Spring 4-30-2018

Mental Mathematics in the Classroom

Linda Li
lil@bgsu.edu

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ACTION Program

Bowling Green State University

The purpose of this action research study is to investigate the impact of mental mathematics in the classroom and how it affects student achievement. Participants are students in a 9th grade Honors Geometry classroom with a class length of 43 minutes in a suburban setting. An initial survey was conducted to evaluate student confidence and reasoning abilities on a Likert scale. Throughout the research time frame, students were presented tasks requiring mental mathematics as an in-class activity. At the end of the experiment, students were to complete a post- survey to measure growth in areas like number fluency, self-confidence, and views towards mathematics.

Introduction

When students hear the words “mental mathematics”, it can possesses negative connotations, which can lead to students neglecting a valuable tool both inside and outside the classroom. While it is a more prominent concept for younger age groups, mental mathematics should continue to be stressed at the secondary level (Rubenstein, 2001; Manitoba Education, 2014). Mental mathematics is not the procedural knowledge behind time tables and information, rather, it is real-world applications of mathematics, number fluency, and problem-solving skills without the use of computational tools (Rubenstein, 2001; Manitoba Education, 2014). The key issue behind why students are lacking in mental mathematics lies in the fact teachers do not have a proper understanding behind the importance of number sense and how it can be taught in the classroom. By taking the focus away from rote memorization and emphasizing mathematical fluency, students are more likely to gain a deeper understanding behind the value of mental mathematics (Liu, et al. 2015).

In order to steer students away from their fear of mental mathematics, the responsibility falls on the teacher and different methods of classroom instruction. This study is not representative of the entire student population, and it does not account for external differences including, but not limited to, gender, race, religion, socioeconomic background, personal achievement, and many other factors. Additionally, the classroom set-up includes a student teacher and a cooperating mentor teacher (CMT), which may impact the results presented in the study. The purpose of the research is to examine whether frequent incorporation of mental mathematics is linked to higher student achievement. Overall, it is hypothesized regular exposure to mental mathematics will improve mathematical fluency, boost student confidence, and increase students' understanding of mathematics in the real world.

Literature Review

Mental mathematics is often neglected at the secondary education level; however, it should be emphasized all throughout a student's educational career because of its long-lasting impact. Often, mental computation is considered a form of arithmetic calculation without external resources such as paper, pencil, calculators, and computers., and students are exposed to real world ideas such as estimation, financial calculations, and even purchasing daily items like groceries (Rubenstein, 2001; Manitoba Education, 2014). By exploring applicable situations, students are more likely to gain a better understanding of numbers and how to solve tasks requiring these skills.

Mental Mathematics and Number Sense

The strong connection between mental mathematics and number sense must be considered because both are crucial in ensuring mathematical fluency. Since these ideas are not clearly defined, teachers often lack knowledge behind what exactly number sense is, and how it can be enhanced through mental mathematics (Ma, 1999; Faulkner, 2009). In the 2001 book *Psychological models for the development of mathematical understanding: Rational numbers and functions*, good number sense was defined as including, "Fluency in estimating and judging magnitude, ability to recognize unreasonable results, flexibility when mentally computing, and ability to move among different representations and to use the most appropriate representation" (Kalchman, Moss, & Case, 2001). Mental computation offers students the opportunity to view mathematics as valuable, and it is a skill students can use in everyday life compared to over-reliance on external resources.

The National Council of Teachers Mathematics found the key is to create a classroom with a balanced instructional program, which can include technology-based lessons, mental mathematics, written arithmetic, and interactive manipulatives. By incorporating mental mathematics at all education levels, students have more flexibility in choosing which form of instruction is most appropriate in a given task (as cited in Rubenstein, p. 443). Exposing students to mental mathematics gives them the necessary tools to develop a basic understanding of numbers and when to use it compared to other available tools.

Misconceptions of Mental Mathematics

One major misconception is the relationship between mental mathematics and information retrieval, which is often referred to as rote memorization. The idea behind mental computation is for students to develop their own strategies in solving a given problem and use different methods for obtaining the same answer. On the other hand, information retrieval without external resources does not employ the same thought processes because it is more results-oriented rather than focused on numerical fluency (Liu et al. 2015; Heirdsfield, Cooper, & Irons, 1999). In order to strengthen student understanding with numbers, symbols, and other mathematical operations, the emphasis must be placed on mental mathematics rather than rote memorization. Instead of measuring fluency by speed, there are other criteria such as flexibility, accuracy, and strategies used to solve the problem. In the aforementioned research done by Liu, it was found that retrieval-based training was not applicable towards non-trained problems, which can include problems presented in variations from the original, a higher-order task, or asking students to demonstrate their understanding using different representations. The lack of transfer between retrieval-based training and building stronger problem solvers illustrates the need for mental computation training especially in the K-12 classroom.

