able to gain it back the second time in second grade. I am also the kid who learned how to do math one-dimensionally; there were no other options growing up and going to elementary school. All of my teachers taught math in the same one-dimensional way. They essentially had a fixed mindset, which means they were limiting the ability of their students to achieve success in math (Dweck, 2006). I do not blame any of my teachers for the lack of exposure to different problem solving strategies because at the time this was how math was taught. It was a philosophy of how fast could you solve the math problems instead of showing and explaining how you arrived at an answer. Completing timed math tests on addition, subtraction,

multiplication, and division was commonplace. Three minutes were given to complete 50 math problems and it always appeared to be a competition, because there was always one kid that would excel in completing all of the exams. Timed tests are not bad if there is a foundation for learning behind them; however, historically this was most often not the case. It was not until junior high I learned about flexibility of numbers and conceptual understanding of numbers. I remember it like it was yesterday.

Seventh grade began with a math teacher who had a very fixed mindset; he would only teach one way to solve the math problems. Again, I struggled understanding how numbers worked and was nervous when I did not know the answer. My parents recognized this struggle and moved me to the other math teacher, Mr. W. That is when my mathematical understanding changed. Mr. W. taught many different strategies that could be applied to any situation. I remember adding the numbers $28 + 38$, Mr. W. taught me to add two to 28 to get 30 and then add two to 38 to get 40. Then, add $30 + 40$ to get 70 and, lastly, subtract the four that were added to the beginning thus getting 66. He taught me that numbers can be flexible and there is more than one way to solve problems. With my second grade teacher Ms. M. and my seventh grade teacher Mr. W., I was able to gain confidence in school, mathematics, and myself.

Professional Context

Several instances have inspired me to complete this project as it pertains to professional growth and development. While taking classes at Hamline to obtain my teaching license, I had a math professor that reinforced the manner in which I learned math in junior high. My professor taught me the importance of understanding the processes to solve problems and that it is not about the answer. Through his class, the importance of teaching number flexibility and conceptual understanding of numbers to improve number sense was shown. He reinforced

seeing numbers in a different way and that there are many solutions to each problem. While completing a case study on an individual student, the opportunity to see how the student thinks and current mathematical comprehension surfaced. Analyzing a student first hand, showed the differing learning paces of students and the manner in which they view learning.

All kids progress and see math differently. Giving clear instructions in lessons and asking open-ended questions to gauge student understanding is critical. This manner of teaching allows students to grow mathematically and should be woven into lesson development to allow for students to advance mathematically. My Hamline University math professor inspired me to make a difference in my classroom.

My first year of teaching math was a whirlwind. Classroom management while delivering a meaningful instruction was challenging. I used techniques to improve my sixth grade students' number sense through our district appointed intervention, Number Talks. Number Talks is a series of five to ten minute math sessions that was created by Kathy Richardson and Ruth Parker (Humphreys & Parker, 2015). One focus of Number Talks is to promote sense making of math through the flexibility of numbers (Humphreys & Parker, 2015). Numbers Talks also focuses on building number relationships, which lead to a strong foundation of conceptual understanding of numbers (Hughes, 2018). Using math coaches, experts, and researching new pedagogical techniques provided a deep understanding of the philosophy behind Number Talks and its effectiveness. In my experience, some sixth graders struggled with confidence and number sense; closing the learning gaps with definitive strategies for these students was of great importance.

An overall need to improve confidence in the classroom for sixth graders was also needed. Cooperative learning was a tool that had a positive impact. Cooperative learning is a

pedagogical construct that focuses on learning through social interactions with each other to accomplish a primary goal (Gillies, 2014).

By combining cooperative learning and Number Talks, students' confidence and number sense was improved. Research has provided many techniques that should be used to improve number sense and research has provided several cooperative learning strategies to improve a student's confidence, but little research has combined both of them together. With research and analysis on number sense and cooperative learning, strategies were used to prove the importance of using them in conjunction. Together these techniques could improve student number sense and confidence in mathematics as the students move forward in their academic careers.

Rationale

I was inspired to work on this project due to a combination of many events that have occurred throughout my life. The struggles that I went through as an early elementary student, a junior high student, and a college student to the successes I found in each of these areas have motivated me to make a difference and improve the learning of students. As an elementary student I struggled with confidence but was able to find it because of a teacher. As a junior high student I struggled with conceptual understanding of numbers, but again was able to find it because of a teacher. As a college student at Hamline University I struggled with understanding the flexibility of numbers, but again was able to find it because of a professor. It is these stories and experiences that have inspired me as a teacher to try to make an impact on the lives of my sixth grade students.

In the classroom, I have observed my students struggling with their basic math facts and finding ways to solve the problems. My students appeared to be stuck in the one-dimensional method of solving problems. It is because of these struggles I have decided to learn more about

Number Talks and the many ways they can improve students' conceptual understanding of numbers. I also observed my students struggling with their confidence, so again I decided to explore cooperative learning strategies that would improve their confidence. By combining these two methods together, I hoped to change the classroom culture and improve student learning and understanding.

Another reason for doing this project was to transform the mindset of my sixth grade students. A fixed mindset often exists at this age and some students rely on the “safe” method in solving problems. The goal was to increase their growth mindset by teaching them to push themselves in their learning and provide opportunities to attempt new methods that make “sense” instead of relying on the one dimensional method that has been ingrained since kindergarten.

In addition, this project helped increase my personal understanding of number sense and cooperative learning as I continued to teach sixth grade. Much research exists on improving number sense in students and cooperative learning and how it builds confidence and changes the classroom environment, however there has been little research on the effectiveness of both when combined with each other. This project examined the impact that marrying these strategies had on student learning and student growth as they progressed. I hoped to understand why, if both are proven pedagogical methods, they have not been combined to improve student learning and to see how they may affect student growth and confidence.

Creating curriculum and strategies for other educators was of great importance, as it benefits all students. Providing teachers with a resource that can help them improve the classroom culture and help them manage their classrooms in a positive, student driven manner was a crucial focus. The other critical focus was on student learning and understanding of math

in a flexible, conceptual, and growth mindset while working together with others to accomplish a main goal.

This project provided sixth grade students the opportunity to have a tool they can use through the rest of their academic career. Creating successful sixth grade math students that were taught to modify their mindset, see numbers in a flexible and conceptual way, while working in a cooperative and positive manner was the ultimate goal. Students should continue to push themselves and never settle for the easy way out. I needed help improving my learning throughout my education, and I wanted to provide the same opportunity for my students.

Finally, this chapter addresses the essential question; *How do math interventions with a focus on numbers sense, primarily number flexibility and conceptual understanding of numbers, coupled with cooperative learning improve mathematical literacy for elementary students?* and what needed to be done in order for this to be proven successful. Every student should have the ability to show success in school and into the future.

Summary

This chapter focused on the personal struggles that I have experienced as a child and the motivation I have now based on those experiences. My professional observations and experiences working with students struggling to develop an understanding of how to see math differently has also motivated me to address the gaps in mathematical success. Also addressed in this chapter was my development from a fixed mindset in regards to cooperative learning and math, and how I increased my growth mindset moving forward as I continued to teach elementary school students. Two main interventions, cooperative learning and Number Talks, when coupled together, can be an extremely useful tool to improve students' confidence and number sense.

