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Implementing Number Talks in Classrooms

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Abstract

The purpose of this action research project was to determine how participating in regular number talks would increase students' mental math computation abilities. It analyzed the effectiveness of implementing a six-week number talk intervention in a fourth-grade classroom. The study was conducted in a Dual-Language School where the majority of students are English Language learners. Throughout the six-weeks, thirteen persistently high-risk and some-risk participants were progress monitored using the FastBridge portal. This study explored the students' abilities to participate in collaborative discussions, gain fluency skills and have a better understanding of number sense. The goal of the intervention was to help increase the participants FAST CBMmath Cap scores. This study provides support by using a number talk intervention to increase students' mental math computation abilities.

Keywords: number talks, fluency, collaborative discussions, number sense

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Implementing Number Talks in Classrooms

Math instruction should be taught using a variety of methods and strategies. The problem is students in elementary school have focused on memorizing facts and learning one way to solve problems. This phenomenon is well-known for arithmetic where many children use one favorite strategy to solve all addition or all subtraction problems (Heinze, Arend, Gruessing, & Lipowsky, 2018). Educators have focused on getting students to memorize facts instead of strategies in the classroom. Standards for Mathematical Content, published in 2022 stated mathematically proficient students should be able to solve a problem using a strategy that fits it and be able to use various methods accurately and efficiently to calculate a problem (CCSSI, 2022). The strategies used by a student to solve a math problem can be based on the procedures associated with the problem or an invented approach based on strong conceptual understanding of the problem being addressed (Burns, Walick, Simonson, Dominguez, Harelstad, Kincaid & Nelson, 2015). Children report math anxiety as early as the second grade. Around one-third of all children reported anxiety about being unable to do a mental calculation task, math homework, or something in math in general. (Sorvo, Koponen, Viholainen, Aro, Räikkönen, Peura, Dowker, & Aro, 2017). When students can share mathematical thinking aloud with classmates, it allows for the communication of skills and strategies that are being used. Although there has been a recent focus on strategies and interventions that are effective in improving reading performance, information regarding evidence-based practices and instruction in mathematics is not always readily available to educators (Luevano & Collins, 2020).

The purpose of this action research project is to determine how participating in regular number talks will increase students' mental math computation abilities. According to the school trilateral, the goal is to increase the FAST Math scores by 8%. In the years prior to this project,

the fourth-grade classes have failed to reach FAST Benchmark scores. Students have struggled to maintain their fluency of math facts. Fluency of numbers is something students focus on throughout the years. “Fluency is defined as students’ ability to use number sense and relationships and compose and decompose numbers, rather than speed and accuracy in solving problems” (Bouck, 2021). Fluency refers to the ability to solve math facts including addition, subtraction, multiplication, and division (Musti-Rao & Plati, 2015). With that, teachers are incorporating more mental math thinking and number sense into daily schedules. As research on number talks continues, the hope is there will be an increase of teachers who implement them into daily schedules, as well as an increase in students’ ability to share mathematical thinking.

As part of this action research project, a literature review was conducted in order to determine how number talks increase students’ mental math computation abilities. The articles used for the literature review were published between the years of 2010 and 2021. The articles were collected from databases using a variety of search terms including number talks, fluency, computation, number sense, collaborative discussions, and math reasoning. The literature review will describe how classroom discussions focused on mathematics have a positive effect on students. The literature review will be used to determine how effective number talks are in classrooms.

When students participate in regular number talks, mental math computation abilities increase. With the incorporation of collaborative discussions around math, students will increase FASTBridge assessment scores. “Number talks are meant to deepen and expand students’ understanding of the mathematics and to build flexibility with numbers and operations” (Bouck, 2021). When students participate in these daily discussions, there will be a better understanding of number sense and the ability to use numbers in everyday life.

In this review, evidence will be presented showing the effectiveness of number talks in classrooms. Details will be discussed about the impact on teachers and students and the safe learning environment that is needed. Next, evidence-based practices and strategies will be examined to uncover the importance of improving students' flexibility, accuracy, and speed. Finally, a report of student's growth and improvement will be used according to the FASTBridge assessment scores.