Established Research

Problem solving without the use of computational tools has been conducted in the classroom in many ways to improve mathematical fluency. Researcher Anthea Johnson conducted ten number talks on addition and subtraction strategies with fourth grade students to evaluate their approaches to given exercises (Johnson, 2014). The number talks were designed to help students build mathematical fluency through multiple representations and encouraged students to focus on the process of mathematics rather than the solution. For example, Johnson asked students to discuss strategies behind the problem 39+39, which can be done by adding the digits and by taking 40+40 then subtracting 2. Through the use of questionnaires, pre-tests and post-tests, interviews, and notes, Johnson collected both quantitative and qualitative data for the experiment. Results showed students became more comfortable with different strategies, but they still depended on standard algorithms to solve certain problems. Surprisingly, Johnson found a decrease in student confidence with mental calculations after the number talks as documented from the post questionnaire. Major improvements were found from the data as well. Prior to the number talks, students generally believed there was only one right way to solve a math problem; however, this perception drastically changed from "agree" to "strongly disagree". Compared to the beginning of the intervention, students listed more than three times the amount of addition strategies they mentioned on the pre-questionnaire, which averages out to be more than four approaches per student. Overall, the students' accuracy on the problems increased from the pre-test to the post-test, with only four students receiving a perfect score on the pre-test compared to fifteen students receiving perfect scores on the post-test. Johnson's research exhibits one method of incorporating mental mathematics in the classroom and how it impacts student achievement.

Rheta Rubenstein in "Mathematics Teacher" articulated additional teaching strategies that can be used in a classroom for students of different age levels and content areas (2001). One strategy was the inclusion of in-class practice using mental computations, which can be in the form of bell work, exit slip, or in-class activity followed by a debrief period. During this time, students can share different strategies they used in solving the problem, and it was a useful way to demonstrate how there are many approaches to the same question. By doing so, students may identify more with certain strategies, and they can take those findings in future math classes and daily situations requiring mental mathematics. Since mental computations are commonly needed, Rubenstein also included a technique known as a "mental math moment", in which the teacher pointed out different opportunities where mental math may be an even more appropriate strategy than using technology or paper and pencil. Assessments for mental computations can take place in a wide variety of ways. For example, low-stakes testing in the form of quizzes serves as a way of receiving feedback along with more creative approaches, such as writing about real-world scenarios where mental mathematics can be used. After making mental mathematics a significant aspect of her class, Rubenstein (2001) finds students more confident in their reasoning skills, more likely to approach problems in multiple ways, and "liberated from calculator dependence" (p. 446). Rubenstein's research shows various techniques of integrating mental math into the classroom and how it can be assessed.

Long-Term Impacts

The research behind mental mathematics supports how it can serve as a predictor for test scores and life-long academic success because of its' impact on neurological changes. Researchers Price, Mazzocco, and Ansari investigated the connections between brain activation and certain mathematical processes, and whether strong mental arithmetic skills influence high school test scores. The experiment took place during a scanning session while individuals were asked to complete single-digit arithmetic computations, and the results found students achieving a higher score on the PSAT engaged parts of the brain associated with deeper content fluency, "…while those with lower scores were engaging systems associated with processing numerical quantity, and likely relying on procedural computations." (Price, 2013). By spending more time on mental mathematics and arithmetic, teachers can boost achievement within the classroom and on standardized tests. The relationships explored in Price's research further demonstrate how mental computations, with the support of neurological evidence, can have long lasting impacts for a student's future.

Methodology

Participants

The participants of this study were 24 students from 9th grade in an Honors Geometry class. Most the students were from a middle-class, suburban background, and they tended to excel in mathematics. The students can be classified as gifted students, but they showed low engagement in classroom discussions. They were exposed to the same materials, and a form of assessment was conducted before and after the experiment to measure progress. Student background cannot be accounted for because it is dependent on the school district and regional demographics.