CHAPTER TWO

Literature Review

Overview

There is a multitude of research that exists which discusses students' struggles with mathematics (Shore, 2018). Not only do some students struggle, but also some teachers struggle for different reasons. Number sense is not being developed in mathematics classrooms due to teachers not having enough time and lacking the resources (Shore, 2018). Teaching math effectively with a focus on number sense and using proven collaborative strategies helped change this mindset. Cooperative learning is one of the most beneficial learning strategies because it allows students to interact with each other and share their ideas to work toward the same goal (Slavin, 1981).

When professionals are able to identify children's learning needs early on, the ability to implement interventions that may prevent mathematical failure can be done (Jordan et al., 2006). Number sense is something that can be developed and taught to children (Jordan & Dyson, 2014), and number flexibility is an important skill that needs to be developed to help prevent failure. It is important that math is taught as a flexible conceptual subject that is about sense making (Boaler & Dweck, 2015), and it is important to intervene early on in a child's life to prevent mathematical failure. It is also important that appropriate cooperative learning and mathematical interventions are used. Number Talks is a proven pedagogical method that has been used to help prevent failure by developing number sense and flexibility. Number Talks along with employing the use of cooperative learning greatly improved children's math skills. These two interventions along with number flexibility and conceptual understanding of numbers are examined within this literature in an effort to answer the question: *How do math*

interventions with a focus on numbers sense, primarily number flexibility and conceptual understanding of numbers, coupled with cooperative learning improve mathematical literacy for elementary students?

To begin this review, various areas of number sense and cooperative learning were explored in order to answer the research question and make connections. Before that can be done, it is very important to understand what number sense is and the many components of number sense. Number sense and the five key components of number sense in young children are defined (Jordan et al., 2006). In this chapter the discussion of the importance of early development of number sense through these five elements of number sense was addressed.

After the introduction to number sense, this study examined two of the components that are essential in the development of number sense, flexibility and conceptual understanding of numbers. Thus, providing an understanding of what flexibility of numbers is, and what a conceptual understanding towards numbers consists of, may allow for understanding the importance of these skills for elementary students in order to be successful math learners.

To improve all aspects of the development of number sense the next focus was cooperative learning. Cooperative learning strategies that can be implemented into the math classroom is addressed. The establishment of a community of learners through cooperative learning is an important part of any classroom environment. Cooperative learning can make math and learning fun, so students are able to develop a growth mindset and be willing to see numbers differently.

Finally, a strategy used to improve flexibility and conceptual understanding of numbers, Number Talks, was examined. This study defined Number Talks, how they work, and the benefits of doing them with your math class daily. As Boaler (2015) states, “Number Talks are

the best pedagogical method I know for developing number sense and helping students see the flexible and conceptual nature of math” (p. 50). This study reinforced their confidence in Number Talks and provided and outlined the many ways that number talks will improve number sense.

Number Sense

As Berch (as cited in Gersten & Chard, 1999) stated “Number sense is an emerging construct that refers to a child’s fluidity and flexibility with numbers, the sense of what numbers mean, and an ability to perform mental mathematics and look at the world and make comparisons” (p.19-20). Although this is a relatively older article, number sense has maintained a similar meaning over time. Developing number sense leads to the automaticity of numbers which helps children as they begin to solve more advanced math problems (Gersten & Chard, 1999). The five components of number sense that are key elements of number sense in young children are; counting, number knowledge, number transformation, estimation, and number patterns (Jordan et al., 2006). Table 1 illustrates the five key elements that should be present in young children in determining number sense.

When counting, some children tend to think about counting in simplistic ways before engaging in elements of number sense that require higher level thinking skills (Baroody, 1987). That is why it is important for children to be able to interact with concrete objects when they are entering school. This will help children develop and move to more advanced counting strategies and be able to solve math mentally. Children should be starting to develop the one to one method and gradually progressing to different counting strategies such as counting by two’s and three’s as they continue to grow when practicing counting.

Number knowledge is the next focus area for children to start to develop number sense.

Table 1
Key Elements of Number Sense in Young Children

Area	Components
Counting	Grasping one to one correspondence Knowing stable order and cardinality principles Knowing the count sequence
Number knowledge	Discriminating and coordinating quantities Making numerical magnitude comparisons
Number transformation	Transforming sets through addition and subtraction Calculating in verbal and nonverbal contexts Calculating with and without referents (physical or verbal)
Estimation	Approximating or estimating set sizes Using reference points
Number patterns	Copying number patterns Extending number patterns Discerning numerical relationships

Note. Data are from Jordan, Kaplan, Olah, & Locuniak (2006).

Children are learning how to recognize different quantities and comparisons between objects. Children as young as four years old have begun to develop a greater knowledge of numbers as they focus on counting and quantity (Griffin, 2004). As children progress and develop in school so does their knowledge of numbers. They are beginning to shift from counting and quantity of numbers to the more formal number symbols, and they are better able to expand their number knowledge by dealing with double-digit numbers (Griffin, 2004). For example, children begin to recognize different amounts of objects, such as stacks of blocks, based on the size of the stacks. They are able to identify at an early age quantities of items such as snacks, and they are able to recognize when someone else is getting more or less than they are. When children are able to

recognize the different quantities, they are able to tell different amounts in two different piles of objects. Through the development of number knowledge, children begin to learn that numbers that appear later in counting sequences have greater values than those in earlier sequences (Jordan et al., 2006). Children begin to recognize that numbers themselves have magnitude, and they can see that eight is larger than five and six is less than nine (Jordan et al., 2006).

Number transformation happens when students begin transforming numbers by adding and subtracting and by being able to make calculations of numbers both verbally and nonverbally (Jordan et al., 2006). When children are young, they develop the ability to add and subtract items and transform the different amounts based on their observations of items such as stacks of blocks. As the children get older, the calculations and understanding become more difficult because of story problems. Children may not be able to read the words or understand the meaning of those words, thus solving story problems becomes a difficult skill to master. The transformation of numbers may occur but a child's inability to be able to read the story problem may exist. Basically, children who are engaged with words at home are much more apt to come to school with a developed vocabulary and language structure, which oftentimes leads to being more prepared to learn how to read and write (Shore, 2018). When children are not engaging with words at home, may be a potential reason they struggle with reading the story problems. This is why these interactions at home are important, because interactions with words tend to lead to interactions with numbers in the same way. Early reading and understanding is important because it does lead to the development of number sense, thus allowing the child to process and understand the story problems.

Estimation is a child's ability to see numbers and objects and being able to estimate their values (Jordan et al., 2006). There are two types of estimation that are important in the

development of children; non-symbolic and symbolic. Non-symbolic estimation involves nonverbal processing without using numbers; children will manipulate quantities without counting (Tosto et al., 2017). An example of non-symbolic estimation would be looking at two stacks of blocks and being able to estimate which stack has more blocks in it. Symbolic estimation is using numbers to get a ballpark answer or guess using numbers. For example, if estimating the sum of 33 and 51 one would be able to add 30 and 50 for a good estimation. It is important for children to develop both types of estimation in order to have good number sense. According to Tosto et al. (2017) there was a correlation associated with non-symbolic and symbolic estimation and mathematics. Although, Tosto et al. (2017) did find evidence that there was a stronger correlation between symbolic estimation and mathematics than in non-symbolic estimation. Estimation is a very crucial component in the development of number sense because it allows children to be close to the answer and develop a good feel for numbers.

Through these non-symbolic and symbolic estimation strategies, children are beginning to develop a better sense of numbers and are able to make sense of number patterns. Exploring patterns may lead to improving children's deductive reasoning skills as they produce equivalent patterns using different communication and learn to predict what comes next in an existing pattern (Greenes et al. 2004). According to Ginsburg (1997) children develop a foundation of number sense through informal interactions, which are in a non-school setting, with number patterns. Ginsburg (1997) also noted that in order for the informal interactions to be effective they need to be coupled with formal mathematics, which are school interactions. It is important to build on the informal interactions, because when the students get to school and interact with the formal instruction of mathematics they will already have a foundation in place. When the children get to school, they will have a more developed sense of number patterns.