Review of the Literature

Number Sense

In the study by May (2020), teachers set out to find how fifth graders' mental math practice improved their numeracy. The question addressed included how students improved in flexibility, accuracy, and speed. According to the findings, the increased practice of explicitly taught strategies showed significant improvement from the baseline information showing 72% of the problems solved using the standard algorithm initially, but after the treatment, only 2% of the problems were solved solely with the standard algorithm. Moreover, an additional survey showed greater flexibility in the treatment group at the cycle's end. Additionally, students increased in their confidence when solving mental calculations. When students solved problems using different algorithms, it gave them the opportunity to solve problems in different ways. This study, presented by May, seems to indicate number talks may increase students' numeracy in the strand of efficiency.

Similar findings were also discovered by Baroody, Eiland, Purpura, & Reid (2012) when researching the discovery of children's number sense with basic sums. In this study, there was an opportunity to evaluate the implications of a hypothetical learning progression of mental math strategies in the elementary classroom. The results of this study revealed the students improved from fluency rate of 5% on the pretest to about 45% on the posttest. The results indicated structured discovery learning is feasible for helping students achieve fluency. In contrast, May found students increased in their confidence when solving mental calculations when they had the opportunity to discuss different strategies. When students discussed their thinking, they gained confidence and became comfortable working with numbers. In other words, number sense in the classroom will increase student mental math strategies.

In another study by Bouck & Bouck (2021), teachers set out to determine how number talks had a positive effect on students with disabilities in math. The questions addressed included how implementing number talks with flexibility and fidelity affected students, as well as how to use number talks as a formative assessment and intervention. According to the findings, approximately 5% of school-aged children experience a mathematical disability and other students with disabilities without an identified mathematical disability still have trouble or receive support in mathematics. These talks can serve as an important addition beyond curriculum-based measurements to determine whether students are responding to interventions and whether they need additional interventions regarding mathematics concepts. This study presented by Bouck & Bouck (2021), seems to indicate number talks have a positive effect on students and deepen and expand students' understanding of the mathematics. The study also indicates number talks help to build flexibility with numbers and operations.

Researchers Courtney-Clarke & Wessels (2014) discovered similar findings when researching number sense of final year pre-service teachers. In this study, poor performance of Namibian primary school learners in both national and international standardized assessment tests and explored the number sense of 47 final-year primary school pre-service teachers in Namibia. The results of this research revealed learner performance is linked to teacher subject knowledge and teachers' confidence in doing and teaching mathematics influences the way they teach and their willingness to learn mathematics. The results were reflected in the mean of 22.7% obtained in the number sense domain 'Knowledge of and facility with numbers' and in the interview data for this domain. The lack of a sound foundation in the domain of numbers and operations was the root cause of the low standards of performance of Namibian learners in mathematics at all levels and the lack of improvement over the last decade or more. In contrast,

Bouck & Bouck (2021) found incorporating number sense provides a quick means of engaging informative assessment of their students' mathematical thinking, understanding of number and number relationships, mental computation, and strategies to solve problems. In other words, it is important teachers have a solid foundation of number sense and the capability of incorporating number talks into their classrooms so students can be successful. When teachers have a solid foundation of number sense, students have the opportunity to apply and problem solve using mathematical thinking.

Collaborative Discussions

In the study by Boyd (2015), the purpose was to raise awareness of how the varied form and responsive use of teacher questions can invite and direct not only more student talk in classrooms but elicit specific and varied features of student talk that enhance comprehension building. The study also set out to find evidence of student engagement and high-level thinking. According to the findings, teachers who included collaborative discussions, such as turn and talks, were able to elaborate answers and discuss their thinking in detail. This indicates collaborative discussions are necessary when working with math. When students have the ability to share their thinking aloud, it increases their mathematical thinking, but also gives them the confidence to speak to their peers. Teacher talks shape the *what* and *how* of classroom talk, and teacher questions are the dominant discursive tool of choice in both language learning and mainstream classrooms.

Similar findings were also discovered by Orosco, Swanson, O'Connor & Lussier (2011) when researching the effects of dynamic strategic math on English language learners' word problem solving. English language learners (ELLs) struggle with solving word problems for several reasons beyond math procedures or calculation challenges. As a result, ELLs may not

only need math support but also reading and linguistic support. Often times, ELL students struggle with reading and comprehending word problems, as well as solving the problems. They do not have the capability to orally read the word problem and solve it correctly. The purpose of this study was to assess the effectiveness of a math comprehension strategy called Dynamic Strategic Math (DSM) on word problem solving for Latino ELLs. The results of the research revealed students' baseline data increased word problem solving for all the participants. All students' level of performance was maintained during follow-up sessions. The results suggest the intervention facilitated math problem–solving performance and increased student math comprehension. In other words, collaborative mathematic interventions focused on reading and math help increase student learning.