Procedure

All 24 students completed a pre-test and a post-test, which represented qualitative and quantitative data. Students completed a survey analyzing their views of mathematics and their confidence in this subject area. At the end of the time frame, students completed the same assessment as a post-test to measure improvement and their personal growth. Additionally, students also reflected on their experience on the post-test by responding to short written prompts about mental mathematics. The purpose of the qualitative and quantitative data was to measure how student attitudes changed about mathematics and whether the frequent exposure to mental mathematics helped students improve their mathematical fluency.

The pre-test (appendix A) was designed to measure student perception of mental mathematics, which was the qualitative survey conducted using a Likert Scale. For each question, students were presented with a scale from 1-5.

1- Strongly disagree

2- Disagree

3- Neither

4- Agree

5- Strongly agree

The questions asked students to express how they felt towards mathematics, mental mathematics, and their confidence in calculations without using a calculator. The purpose of the research was to increase students' efficacy towards mental mathematics and change their attitudes towards the topic, which was why I chose to collect data in the form of an attitudinal survey including both quantitative and qualitative responses.

In order to prepare students for the research, I established classroom norms prior to data collection. First, students already had experience working in small groups and engaging in think-pair-share, which was an important instructional strategy that I used to facilitate discussions during the research time frame. Additionally, I created a classroom environment where students could answer questions differently and represent their thinking in multiple ways in daily lessons before exposing students to the mental mathematics tasks. By familiarizing students with both classroom norms, it better isolated the role mental mathematics played during the study and how it impacted student thinking.

During class, frequent tasks (appendix C) requiring mental mathematics were presented, and students completed them without technological assistance. Each day, students engaged in a new task, and some have been more challenging than others. The school district had three regular instruction days in a week with 43 minute periods and one 78 minute block period. On regular instruction days, students completed one task, and students completed 1-2 tasks on the block days depending on the difficulty. Some tasks specifically related to the math content area and daily lessons, whereas some focused on student reasoning and analytical thinking. After the completion of the task at hand, students discussed with their small group what they found *and* the process they used to find their answer. After the small group discussions, they had time to share their answer to the class, and I encouraged students to share different methods of solving the task. By doing so, students were more likely to be engaged in the discussion, but it also showed students the idea of different mathematical representations for the same question. If the tasks presented are not challenging enough, they can be adapted to match the students' level. The goal is for students to feel more comfortable with mental mathematics after frequent experience, and they can incorporate it more into their daily processes even outside of the designated class activity.

At the end of the study, students had the opportunity to reflect on their experience by taking the post-survey (appendix B) and answered guided prompts to gauge their attitudes towards mental mathematics. I collected their responses and compared it to pre-test data to measure attitudinal changes.