Through validated research and relevant math curriculum in primary school, the previous five components have been assessed skills in helping to identify whether or not children have adequate or functional number sense (Jordan et al., 2006; Griffin & Case, 1997). It is also a strong indicator of what type of skills the child is lacking. In understanding students' skills regarding these components; educators have a baseline from which to grow.

Finally, the development of number sense is something that begins early at home. Educators, especially early educators, should encourage families to expose children to numbers at an early age. Children begin to have experience with numbers at home when they hear their parents counting or using money. Encouraging children to informally expose themselves to numbers through play and interactions before they even come to school can help strengthen their number sense. To help students develop their number sense early it is important for children to play with puzzles, shapes, and numbers and start thinking about their relationships (Boaler, 2015). By having students think this way about numbers educators develop their mindset about numbers and they will more than likely have a growth mindset when it comes to math. If students are not encouraged to think about numbers and their relationships and are only taught the concepts and procedures, the students essentially develop a fixed mindset about numbers. When the students have the fixed mindset they only attempt to solve problems in one way.

There are two types of mindsets; growth mindset and fixed mindset (Dweck, 2006). Individuals with a growth mindset are willing to take a risk and move beyond the safe choice. The students are the ones who will move beyond the easy puzzles and attempt the more difficult ones because they want to grow (Dweck, 2006). Individuals with a fixed mindset settle for the easy tasks such as solving puzzles. The students stop trying to solve the puzzles when they become difficult and revert back the easy puzzles because that is where their comfort zone is

(Dweck, 2006). When children are encouraged to go outside of their comfort zones when working with numbers, the children are being pushed to develop their number sense. When students get stuck, the need to help them move from a fixed mindset to a growth mindset is done by encouraging them to try and teaching them how to try.

Number Flexibility

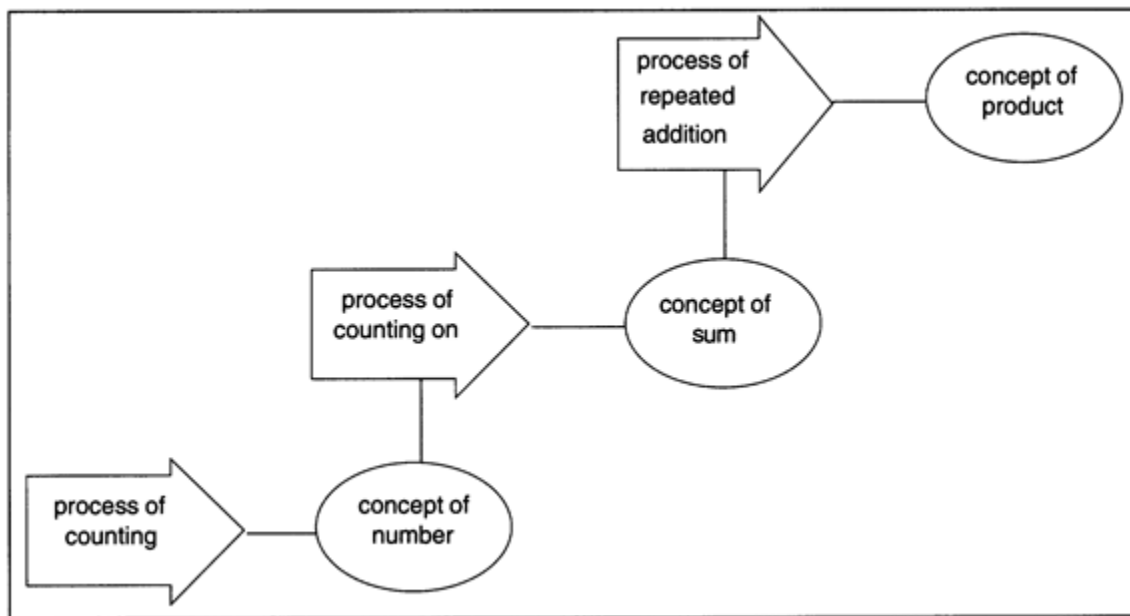
According to Eide (2020) flexibility of numbers means having the ability to view numbers in a different way, an example would be the number 15 and being able to see it as $10+5$ or $20-5$ or 3×5 . Having flexibility with numbers opens up many possibilities. When students can see that 15 can be found three different ways it creates an understanding that not every problem has to be solved in one way. When students are not taught how to be flexible with numbers, they often will rely on specific procedures or methods for solving problems, and they start to believe that these procedures and methods are important and need to be memorized when solving problems (Boaler, 2015). These same students who cling to the procedures and methods are the ones who continue to struggle with mathematics. This is especially evident when students are asked to solve addition, subtraction, and multiplication problems because when they write the numbers vertically they tend to see the numbers as a digit instead of seeing its value. The reason they tend to do this is because this is the way it was taught to them by their teachers. The students need to write the numbers to the problems horizontally because they will then begin to see the values of the entire numbers instead of the numbers as digits (Parrish, 2011). Students that are continuing to memorize the procedures and methods without using flexibility and compressing concepts are learning math in a way that is not improving their number sense (Boaler, 2015). Students need to know the procedures and methods, but they need to use flexibility of numbers in order to help them understand and retain the procedures and methods.

Essentially number flexibility moves students away from the basic understanding that numbers have only one solution to the many possibilities that are available to them. When students understand this type of flexibility they are beginning to develop a stronger sense of numbers.

Conceptual Understanding

Conceptual understanding is the students' understanding that a concept exists and how the concept works. Figure 1 shows how each mathematical concept builds on each other in a step-by-step process.

Figure 1
Concept Steps



Note. Data are from Gray & Tall (1994)

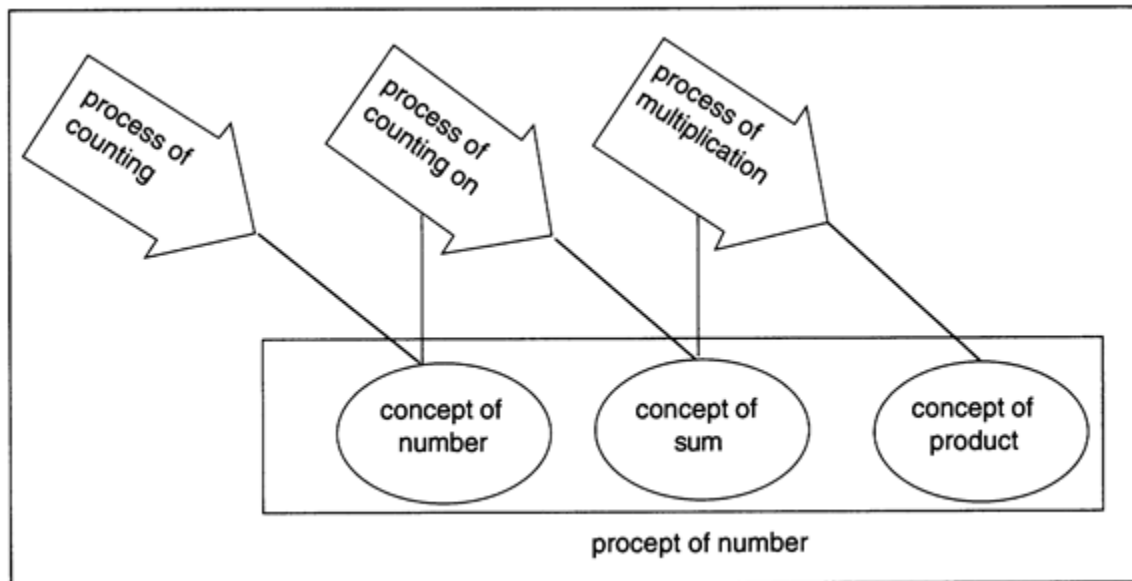
When a child learns the process of counting they are developing a concept of number. When they learn the concept of number it leads to the next step, which is the process of counting on. When they learn the process of counting on it leads to the concept of sum. After they learn the

concept of sum they learn the process of repeated addition, which in turn leads to the concept of product.