In a study by Madosi, Spangenberg, & Ramdhany (2020), teachers set out to determine which values learners consider important in the learning of mathematics. The question addressed was how mathematic learners from a public school in Gauteng, South Africa consider important in the learning of mathematics. According to the findings, the results revealed learners value hard work and effort when doing mathematics, various methods to obtain the answer to a mathematics problem, authentic examples of shapes to understand their properties, demonstration and explanation of mathematics concepts and proofs, and teaching and explaining mathematical concepts. This seems to indicate learners have different values, which could affect their learning and eventually their performance in mathematics.

Researchers Calor, Dekker, Van Drie, Zijlstra, & Volman (2019) discovered similar findings when researching the effects of shift-problem lessons on mathematical discussions in the classroom. According to the findings, the quality of the mathematical discussions in the shift-problem condition was better compared to that in the conventional textbook condition. The shift

problem lessons were more beneficial than that of using the textbook. The results suggest mathematical discussions need to be held in the classroom, not only using the textbook, but through discussions such as number talks.

Fluency

In the study by Reisener, Dufrene, Clark, Olmi, & Tingstrom (2015), they set out to determine how selecting effective interventions helped to increase math computation fluency via brief experimental analyses. The questions addressed included if students demonstrate differential responding to math fluency interventions during a BEA of the interventions. According to the findings, variability within and across the participants in response to the empirically supported interventions. Visual analysis of the data indicated all students responded favorably to at least one intervention during the BEA. This seems to indicate effective interventions are necessary for students struggling with mathematic computation fluency. When students participate in math interventions, they become more successful with their fluency computation.

Nelson, Parker, & Zaslofsky (2016) discovered similar findings when researching the relative value of growth in math fact skills across late elementary and middle school. In this study, the results revealed the importance of math fact fluency. In particular, the observed results indicate math facts may retain predictive value for math proficiency despite their absence from the formal curriculum in later grades. Results suggest growth in math fact fluency may hold some instructional relevance through eighth grade. Students struggle with math for a variety of reasons, but proficiency with basic computation is the most critical component. If students are not proficient in math fact fluency, they are less likely to meet grade level expectations in later

years. Like Reisener, Dufrene, Clark, Olmi, & Tingstrom (2015) stated, fluency interventions such as number talks will increase students' proficiency levels.

In a study by Purpura, Baroody, Eiland, & Reid (2016), teachers set out to evaluate the efficacy of highly guided discovery learning. The study focused on the relations underlying add-1 and doubles combination families and to compare the impact of such instruction with minimally guided instruction. The results of this study revealed the frequency of practice may not be the most important factor in the meaningful memorization of basic combinations, but discovery of mathematical relations may play an important role in enabling children to flexibly solve new (unpracticed), but related, combinations. When students are asked to memorize facts, they are memorizing over 100 isolated equations. Memorization does not stick for many students and does not allow students to explore the foundational relationships between numbers and the properties of the operations. This seems to indicate discussions related to numbers will benefit students more than memorizing facts.

Researchers Poncy, Fontenelle, & Skinner (2013) discovered similar findings when researching the use of Detect, Practice, and Repair (DPR) to differentiate and individualize math facts. In this study, a multiple baseline design was used across probe sets to evaluate the effect of detect, practice, and repair (DPR) on the math fact fluency rates of a third-grade class. According to the findings, there was a 12.8 DCPM increase over 36 problems. Prior to the implementation of DPR, students were computing an average of 18.4 digits correct per minute (DCPM). After using DPR for 11 sessions, students were computing an average of 31.2 DCPM. The pervasive occurrence of math skill deficiencies suggests researchers need to identify educational treatments to remedy math skills not only for at-risk students and students with disabilities, but also at the

classroom level. In other words, math interventions are needed to increase students number sense in the classroom.

Summary

Examining this research, it provides understanding of math interventions in the classroom. Students need effective math fluency strategies presented to them in the classroom in order to develop strong math habits and skills. If students do not have strong foundational math skills, they will continue to struggle in their math academics. It is also important for students to develop a strong understanding of number sense, participate in collaborative discussions, and have great fluency skills.