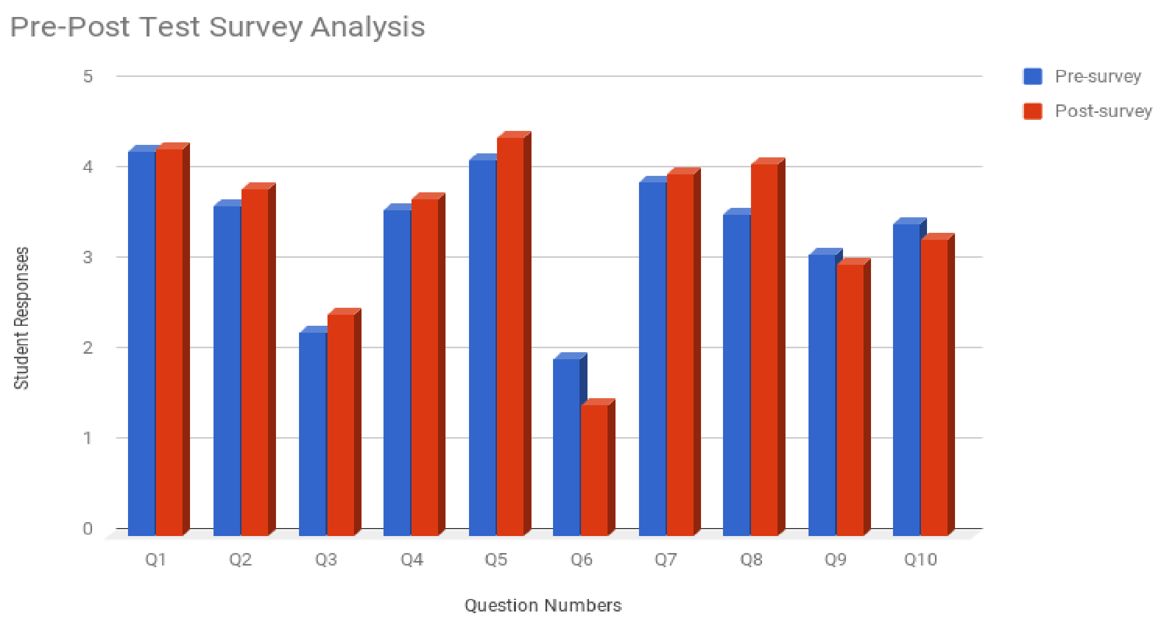
Timeline

At the beginning of the spring semester, February 2018, students completed the pre-survey. The results were documented, which were used to track and measure improvement. Throughout the semester, tasks requiring mental mathematics were given during class roughly daily between February and March (appendix C). The tasks were in the form of a class starter activity, meaning students were introduced to it prior to the daily lesson.

By the end of the semester, students had four weeks of experience with mental mathematics in various ways. In March 2018, students were asked to complete the same survey to measure their attitudinal changes and developed feelings towards mental mathematics. The results were recorded, and an analysis was done between the data from the pre-survey and the post-survey to determine the effect of mental mathematics.

Results

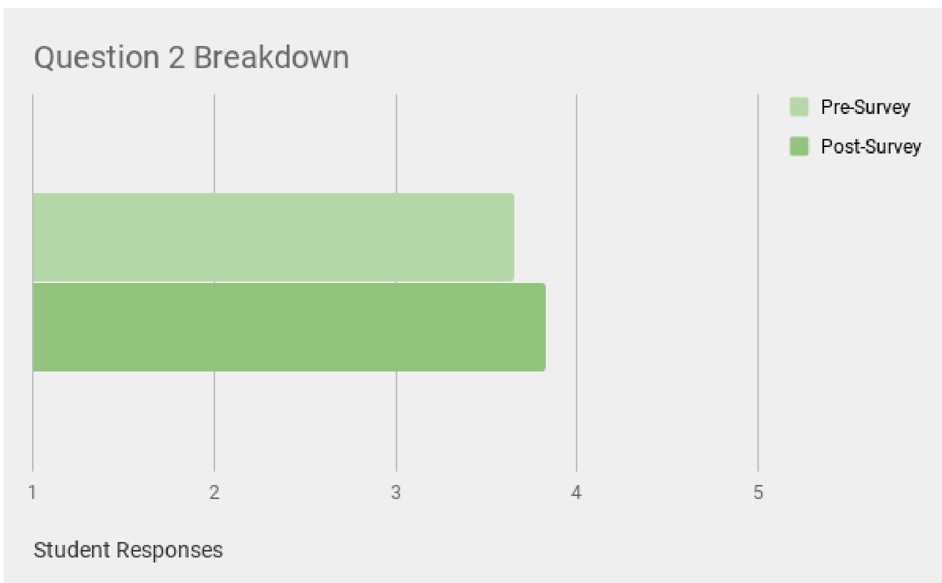
In this section, I analyzed the results of the experiment during the research time frame. Throughout the study, my focus was on three concepts – use of mental mathematics for reasoning and problem solving, mental mathematics in the real world, and explaining mathematics using various representations. Overall, there were slight changes in each of the focus areas, which were reflected in the questionnaire and student responses.



Use of Mental Mathematics for Reasoning and Problem Solving

At the beginning of the year, students were asked whether they had access to a calculator, and all students responded with a "yes", meaning they had the tools necessary for simple calculations. During the research time frame, I presented a series of tasks for students to solve without technological assistance, which were challenging for them because of their reliance on tools and technology. For example, one task presented a scenario asking if a person had enough money to purchase a computer with their current savings (appendix C), but the students' initial responses were, "Why can't I just use my phone to figure it out?" As the research period progressed, students began to see the merit and importance behind mental computations, and the tasks began to serve as a brain warm-up before class and sharpened their mathematical skills from previous years. In the survey, questions 1, 2, 3, 4, and 7 (appendix A and B) pertain to this focus area, and survey results showed a positive trend on all four questions, meaning most students attitudes improved on mental mathematics and its' impact on problem solving and reasoning after the research period. Of the five questions, survey results from the pre-test and the post-test differed most on questions two and three.