In Figure 1, the steps are formed, similar to walking up stairs. When one area is mastered, movement to the next step begins. In Figure 2, the climb is much more difficult, it is not like the stairs in Figure 1. Figure 2 describes the difficulty a child could have when each process is not understood. It will take the child longer to accomplish each of the processes because number perception has not been accomplished yet (Gray & Tall, 1994).

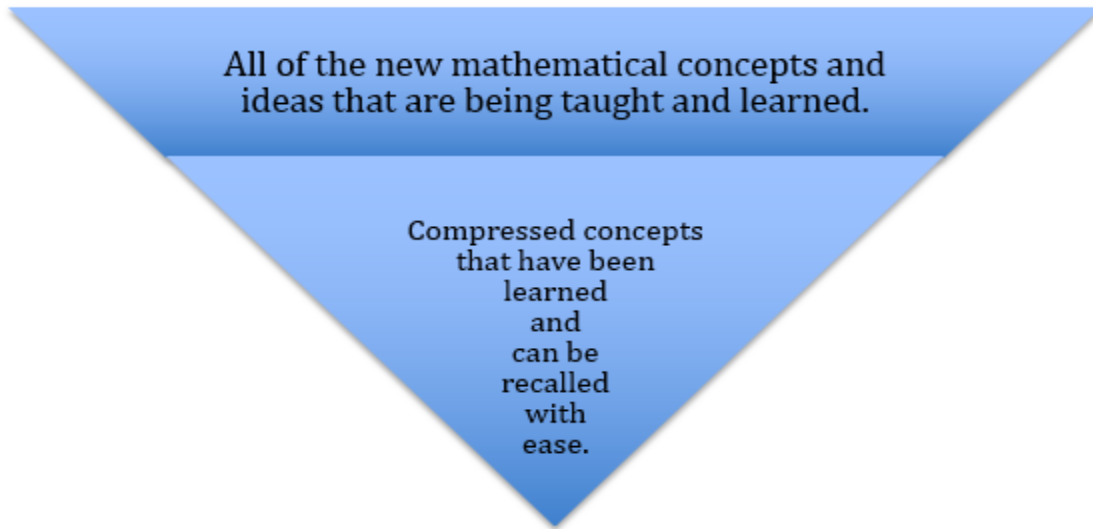
One way to think about mathematics is to think of an upside down triangle, the top of the triangle is all of the new math that is being learned and the bottom of the triangle is all of the concepts that have been learned and is known very well. It is this compression of learned concepts that will serve as a keystone and make it easier to recall how to add and multiply automatically (Boaler, 2015).

Figure 2
Concepts Falling



Note. Data are from Gray & Tall (1994)

Diagram 1



Note. Data are from Boaler (2015)

As can be seen in Diagram 1, all of the concepts that have been taught are compressed and are towards the bottom of the triangle and can be easily recalled. All of the new mathematical concepts that are being taught are towards the top of the triangle. These new concepts cannot settle towards the bottom of the triangle until they are learned and compressed for easy recall.

Cooperative Learning

Cooperative learning is a pedagogical practice used by teachers to increase learning through discussions and collaborating (Gillies, 2014). Cooperative learning involves group work with assigned roles where each member is responsible for sharing work with the group (Bernero, 2000). As Johnson & Johnson (cited by Gillies, 2014) suggests five key elements for establishing cooperative learning groups:

1. Establish a positive environment where groups understand the importance of finishing all work.

2. Each member is accountable for contributions to the group.
3. Manage group behavior by being an active listener, be considerate of others perspectives, state clear ideas, give positive feedback, take turns, and be respectful to everyone in the group.
4. Encourage each other.
5. Allow time for group processing.

It is clear that if cooperative learning groups are to be successful, they need to have these five elements suggested by Johnson & Johnson (cited by Gillies, 2014).

Establishing a positive environment is key, because when students are assured that their environment is positive, it leads to enriching and deeper discussions. Students need to realize that the group cannot be successful unless all members are completing their work and doing their part (Gilles, 2014). If only one member of the group completes his or her task then the group will fail. That is why it is important to focus on all members and the completion of their tasks.

Making sure individuals are accountable for contributing to the group will ensure there is not one person that is the dominant contributor all the time. Accountability is critical because if students are able to communicate with each other positively and accept feedback from each other it only strengthens the group. Educators will often establish requirements for accountability so each student is aware of his or her responsibility, so the group can complete their task (Gilles, 2014). Having a clear understanding of the task and everyone's responsibilities allows for everyone to hold each other accountable and create a successful group.

If students are able to manage their own behaviors, it may not become a barrier for learning. Establishing behavior guidelines for the group will ensure the success of the group. Making sure that everyone is actively listening to group members, taking in other people's ideas

and perspectives, accepting responsibility for their own behavior, being able to add constructive feedback to others ideas, sharing resources, and being able to take turns and not interrupt each other are key elements to the success of the group (Gilles, 2014).

Encouraging one another will only help create a positive and stimulating environment that will lead to a successful group. By being an active listener and offering constructive feedback will only encourage group members to share and feel comfortable with each other (Gilles, 2014). Due to the cooperative learning groups being built on everyone working towards the same goal, it reduces the opportunity for competition within the group (Slavin & Cooper, 1999). By reducing the competition, the students work in a safe learning environment, which is key to the success of the cooperative learning group. The whole goal is to create an environment where everyone's opinion is valued because it helps eliminate anxiety and strengthens the group.

Groups also need to be given the time to process and discuss because it will only deepen the conversations, and they will be able to begin to problem solve as a team (Bendall et al., 2015). When students are not rushed to finish a problem and have time to process, they lead to rich conversations and reduce the amount of anxiety of the group. The hope is to create a climate and culture of collaboration and provide time needed to accomplish goals.

These five components of cooperative learning are extremely important for the success of the students, but along with these components it is important to create relational capacity in the classroom and establish a positive classroom environment (Bendall et al., 2015). Relational capacity refers to members in a group trusting in each other and having a sense of safety within the group (Bendall et al., 2015). This trust has to extend to the relationship between students and teachers as well (Bendall et al., 2015). It is essential that the teacher is able to build relationships with his or her students; otherwise the relational capacity will not exist, thus creating an

unhealthy and untrustworthy environment. Earning the trust and respect from the students right away and building these positive relationships gives the educator the ability to create a positive classroom environment that is perfect for cooperative learning to take place. Not only does the teacher need to connect with students, but also opportunities need to be given for students to connect with each other. This will build trust and increase collaboration, again creating a positive classroom culture.