After reading about the importance of students' mental math computation abilities, the findings suggest using a math intervention to increase students' fact fluency. Using a number talk intervention will provide the opportunity for students to grow on their FAST Math Cap assessment. Students will be given the opportunity to increase their number sense thinking, participate in collaborative discussions, and enhance their fluency skills. Through this action research, the researcher will be able to provide a conclusion about the effects participating in regular number talks would have on student's mental math computation abilities.

Methods

Participants

The action research evaluated how participating in regular number talks, informal conversations focusing on mental mathematics strategies, have on elementary students' mental mathematics abilities.

Research was held in a fourth-grade classroom in NW Iowa. The research site took place at a Dual-Language School where students learn in both English and Spanish. Around 730 students attend this public school. Racial breakdown of the school includes 78% Hispanic, 10% African American, 5% White, 3% American Indian, 2% Asian, and 2% other. At the time of the study, 62.7% of the students were English Language Learners and 7.9% of the students received special education services. All students received free and reduced lunch.

The fourth-grade class included 24 students. Students ranged in age between nine or ten years old. The majority of students were Hispanic, and all participants spoke in English and Spanish. Fifteen of the twenty-four students were also English Language students. Three out of the twenty-four students were enrolled in special educations services for the subject of math.

The independent variable in the study was the implementation of number talks into the daily practice of the fourth-grade students. The dependent variable was the students' use of multiple strategies they could use to solve mental math problems accurately, efficiently, and flexibly.

In order to collect data, the researcher used surveys, questionnaires, pre-test, post-test, and observations during the Number Talks. The pre-test and post-test that was used was the fall and spring FASTBridge assessment. The number talk interventions used were the fourth-grade

Number Talk Power Point used by the district. To begin the number talk, the researcher would pose a question, along with a visual of the math problem. The researcher provided an amount of time for students to solve the problem using different strategies. The students had to think and solve the problems in their head. When the students were done solving the problem, they would place their thumb in front of their chest. If students finished early, they would think of other ways to solve the problem.

The researcher communicated the importance of respecting everyone's answers. The researcher would call on students to share their answer and their thinking. As the students shared their answers, the researcher wrote the answers on the board, along with the step-by-step thinking process of the students.

The statistical test to help analyze the data was the Dependent Samples T-Test. This was used to help determine if the students improved from pretest to posttest. The number talk intervention took place over a six-week period, with approval from the Institutional Review Board at Northwestern College in Orange City, Iowa. The researcher communicated to the students' parents about protecting their identity. The research was kept anonymous, and any identifying features were removed. They were aware participation in the study was voluntary. The data provided was used for research purposes only and kept confidential.

Data Collection

For this action research, the data collected was quantitative. The data includes baseline data scores using the FASTBridge Math Cap assessment. Before the class wide intervention took place, students completed surveys and questionnaires.

The pre and post intervention data for this study was collected using a Microsoft Excel spreadsheet. The independent variable in the study was the implementation of number talks into the daily practice of the fourth-grade students. The dependent variable was the students' use of multiple strategies they could use to solve mental math problems accurately, efficiently, and flexibly.

The research took place over a six-week period. Initial and pre-intervention data were collected. The number talk intervention took place daily for roughly ten to fifteen minutes at the beginning of the math block. At the beginning of the process, the researcher started by giving directions of the number talks. Since none of the students had ever participated in number talks before, directions were crucial.

At the end of the six-week intervention, the researcher used the FASTBridge Math Cap assessment to collect each students' end score. The data analyzed the growth of correct problems and the increase of students' mental math computation abilities.

Findings

Data Analysis

Of the twenty-four students participating in the study, eighteen increased their score. The average baseline score for the students was 1.89 and the average ending score was 3.30. Chart 1 shows the average results of the participants baseline score before the intervention was put into place, and then ending score after the six-week intervention was completed. The correct answers were calculated with the same problems for both the baseline and ending score.

There are a total of thirteen students that range from persistently high-risk and some-risk on their mathematical ability based on CBMmath Cap benchmark. These students failed to meet the required score for fourth grade based on FastBridge. These thirteen students receive an extra math intervention throughout the week along with their 60-minute whole group math instruction. The students either receive the extra math instruction with the researcher, the schools Title 1 teacher, or a special education teacher. The additional interventions are to help increase math fluency. The persistently high-risk and some-risk student data is shown in Chart 2. All thirteen students made growth in their CBMmath scores when participating in number talks along with receiving small group instruction from the researcher, Title 1 teacher or special education teacher.