Question two asked students to express on the scale if they feel confident in mental mathematics, with 1 being strongly disagree and 5 being strongly agree. Prior to the Action Research, the average response was a 3.65/5, but on the post-survey, the response changed to 3.83/5, which represents a roughly 3% increase.

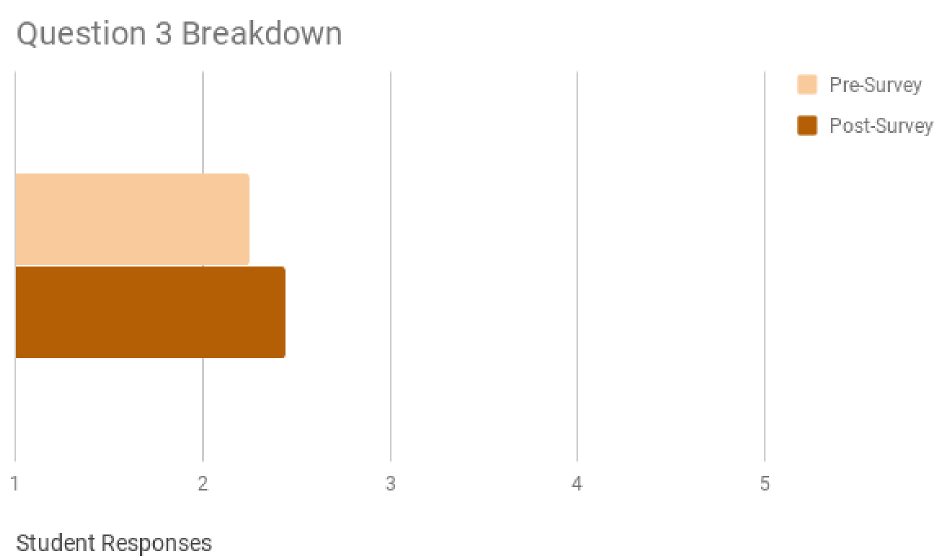


On the post-survey, students also commented on how their feelings towards mental mathematics changed. Some of the responses included:

- *"I used to use my calculator to complete simple equations. Now I don't need to do that because I understand how to figure things out better by using mental math."*
- *"I view it as more important than I used to."*

- *"I saw that the calculations were actually quite simple and did not need the use of a calculator."*
- *"I learned that I am capable of doing more mental math than I expected."*

Question three was another question that elicited changes in student responses between the pre- and post-survey, and it asked students if they rely on their calculators for simple calculations, with 1 being strongly disagree and 5 being strongly agree. On the pre-survey, the average response was 2.25/5 while the post-survey results reflected a 2.44/5. This 3% change was inconsistent with the overall results of the survey and student responses because it showed how more students were leaning towards relying on their calculator for simple calculations.



The inconsistency may be partially attributed towards students not having an opinion on the question and choosing 3/5 because they were unsure about their feelings towards the topic. Additionally, some student attitudes on this specific question remained unchanged, which contributed towards the final result, and other students continued to perceive mental mathematics as useless because of their access to technology. For example, one student responded on the post-survey:

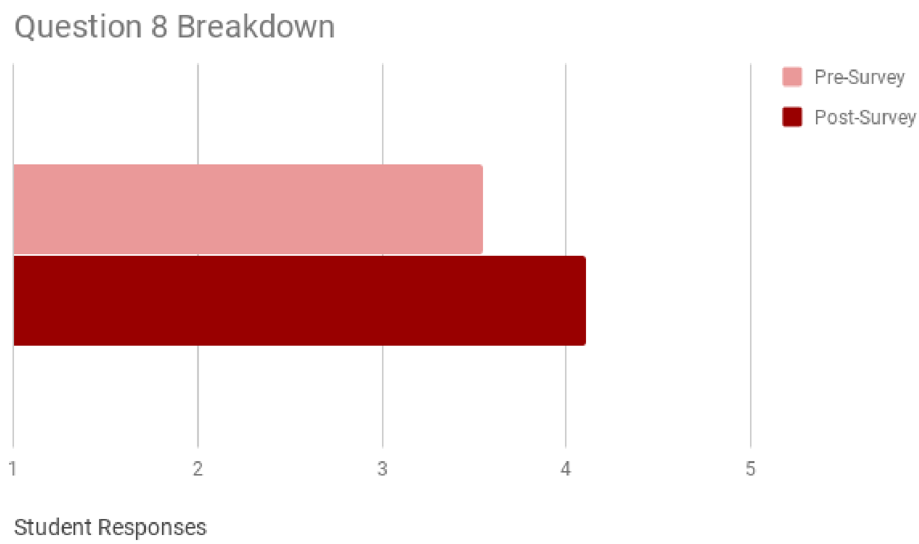
- *"It's still useless because I have a smartphone on me at all times."*