Another thing to keep in mind when forming cooperative learning groups is size. Students work better and achieve more when they work in groups between three to four people as opposed to larger groups of five to seven; a possible reason for this is because students may view groups of five to seven as closer to the whole class discussion (Gilles, 2016). By keeping the groups smaller there is a greater chance that the students will feel comfortable enough to share and have meaningful contributions to the group. If the groups are larger, it tends to be dominated by one or two individuals, essentially leaving out some group members.

The benefits of cooperative learning are endless. Cooperative learning changes the culture of the classroom and it becomes an environment where students feel safe and want to learn. The importance of cooperative learning is that it improves social interactions between students, deepens and strengthens curriculum, and it empowers teachers and students to be successful (Remillard, 2015). Cooperative learning builds a community within the classroom; when a positive community and trust have been established, the successes will seem endless.

Number Talks

Number Talks are a 10 to 15 minute activity that were created to allow students to make sense of mathematical problems while understanding that numbers have flexibility (Sun et al., 2018). According to Parrish (2011) there are five essential components of a successful Number

Talk; classroom environment and community, classroom discussions, the teacher's role, role of mental math, and purposeful computation problems.

The classroom environment is an essential component because there needs to be a sense of safety. If the environment is not safe and there is no trust in the community, then none of the other four components of a Number Talk will be successful. One of the first items to build the trust of the community is to establish acceptance of their ideas and answers whether they are right or wrong (Parrish, 2011). Once this is established, the trust and strength of the community will continue to grow.

Classroom discussions are very important in a Number Talks because that is how the students are able to learn from each other. To begin the Number Talk the teacher writes a problem on the board. Students then put a closed fist that is tucked into their chest, this tells the teacher that they are thinking. After the students have a solution they raise their thumb, this tells the teacher that they have a solution (Parrish, 2011). When the teacher sees that a majority of the students are ready, the teacher asks for an answer only first. After the teacher writes the answer on the board, the discussion begins. The teacher will invite students to defend and support their answers. The teacher's role in Number Talks becomes that of a scribe, questioner, listener, and a learner (Parrish, 2011). As students share their strategies and listen to others and make connections between their strategies, their mathematical understanding begins to deepen (Humphreys & Parker, 2015).

The role of mental math in Number Talks is to help the students rely on what they know and understand about how numbers are interrelated to each other (Parrish, 2011). Mental math helps students strengthen their understanding of place value and seeing numbers as whole quantities instead of columns of numbers (Parrish, 2011). Mental math also allows the student to

think and understand what technique or strategy he or she is using instead of writing down the basic algorithm to solve a problem. In Number Talks, the numbers are written horizontally instead of vertically. The reason for this is to help students see the numbers as whole numbers. An example of how the horizontally written number would encourage the student thinking of the number as a whole would be $98 + 98$. One hope is that the students would see that 98 is close to 100. They would add $100 + 100$ to get 200, but they would have to subtract four because they had to add two to each of the 98s. So the final answer would be 196. If the numbers were written vertically, the students may see eight plus eight equals 16, but they have to write the six on the bottom and then carry the one to the top of nine plus nine. They would then add nine plus nine plus one and get 19. So then they would see it as 196, but they are not seeing the numbers as a whole; they are seeing them as single digits without place value. That is why writing the numbers horizontally helps the students see the numbers as whole numbers.

Purposeful computation problems are a key to a Number Talks. If the teacher wants to work on developing strategies for working multiples of twos then the computation problems should be centered on that strategy. A mixture of random problems does not lead to a common strategy that is useful and beneficial for students while doing a Number Talks (Parrish, 2011). Basically, well thought out computation problems will lead to rich and meaningful strategies that students can build on and improve their number sense.

Number Talks in the classroom have many benefits. One of the many benefits is student engagement. When students begin to share their strategies in front of their peers without judgment they begin to trust their peers. Students may not initially share their ideas in a Number Talks activity because they lack confidence, but with the encouragement from the teacher and the

understanding that all students are capable the idea that the development of a growth mindset in mathematics class is supported (Boaler, 2015; Sun et al., 2018).

In order for a Number Talks to be productive and successful, the prompts or questions that are chosen are important. The level of questioning needs to be more open-ended than close-ended questions. By using open-ended questions, students are allowed to think about what is being asked and have the chance to explain their process. When close-ended questions are used, the explanation stops at one or two words. According to and stated by Boaler (2015) some questions that she suggests are:

- “How did you think about the problem?”
- “What was the first step?”
- “What did you do next?”
- “Why did you do it that way?”
- “Can you think of a different way to do the problem?”
- “How do the two ways relate?”
- “What could you change about the problem to make it easier or simpler?”(p. 180).

When using these types of questions, students are allowed to think about their strategies and why they chose their particular strategy instead of just producing a solution to a problem without an explanation. When students are able to explain their strategy, they are developing their number sense, which is the whole goal of a Number Talks. Number Talks are an excellent way to teach children how to decompose and recompose numbers, which will lead to the understanding of mathematics and will aid the development of the child mathematically (Boaler, 2015).

Summary

Limited research exists regarding the possible positive effects of combining the pedagogical ideas of the development of number sense via Number Talks and cooperative learning. Math confidence and capability will increase with the successful combination of these philosophies.

By being able to define number sense, provide an explanation of the important components of numbers sense, and discuss the importance of the development of numbers sense, a clear picture of steps necessary to improve a child's number sense development were given. Through the research and explanations of developing number sense in children early on, it is extremely important to create the same opportunity for each child to succeed mathematically.

This literature review was able to provide a clever understanding of concepts to be addressed in order to improve number sense. Research shows that improvement in number flexibility and conceptual understanding can cause growth in a child's number sense development. These areas provide a strong foundation for growth in mathematics.

This review of literature supports the notion that cooperative learning is an integral part of students' success in the classroom. Based on the findings from research about cooperative learning it is a useful tool that can be used to improve the confidence of each student. A positive classroom culture is also enhanced with cooperative learning and the building of relational capacity. Education exists as a balance of instruction, assessments, and environment.

With the focus on curriculum, Number Talks is pedagogical intervention that research supports to be effective in the improvement of number sense. Research has also shown that Number Talks is most effective when all five of the components are addressed as defined in the Literature Review. Number Talks is a very important tool that should be implemented at an early age.

Moving forward with this research project, it is imperative to stay focused on the essential question, *How do math interventions with a focus on numbers sense, primarily number flexibility and conceptual understanding of numbers, coupled with cooperative learning improve mathematical literacy for elementary students?* It is also important to address the lack of research tied to using cooperative learning and Number Talks in combination. A true combination of these strategies needs to be employed in order to improve mathematical literacy in elementary students.

Conclusion

Chapter two discussed the ideas crucial to math development in elementary students. The importance of developing students' number sense, number flexibility, and conceptual understanding exist as the base in developing strong math students. These aspects, along with use of Number Talks and cooperative learning will further enhance math confidence and ability.

The next chapter focused on the application of the aforementioned research found to be useful in improving number sense. With the primary focus on number flexibility and conceptual understanding, interventions associated with cooperative learning and Number Talks will be analyzed in order to gauge their effectiveness.

CHAPTER THREE

Project Description

Overview

Chapter three provides a framework, a rationale, the methods used, and concluding thoughts on the importance of number sense and cooperative learning. The framework examines the key components of number sense, the key elements of cooperative learning, and possible interventions that could be used to improve both areas, which are driven by previously shared research and methods.

The rationale explains why this particular topic was chosen and the importance of the research. The importance of blending Number Talks with cooperative learning is discussed. A brief explanation of the areas to be addressed are provided as a foundation for the project.

The outcomes covered the short term and long term goals of this project. The long term goals were to develop number sense and build confidence with mathematics through cooperative learning and Number Talks. The short term goals focused on student confidence and enjoyment in mathematics using cooperative learning and Number Talks.