A dependent groups *t* test results revealed that there was a statically significant difference in baseline scores and ending scores on the CBMmath Cap (*M=1.89, SD=0.98*), as compared to ending scores on the CBMmath Cap (*M=3.30, SD=1.42*), following the number talk intervention, $t\ (23) = -1.97$, $p < .001$. On average, there was a -1.41 difference between the baseline score and ending score.

Lastly, the participants that were identified as high-risk, and some-risk were progress monitored during the six weeks of intervention. The researcher was required to do weekly progress monitoring on these students using the FastBridge portal. The qualitative data in Chart 3 analyzes the growth during the six-week intervention. During progress monitoring, the students answer a set of questions on the FASTBridge portal using their computers. The students sign in and can use scratch paper to do their work. When students finish the progress monitoring probe, the score appears on the screen. When analyzing the chart, all thirteen students' lines are increasing throughout the weeks to display growth in their mathematical capabilities.

Chart 1

Participants at Baseline and Ending Score Bar Graph

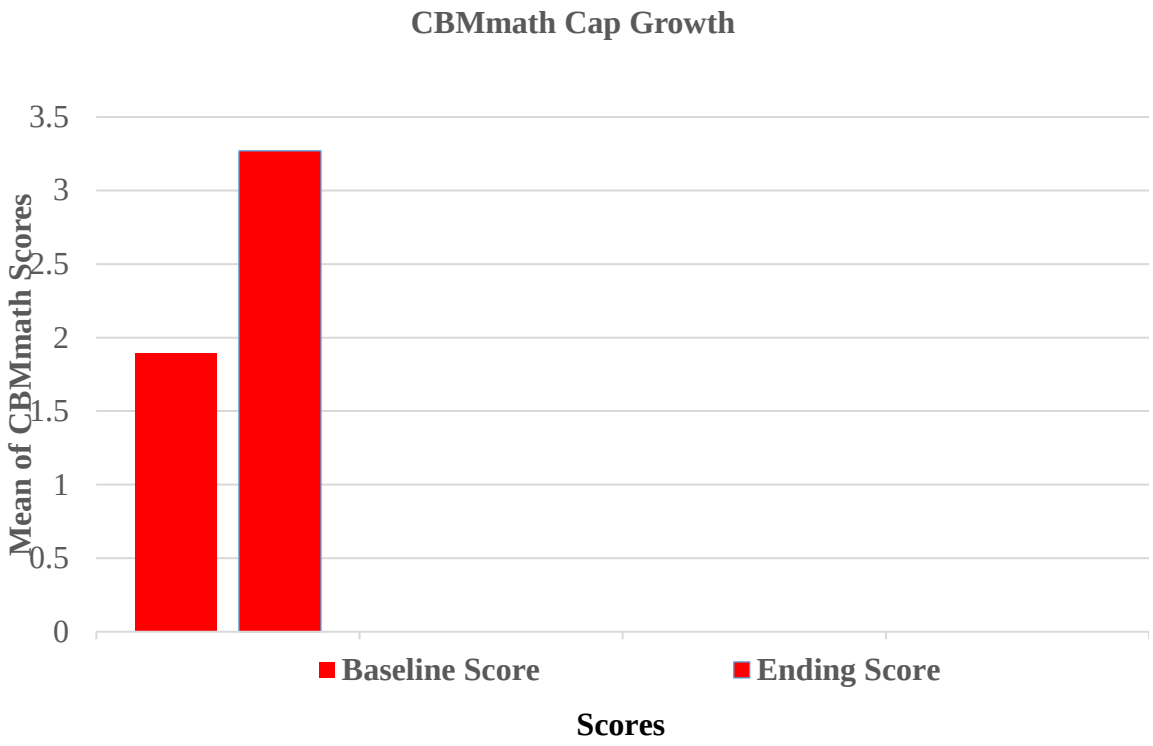


Chart 2

Persistently High-Risk and Some-Risk at Baseline and Ending Score Bar Graph

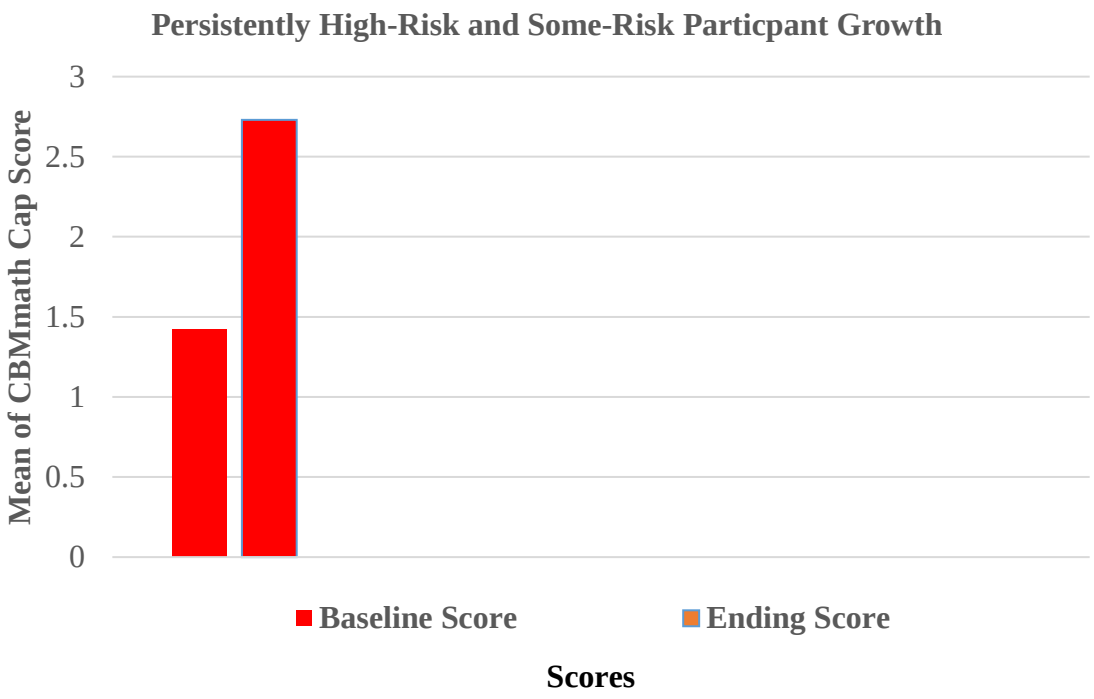
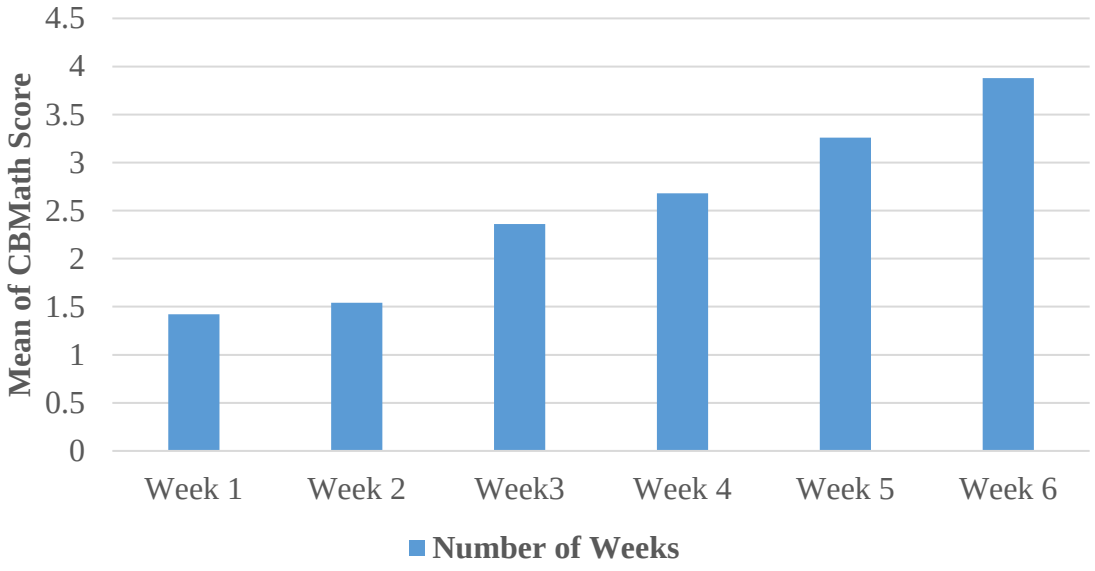