While the use of technology can be extremely important in aiding student learning, students and teachers need to understand when it is appropriate to incorporate tools and technology into student learning. This distinction was what I hoped to accomplish through this research; however, I believe choosing more challenging tasks and extending the time may influence student reliance on their calculators for certain calculations.

Mental Mathematics in the Real World

Another focus area of this research was how frequently students encountered situations requiring mental mathematics in the real world. On the survey, questions 5 and 8 related to student attitudes towards applications of mental mathematics. When referring back to the analysis of pre- and post-test differences, these two questions reflected attitudinal changes in a positive way, and the qualitative results were consistent with these findings. While the implemented tasks included a variety of question types, students were frequently exposed to daily scenarios requiring the use of mathematics.

Question 8 reflected significant attitudinal differences from the time of the pre-survey to the time of the post-survey. The question asked about whether students encounter mathematics every day or just in the classroom. On the pre-survey, the average response was 3.55/5, meaning most students either did not have a developed opinion on the question, or they were leaning towards agreeing with the statement. On the post-survey, the average rose to 4.11/5, which represented a 12% increase and most students either agreed or strongly agreed with the presented statement.



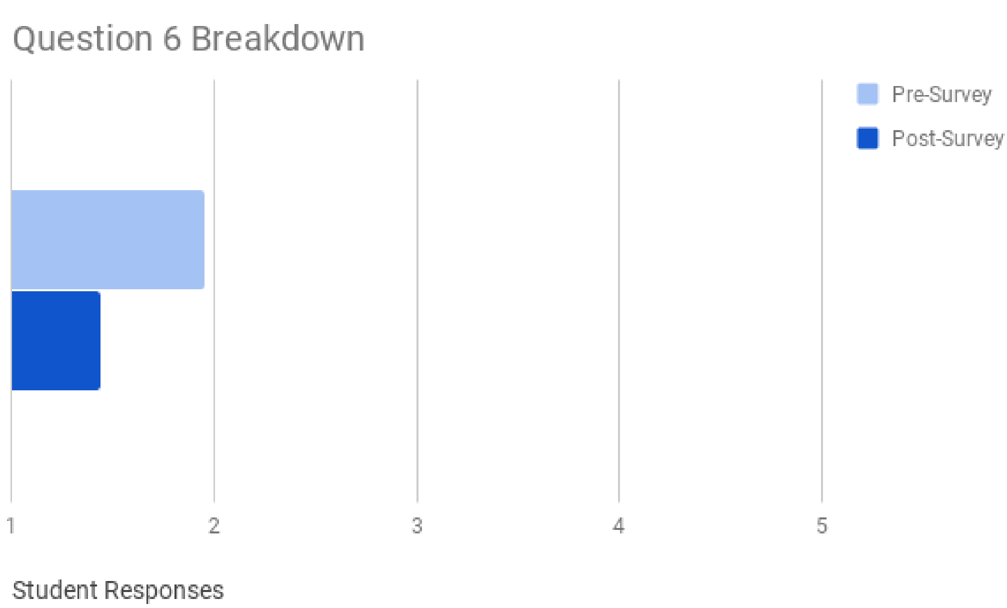
On the post-survey, multiple students responded to the first and second prompt by saying how they found mental mathematics to be an applicable skill. Some responses included:

- *"It is everywhere."*
- *"I saw how much it was used in the real world."*
- *"I realized how often I use mathematics in my every day life."*
- *"It was fun to get to see math apply to the real world."*

While most students responded positively, some students continued to view it as not relatable to the real-world because of their access to technology. For example, one response was, "*I still use mental math but I don't think it is really used in the real world. We have phones and calculators."*

Multiple Representations

The final focus area of my research was doing mental mathematics using multiple representations. The questions on the survey relating to this focus were 6, 9, and 10. These questions targeted student perceptions of whether there was one approach to finding an answer and the emphasis placed on the process compared to the solution. On the post-survey, student responses reflected positive changes on all three questions. Question 6 showed the most drastic changes, and it embodied this focus area the most because it asked students whether there was usually only one way of solving a problem. On the pre-survey, the average response was 1.95/5, meaning most students disagreed with the statement that there is usually only one way of solving a problem. On the post-survey, the average response dropped to 1.44/5, which was an 11% decrease. The drop represented the shift in student mindsets from only one way of solving a problem to using multiple approaches.