The methods of this project addressed the following areas: the participants, the evidence, and the learning plan. The participants and setting were described to give a better understanding of why they were chosen. Evidence was provided through possible assessments that would be used to form the best strategies and inventions that provided an accurate outcome of the project. The learning plan explained how the project will be taught, which measured for the success of the project.

Finally, a final summary of the findings in this chapter were provided. The goals and desired outcomes were discussed. A brief description as to what to expect moving forward to

chapter four was addressed. With the focus on number flexibility and conceptual understanding and using the interventions, cooperative learning and Number Talks chapter two addressed the main question of this research project: *How do math interventions with a focus on numbers sense, primarily number flexibility and conceptual understanding of numbers, coupled with cooperative learning improve mathematical literacy for elementary students?*

Framework

The five key components of number sense development: counting, number knowledge, number transformation, estimation, and number patterns, which were defined by Jordan et. al (2006). These components helped guide this project along with the five key elements of cooperative learning; establish a positive environment where groups understand the importance of finishing all work, each member is accountable for their contributions to the group, manage group behavior by being an active listener, be considerate of others perspectives, state clear ideas, give positive feedback, take turns, and be respectful to everyone in the group, encourage each other, allow time for group processing (Gilles, 2014). This project focused on strategies to improve student number sense, with a primary focus on number flexibility and conceptual understanding of numbers, using cooperative learning and Number Talks. With the focus on number flexibility and conceptual understanding of numbers, this study was able to focus on and improve student number sense. In using cooperative learning techniques, the hope and goal is to build confidence in students while aiding in the improvement of the students' ability to share ideas and strategies. The Number Talks intervention attempted to build student understanding of numbers and realize that there are multiple ways to solve mathematical problems, which in turn has improved student number flexibility and conceptual understanding of numbers.

The five key elements for cooperative learning as outlined by Gilles (2014) and the five key components for the development of number sense as outlined by Jordan et al. (2006) are both important to consider when developing math instruction. When considering cooperative learning and Number Talks strategies discussed in chapter two, the success or failure of the strategies can only be measured if they are implemented together.

Minnesota State Standard 6.2.3.2 states that learners will be able to, “Solve equations involving positive rational numbers using number sense, properties of arithmetic and the idea of maintaining equality on both sides of the equation. Interpret a solution in the original context and assess the reasonableness of results” (Minnesota State Standards, 2007). Multiple Minnesota State math standards will be covered due to the robust design of Number Talks. They are designed to meet the needs of the students; which, in turn will also meet the Minnesota State Standards for mathematics.

Rationale

The rationale of this project is to improve students’ number sense as they move forward in their mathematical careers. Through personal observations of student daily work and early attempts at Number Talks, I observed that many students starting sixth grade at our school struggle with the basic understanding of number sense; thus this project focused on two main areas, number flexibility and conceptual understanding of numbers; the goal was to improve their basic numbers sense so math will become easier to understand and hopefully more enjoyable. The reason for addressing students’ needs through cooperative learning is because it is important to establish a positive, cohesive working environment that is free from judgment and cooperative learning aided in the confidence that students will need moving forward in their academic careers. The Number Talks intervention has been a proven pedagogical intervention that

improves students' understanding of numbers, which helps build upon the foundation of number sense.

Outcomes

The desired outcomes of this project, in the long-term, were for students to have developed a better sense of numbers and have built confidence in mathematics through the use of cooperative learning groups and Number Talks interventions. The development and the building of number sense using these two interventions act as a foundation for the continued success in mathematics, moving forward into middle school and then high school.

The short-term goal of this project was for students to build confidence in themselves and also to obtain an enjoyment for mathematics while improving their number sense. In the short-term students learned strategies that they can apply that may lead to greater enjoyment of mathematics. It also was a goal for the students to develop relationships with other students in the short-term achievement of building confidence. These short-term relationships could possibly turn into long-term friendships or working relationships that benefit both parties as they move forward in their academic careers.

Methods

Participants

The participants of this study are sixth grade students in a suburban school district that is north of the Twin Cities, Minneapolis and St. Paul. The students are in an elementary setting where the class size averages are about 25 to 30 students in a typical year. There are roughly 450 students in the elementary and there are three sections of sixth grade. The particular group of students involved in this study is 20. There are 12 girls and eight boys, with 20% of the

population being non-white students. There are 10% of the students that have a parent that has limited English proficiency, but those students do not receive English Learner services.

Materials

To ensure the success of this project the many important materials are needed. A computer for each student was needed so that students were able to take the initial assessment. The students also needed to have the necessary school supplies such as pencil and paper. There was also a need for a staff computer with a SMART board, which is a board that will project the information that the students will need. The teacher also used a Number Talks text that provided guidance for the appropriate problems to use. Each group received a white board and a dry erase marker to record their answer to the math problem. This provided the students the opportunity to write down what was being discussed in the group. They were also given role cards that explained the different roles of the group. These role cards allowed the students to know what was expected of them and their group in order to be successful.

Evidence

Several forms of quantitative and qualitative data are necessary to show the success of the project and gauging student growth. The following evidence was provided to see if the interventions were in fact useful in the development of number sense, mathematical confidence, and a positive classroom culture in sixth grade students. At the beginning of the year, the students took an assessment on a Google Form (questionnaire) that was used to determine what cooperative learning group they were in. After the cooperative learning groups were established, the student took another assessment that determined how well the group was functioning. This assessment allowed each student to rate themselves and their group members to gauge the cohesiveness of the group. This allowed the teacher to determine the effectiveness of the

grouping as well as if the groupings were contributing to a positive classroom culture for learning.

Next the students completed a district test, FastBridge, Formative Assessment System for Teachers (FAST), which is a computerized test that provides baseline data of the skills that the student knows. The FAST test includes an automaticity test that was used to determine how automatic the students were with their basic math skills. The automaticity test provides data that shows how automatic students are with their grade level math facts. This data allowed the teacher to see what math methods and procedures have been compressed in each student. As Boaler (2015) addressed earlier with the triangle explanation, at the bottom of the triangle the methods and procedures have been compressed in the mind for automatic recall. The data provided a list of problems the students completed and how well they did on each question. Based on the automaticity test the students took a pencil and paper assessment to determine their level of understanding. For example, the assessment was $74/2$ and the students tried to solve this problem using as many different strategies as they could. This allowed the teacher to see where each student's development of number sense was. Through the daily Number Talks this provided a formative assessment because the teacher was able to see how the students are progressing and developing number sense.

Finally, student confidence in mathematics was measured at several points throughout the project. The students were given a rating scale used to measure their confidence in mathematics by rating themselves with a one if they are not confident to a five if they are confident in their understanding and ability. The survey also incorporated a prompt to give a written reflection of their success. This allowed the teacher to see an increase in confidence for each student and if the group had an overall increase in confidence in their abilities..

Learning Plan

Once all of the initial data was collected the learning plan began. The learning plan was three months long because that is the timeline for the FAST test that the students take. Students take the FAST test in the fall, winter, and spring. Using the data from the questionnaire for cooperative learning, the teacher placed each student in a group that provided each student the opportunity to be successful. In order to build the classroom culture and the classroom routine, the students participated in various team building activities that were designed to strengthen the community and build the trust that is needed in order to be successful.