Chart 3

Persistently High-Risk and Some-Risk Participants Progress Monitoring Bar Graph



Discussion

Summary of Major Findings

The purpose of this action research project was to determine how participating in regular number talks would increase students' mental math computation abilities. The action research study results implicate teachers, researchers, and stakeholders the number talk intervention is successful for assisting students in their mathematic computation. This study states 75% of the students made growth on their FAST CBMmath Cap assessment. The average baseline score for the students was 1.89 and the average ending score was 3.30. The reasoning behind this finding is the number talk intervention was very structured with training for teachers and explicitly taught to the students. It was implemented with fidelity and done daily. This research study confirmed the findings made by May (2020) that there is a strong connection between confidence when solving mental calculations when given the opportunity to discuss different strategies.

Students were able to complete the six-week intervention by engaging in the procedures with fidelity. With a class wide number talk intervention throughout the six-weeks, it provided significant findings from this research to show an increase in mental math computation. When participating in the number talk intervention, students were able to work through problems and orally share their thinking out loud. Students were able to share their number sense thinking, as well as have collaborative conversations with their peers. Overall, number talks are successful for students by focusing on number sense, collaborative discussions, and fluency.

Limitations of the Study

There were many important limitations to consider in this research study. One limitation was the participants' behavior. The number talk intervention was held right after recess which led to many distractions and interruptions. Throughout the study, there were three students on behavior plans. While completing the number talk intervention, these students often made it challenging for others to pay attention.

Another limitation was most of the students involved were English Language learners. These students had varying language levels, however, most of them had strong English-speaking skills. While participating in number talks, these students were able to improve their English-speaking skills, as well as gain confidence in working with numbers. The students who did not increase their FAST CBMmath Cap scores were mostly English Language learners.

In addition to the English Language learners, there were also three special education students involved in the number talk intervention. While this was helpful for them to participate in the daily number talks, they struggle with learning new concepts and communicating math skills with their peers.

The number talk intervention took place over a six-week period. Although students participated in number talks daily, the results could have been different if more time was given. When these limitations are taken into consideration, it makes it difficult to consider whether the results would have been different.

Further Study

The next step will be to implement this action research into other fourth grade classrooms. To do this, teachers will be presented with the results of this study and trained on how to implement the number talk intervention. The intervention will be modeled for teachers and made sure it is implemented correctly and with fidelity.

Another future step will be to continue monitoring students' mental math computation abilities. The researcher will continue to implement the number talk intervention for another five weeks. After the five-week intervention, students will take the FAST CBMmath Cap assessment. The researcher will then compare the baseline and endings scores.

In a future study, it would be interesting to see the results of an investigation conducted with participants that were not English Language learners. With English being their second language, many of the participants struggle with number sense and the ability to communicate their thinking.

Overall, the implementation of number talks will be the focus for the researcher and other teachers for the remainder of the year. The focus will target number talks and the increased mental math computation abilities. Ultimately, the goal and focus will be on meeting the standards and benchmarks most conducive to student achievement.

Conclusion

This study provides support by using a number talk intervention to increase students' mental math computation abilities. Implementing number talks into the classroom will support the growth of FAST CBMmath Cap scores. The twenty-four students who participated in this action research study benefited from engaging in a six-week intervention to help increase their mathematic capabilities.

Like stated earlier, math instruction should be taught using a variety of methods and strategies. The problem is students in elementary school have focused on memorizing facts and learning one way to solve problems. "Math fact fluency is foundational for later mathematics education. Unfortunately, many students across the nation continue to struggle with these core skills" (Berrett & Carter, 2018). The ability to solve basic math facts is a foundational skill that is necessary for challenging curriculums (Ok & Bryant, 2015). Researchers have shown if students lack fluency skills, they will be more likely to struggle on tasks that are perceived to be too difficult (Poncy, McCallum, & Schmitt, 2010). During this study, participants benefited from collaborative discussions and increasing their fluency and number sense capabilities. Participants were able to do this by sharing their thinking out loud and working through problems with their peers.

The results of the intervention had a positive impact on the participants. The participants enjoyed learning new math skills and collaborating with their peers. The participants gained a deeper understanding of math fluency, as well as having collaborative class discussions. Overall, 75% of the students made growth on their FAST CBMmath Cap assessment after participating in the number talk intervention. With these results, it will be necessary to continue implementing the intervention in other classrooms and grade levels.

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