Student responses in the prompts echoed the quantitative findings, and many students noted how there were multiple approaches to solve a problem. Some responses were:

- *"I saw that there is more than one way to solve problems."*
- *"It showed me there are many ways of doing things and people think differently."*

Discussion

While the mental mathematics tasks varied in difficulty, the students practiced a variety of skills ranging from simple computations, mathematical applications, and logical riddles. At the beginning of the research period, students were not as active in the small group and whole class discussions, but as the students became more familiar with the question types, they became more involved. By the end of the research period, students became more comfortable with sharing their opinions on the questions and considering multiple approaches to the presented task, which may be due to the established classroom environment and rapport.

During the research time frame, many external factors could have impacted the results. First, the students who participated in the research were students from an advanced mathematics class, which meant their comfort level and mathematical efficacy may tend to be higher in comparison to other students. Additionally, the established classroom environment was crucial in the research process because of how frequently students engaged in peer interactions. Finally, the allotted time on the study influenced the results, which can be improved in future research.

Conducting the research with honors students who already had a good perception of mathematics impacted my final results because the initial survey results were generally positive towards mathematics. During the research time frame, the students showed enthusiasm towards the in-class tasks, and they demonstrated good classroom behaviors at their small group and whole class discussions. If a similar study were to be conducted in the future, a different student population may significantly influence the results. Given a different group of students, some levels of scaffolding should be built into the tasks to ease students into the discussions. For example, the mental mathematics tasks can begin with easier computations to build mathematical efficacy and student confidence. As the time frame progresses, more complex problem types can be presented to students without overwhelming them right away.

Another factor influencing the research results was the established classroom environment. The classroom set-up was essential to the research process because students were arranged in small groups since the beginning of the school year, which increased the students' likelihood to engage in peer interactions. Without the given classroom arrangement, students would not have as many opportunities to share their ideas with their classmates and engage in think-pair-share, which I viewed as an important factor in the research results. Based on classroom observations, students were less likely to share their opinions before discussing it with others, and this research focused on mental mathematics along with viewing mathematics in different representations. Without student discussions, it would have been difficult to accomplish the goal of mental mathematical fluency using various problem solving processes.

Finally, the restricted time frame impacted the research results. Having mainly 43-minute class periods, mental mathematics was allotted 5-8 minutes per period after the bell work, which was not adequate time for all the tasks. Additionally, the research only took place for a month, which meant students were not fully immersed in the experience for an extended period. As a student teacher, I had limited control of the classroom, but if the research were to be repeated in the future, many adjustments could be made to strengthen results. For example, I believe combining the time dedicated towards bell work and mental mathematics would be more efficient and grant more time for students to think through and process the problem. Also, it would be helpful to start the mental mathematics tasks at the beginning of the year and extend it to the end to build consistency and train students to become stronger problem solvers.

Implications

During this research process, I learned many things that I plan to use in my future teaching career. First, I realized the importance of allowing students to discuss ideas in their small groups before sharing with the class. Because some mental mathematics tasks were challenging, the students were more engaged if they were able to think on their own, share with their pod, before sharing with the rest of the class. Also, giving students the chance to talk with their peers was useful in fostering multiple representations. As I walked around to hear group discussions, I could confirm some students' thinking, which made them more confident to share their problem-solving process with the rest of the class. I plan on using this instructional strategy in my future classroom in all lessons, not just restricted to activities practicing mental mathematics.

After conducting this research, I also realized how strong students' mental mathematics skills are. Often, students rely on their calculators for simple computations, but this study showed me how students are extremely capable of reasoning through problems using various approaches. As a future educator, I learned we need to foster a sense of independence and student confidence in their skills in every lesson. By providing the necessary space for students to grow as thinkers, students are more likely to be capable at mental mathematics and equipped to use it in the real world.