Due to the time frame of the FAST test, the students participated in the cooperative learning activities until the FAST test opened, which is usually two weeks after school starts. Until the FAST test data was available, the students were assigned roles for their cooperative learning groups to begin establishing a community. The roles changed so each student had an opportunity to experience each job, there were four students in each group. The roles of each student were as follows: facilitator, questioner, scribe, and the timekeeper. The facilitator is the leader of the group, the questioner is the person who poses the questions to the math problem, the scribe is the person who writes everything down, and the timekeeper is the person that keeps the group focused and on track. At the end of each week the students had the opportunity to reflect on the group; this is where students were able to rate and explain how each group member was doing.

Next the Number Talks lesson was taught in a whole group setting at first in order to establish the routine and build the understanding of the Number Talks. The Number Talks lesson worked the following way; the students had four hand signals that they used:

1. a closed fist

2. a thumbs up
3. a pinky and thumb up with three fingers tucked
4. a thumb up with the pointer finger out

Number Talks requires a universal unspoken language that kids needed to understand (see above). Number Talks encourages all of the students to keep their hand signals discrete by holding their hand signal close to their chests to help build confidence and increase participation. The closed fist meant that the student was thinking, the thumb up meant the student had a strategy to the problem, the pinky and thumb up with three fingers tucked meant that the student agreed with someone else's strategy, and the thumb up with the pointer finger meant the student had a different strategy to the problem.

To begin the Number Talks, the teacher put the Number Talks, which was on a Google Slide, on the SMART board for the students to see, once the students had a solution to the problem they used their hand signals. Once a majority of the students had a strategy the teacher asked the students for their answer; for example, if the Number Talks problem was $32 + 27$ the students gave their answer. Once all of the answers had been given; for example, if one student says 58 and another student says 59, the teacher would write down both answers. The teacher asked if everyone agreed that the answer was either 58 or 59 and then moved on to the next step, which is where the teacher asked a student to explain his or her strategy. The teacher was the scribe as the student explained his or her strategy, so if the student said, "I took 30 and added 20 together first to get 50," the scribe wrote that down. Then if the student said, "I took two plus seven to get nine and then I added 50 plus nine to get 59" the teacher wrote all that down. As stated in the Literature Review, the teacher should use open-ended questions such as; "How did you think about the problem?"; "What was the first step?"; "What did you do next?"; "Why did

you do it that way?"; "Can you think of a different way to do the problem?"; "How do the two ways relate?"; or "What could you change about the problem to make it easier or simpler?" (Boaler, 2015, p. 180). In addition to these questions other strategies could be used to increase student metacognition. For example, students could be encouraged to explain using directives such as; "describe your thinking about the problem." Using the open-ended questions and directives allowed students to think about the numbers instead of stating just the answer and then moving on. It is not about the answer, it is about the process involved in getting the answer.

Once the cooperative learning and Number Talks was established, the combination of the two began. The students broke off into their cooperative learning groups and established each of the four roles. The teacher provided the class with a Number Talks problem to solve. In their groups, the students discussed each of their strategies and wrote them on their white board that was provided to them. After about two minutes, the teacher asked each group to share one of their strategies with the whole class. The Number Talks lasted between five to ten minutes daily depending on the discussions that occurred.

Timeline

The timeline for this project was three months. This project began in the fall of 2021 and was completed in the spring of 2022. Depending on the findings of this project and the effectiveness, this could be a longitudinal study that would start each school year and progress throughout the whole year. Assessment of the students' progress every two to three months will be the key factor in determining the final timeline.

Summary

In closing, chapter three discussed number sense in sixth grade students and the reasoning for developing and improving the number sense. This project improved a child's number sense,

increased their confidence in mathematics, and created a positive learning environment.

Through the two main strategies that were addressed in this chapter, cooperative learning and Number Talks, the gaps in confidence and number sense that occurred in the sixth graders should start to lessen due to the effectiveness of these strategies. The goal of this project was for the students to have a better understanding of numbers and how to apply them to real world situations along with building the confidence that is necessary to move forward in their academic career.

Chapter four offers a reflection of the importance, implications, and limitations of work that has been done in the first three chapters, as well as a conclusion to the Capstone project.

CHAPTER FOUR

Reflection

Introduction

The purpose of this study was to explore the combination of two pedagogical techniques that contribute to the development of mathematical literacy in sixth grade students at a suburban elementary school in Minnesota. The techniques involved in this project will be Number Talks, which focuses on the development of number sense, and cooperative learning, which focuses on the learning environment.

Overview

Chapter four provides a personal reflection, literature review, project description, project implications and limitations, future research projects, opportunities and agendas and a final summary.

The personal reflection reviews the project that was implemented and the major learnings I encountered as a researcher. I reflect on the positives and negatives encountered during the project and how each affected my learners. I also reflect on how my past experiences affected this project both as a learner and a teacher.

The literature review was the guiding piece that helped me to answer the essential question: *How do math interventions with a focus on numbers sense, primarily number flexibility and conceptual understanding of numbers, coupled with cooperative learning improve mathematical literacy for elementary students?* It also helped me understand and learn about cooperative learning and Number Talks separately. The literature review also guided me in the development of this project by the research that was done in order for me to be able to combine the two together to analyze their effectiveness.

The project description provides a step by step order to follow when attempting to incorporate the project. This description also gives detail to what should be done to successfully measure mathematical ability and confidence.

The implications section describes possible conclusions that can be drawn from the implementation of cooperative learning and Number Talks together as one. The limitations section discusses all of the areas that could be seen as possible limitations when completing this project.

Personal Reflection and Learnings

As I reflect on this process, it has become very clear to me that one of the most important actions teachers need to do before any quality learning can take place is build trust with the students. Trust is gained through the building of relationships and creating a strong learning environment. This can only be achieved through the understanding that all students have different needs and all they want to feel is a sense of belonging. By getting to know the students and building trust, the learning then becomes much easier. They want to feel that their opinion and answers matter.

This journey has given me the opportunity to grow as a person and an educator. I have overcome many of my struggles, and I have begun to accomplish so much as a result of those experiences and struggles that I had at an early age. As an educator, I constantly try new theories and techniques and never settle. I am always looking for ways to improve how I teach, especially math, and this project has motivated me to improve my students' learning and confidence.

A major motivator behind this project is the fact that little research has been done regarding the combination of cooperative learning and Number Talks. I have learned that there

are many great theories and forms of research that have proven both to be successful when they are alone. The combination of both together intrigued me because of their success alone. I felt the combination of the two would benefit my students as they continue to grow as learners. It is not about copying something someone else has done, but taking the parts of research that are compelling and molding into something that benefits the learning of both the teacher and the students.

Literature Review

Some research that I have found the most important and helpful has been from Carol Dweck. Learning about the mindset that the students need to have, along with the teacher, has been very impactful. As Dweck (2006) stated, “Fixed mindset teachers see themselves as a finished product, they share their same knowledge year after year to their students” (p. 201). This is the teacher that I do not want to become. I want to be the teacher that grows each year and tries new things to improve. Dweck (2006) also states that, “Extraordinary teachers are the teachers that teach, they are the ones that learn along with their students” (p. 202). In order for this project to be successful, students should have an open mindset and should be interested in learning new things.

The cooperative learning studies that have been completed have helped me to understand the importance of being a cooperative learning teacher, or facilitator, not a large group lecturer. When a teacher is a large group lecturer, they lose a lot of the interpersonal relationships that are associated with the small group learning communities. The research from Gillies (2014) suggests that the small learning community gives students a voice, and they are able to gain confidence within the small group that they may not gain in the large group because they get lost in the crowd. Gillies also points out that students who focus more on cooperation and less on

competition become far more successful. When students compete against each other they have a tendency to get discouraged, but when they are in their small group and they are cooperating with each other to accomplish one main goal, their confidence increases.