Finally, I learned the importance of finding engaging tasks and activities while still challenging them in an appropriate way. During the research period, I used questions promoting mathematical reasoning and problem-solving, but students found these tasks to be fun and interesting, especially in comparison to the lesson material. Students enjoyed doing something different, which in this case was mental mathematics, but as educators, we need to continuously engage students using various strategies to keep them active and curious. In my lessons, I will choose activities students perceive as fun while challenging them mathematically. Additionally, students often ask questions like, "Why are we learning this? When are we ever going to use this?" After my research period, students reported they believed mental mathematics is used in the real world and more applicable than what they initially thought. By helping students bridge the gap and make explicit connections with the real-world, they are more likely to stay engaged and recognize the value in what they are learning.

As I continue teaching, I plan on using my findings to strengthen my instruction and provide students with a more well-rounded education. By helping students realize their inner potential using mental mathematics, they are likely to become more mathematically fluent and confident in their skills without relying on tools like a Smartphone or a calculator. As a teacher, we need to provide the proper space and environment for students to grow, and I hope to continue these pedagogical practices in my future classroom experiences.

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Appendix A

Mental Mathematics Name: _______________

Pre-Survey

Question 1: Mental mathematics is an important skill.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 2: I feel confident in mental mathematics.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 3: I rely on my calculator for simple calculations.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 4: I enjoy mathematics.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 5: Mental mathematics is used in the real world.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 6: There is usually only one way of solving a problem.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 7: I can check my answer by asking if it “makes sense”

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 8: I encounter mathematics every day, not just in the classroom.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 9: The solution is more important than the process in mathematics.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 10: Mathematics is essentially memorizing rules, facts, and formulas.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Appendix B

Mental Mathematics Name: ________________

Post-Survey

Question 1: Mental mathematics is an important skill.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 2: I feel confident in mental mathematics.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 3: I rely on my calculator for simple calculations.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 4: I enjoy mathematics.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 5: Mental mathematics is used in the real world.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 6: There is usually only one way of solving a problem.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 7: I can check my answer by asking if it "makes sense"

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 8: I encounter mathematics every day, not just in the classroom.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 9: The solution is more important than the process in mathematics.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Question 10: Mathematics is essentially memorizing rules, facts, and formulas.

5 Strongly Agree	4 Agree	3 Neither Or N/A	2 Disagree	1 Strongly Disagree

Did your feelings towards mental mathematics change? How?

____

____

Did you enjoy incorporating mental mathematics into the classroom? How/why?

____

____

If you were to describe mental mathematics in 3 words, what would it be?

____

____

Appendix C

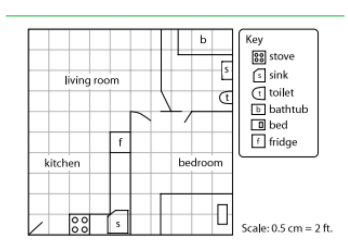
- If side a = 7 cm and side b = 4 cm, estimate the length of side c (to nearest whole number) using the Pythagorean Theorem
- The perimeter of a square is 24 units. What is the area?
- Bjork wants to buy a computer that costs $700 before taxes. If Bjork has only $750, will he be able to pay for the computer (taxes = 12% total)?
- A checkerboard alternates black and white squares. If a checkerboard is 8 squares wide by 8 squares long, how many squares are black?
- Ina is five inches shorter than Ra. If Ra is half a foot taller than Horus, then who is the shortest?
- How many reflections over the line do you need to return to the original position?

- At Deklin's school, they have 72-minute classes. If Deklin takes math every day this term, how much time will he spend in the math classroom in one week?
- A turkey must be roasted 15 minutes for every pound. If a turkey weighs 20 pounds, how long (in hours) would you have to roast it?
- Complete the pattern: 1, 1, 2, 3, 5, 8, _____, ______
- Evaluate: 25 x 16
- Simon says that in five years, his dad will be double Simon's age. If Simon's dad is 43, how old is Simon?
- Which unexpected expense costs more in a year?

a) Your car breaks down, costing you $1100.

b) You get demoted at work, losing $100 a month.

- Which letter comes next? J F M A M J J A S O N
- What is the actual area of this apartment? (A = l x w)



- What is 11% of 150?
- A building blueprint has a scale of 1 cm: 2 ft. If a door is 3' x 8', how small should it be drawn on the blueprint?
- How do you write 100 using only 9s?