Some of the other research I have found very helpful in the implementation of this project has been from Boaler (2016), Humphries & Parker (2015), and Hughes (2018). All of these professionals have been extremely helpful because of their influence on the discovery of Number Talks; this project would not have been possible without their research. The foundation of Number Talks and all of the extensive research they have done has proved to be an integral part of this project.

Through these areas I have discovered the importance of each of the strategies alone, but I wanted to combine them together to see if they would be even more successful. All the research that has been done on cooperative learning and Number Talks has given me the confidence to grow and learn as an educator and to implement both of the pedagogical methods as one.

Project Description

The project is to be implemented in three phases, each phase will last approximately one month. A teacher assessment, designed for the teacher to reflect on the classroom environment, is used each month to gauge progress of the project. The project starts with team building activities to help strengthen and build the community. After the team building activities, the students will be introduced to cooperative learning. I plan on starting slow with the students by having the first cooperative learning groups consist of two students. The reason for this is to get the students comfortable sharing their ideas with each other and establishing a working community. Next, will be the introduction to Number Talks, which are 10-15 minute math

activities that are meant to encourage the students to think about math and solving problems in multiple ways. Before moving on to the next stage of the project, the students will be taking a computerized test that will measure mathematical growth and automaticity of basic math facts. The final piece before the next phase is a pre-assessment. For the pre-assessment students are given the mathematical problem, $74 \div 2$, and they will try to solve it in as many different ways as they can. The range of solutions varies between one and five. The pre-assessment measures how well the students are able to use their number flexibility and conceptual understanding skills.

In month two, there is another team building activity that is designed to reinforce and strengthen the cooperative learning groups. The teacher completes another self assessment on the classroom environment and the progress of the project. Next, the cooperative learning groups will expand from two students to four students. The reason for the expansion is to build a more cohesive learning environment and increase collaboration. Along with the expansion, Number Talks will continue to be taught in a similar manner. The exception will be that the discussion will be done within the cooperative learning groups with a share out as I scribe their strategies on the board. The cooperative learning groups will also have an opportunity to complete a weekly reflection on how the group is working together. I will be reviewing these reflections and making adjustments to the groups if necessary.

The final month begins by facilitating another team building activity that will consist of students providing feedback to their peers about how well they worked together as a group. Finally, this month consists of a student driven Number Talks. The Number Talks are posted on the board to start the day and the students will get into their cooperative learning groups and complete the Number Talks as a group. Each student completes their assigned role for the week

and again will complete a weekly reflection about their group. The final component to wrap up the third month is a post-assessment, which is another look at the $74 \div 2$ assessment. Again, like the pre-assessment, students will be asked to solve $74 \div 2$ in as many different ways they can. The goal is for each student to be able to solve the problem in three or more different ways. This final assessment provides data to see if the students are progressing with number sense. The teacher completes a final self assessment to determine the effectiveness of the classroom environment and the success of the project.

Implications

Cooperative learning and Number Talks are two proven pedagogical strategies that are very effective on their own; by combining the two strategies, the hope is to increase student collaboration, confidence, and number sense. Research identified in chapter two has shown that cooperative learning increases student confidence, collaboration skills, and creates a positive classroom environment. Number Talks has been proven to increase student number sense.

In order for administrators to get on board with this concept, it is important to pilot the project first, to see what types of gains or shortcomings are occurring. If the combination of cooperative learning and Number Talks is proven to show gains, then schools can support the combination of cooperative learning and Number Talks by incorporating it into the classroom daily. If gains are being made by the combination of the two, then it would be beneficial to send teachers to training on Number Talks and cooperative learning. Those teachers would be able to offer staff development. This project could potentially become a staff development presentation based on the results of the study. This study could also serve as a potential ISAG (Individual Student Achievement Goal) which is a goal that each teacher sets each year as part of their Q-Comp (Quality Compensation) requirements.

Limitations

One of the limitations of this project is the sample size. Due to the number and the diversity of the student sample, the effectiveness of the project in all classrooms or across a broad spectrum of classrooms is difficult to gauge. Some other unexpected occurrences may be the population of special education students. If they are scheduled to be out of the room at the time that the project occurs, this could affect the dynamics of the community and could potentially make a group smaller. The communication with the special education teacher is imperative.

Other limitations to this project could be outside factors such as absences, band, orchestra, and choir lessons or other occurrences that would cause the student to miss the project timeframe. Careful planning so these limitations do not occur are essential in the collection of the data and the success of the project. A final limitation for the students could be the time of implementation in their educational journey. As sixth grade students, earlier implementation may have shown greater gains in confidence and number sense.

Future Research Projects

Some of the next steps involved in this project would be to share the results with my math committee members at my school district. Only after the project is completed and the data collection is analyzed would this be a possibility. Upon further discussion within my school, the math committee could recommend piloting this project with each teacher at multiple grade levels. As data is collected about the effectiveness of this project, we would be able to discuss with each other the possibility of implementing it to the whole school or revisiting areas as necessary. If this project is proven to be successful, it would be extremely beneficial to start implementing in all elementary classrooms.

Future Research Agenda

This project would be part of a longitudinal study to test the effectiveness of combining both cooperative learning and Number Talks together. The project would be implemented and piloted to a kindergarten class, that is followed throughout their elementary school grades until they reach sixth grade. The hope would be that it is proven to improve test scores as well as confidence and overall mathematical understanding.

Results and Benefits

The results and benefits of this project are the projected positive effects that result from the combination of two proven pedagogical strategies. By combining both of them, it only benefits and enhances the learning of the students. It transforms the teacher from large group, direct instructor to small group facilitator, allowing for a student centered classroom. It also boosts student confidence because they do not feel like they are a number but a group member. The benefits of combining Number Talks with cooperative learning enhances the students ability to share their ideas in a small group atmosphere free of judgement and competition. It is now a group of cooperation and collaboration. If this study proves to be successful, it could carry over to other subjects. When students gain confidence and collaboration and are beginning to develop problem solving skills, they are more likely to use it with all of their subjects.

Summary

This chapter was a reflection of the journey I have made through the completion of my capstone project. It began with my personal reflection and learnings as I moved through this process as I continued to focus on the essential question: *How do math interventions with a focus on numbers sense, primarily number flexibility and conceptual understanding of numbers, coupled with cooperative learning improve mathematical literacy for elementary students?* This

question guided me as I began to understand how important this question was to the development of my project. Through the research, I was able to draw valuable information and apply strategies that were integral in the development of this project. I was able to form a product with the combination of two strategies I believe could have an impact on future students.

The journey is not over; I look forward to the implementation of this project in the fall of 2021 when the true results of this project will be able to be seen. I will, then, be able to truly see what implication and limitations this project has, which will be very exciting. The implementation of this project will also be one of the driving forces for future research projects as I continue to grow as an educator and will help guide me as I develop a possible research agenda to present to my colleagues.

It is with great excitement that I await the opportunity to analyze the results of this project and be able to really see if it is beneficial to students. My hope is that this project will exceed any expectations and will benefit all students as they move forward in their academic careers.

My journey may be over as a graduate student at Hamline University, but it has just begun as a researcher and educator. As I move forward, I will continue to look for ways to improve student learning and understanding, and I will use the essential question to help guide me through this journey: *How do math interventions with a focus on numbers sense, primarily number flexibility and conceptual understanding of numbers, coupled with cooperative learning improve mathematical literacy for elementary students?*

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