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DOES PLAYING MATH GAMES IMPROVE STUDENTS'ATTITUDES TOWARDS MATHEMATICS?

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Introduction

The way math is taught has changed over the years with new research and methods constantly introduced. In a new movement of math instruction, games are introduced to create a fun, engaging way for students to practice math. According to recent research, it has been shown that students derive more enjoyment from playing games to learn math in comparison to using the more traditional methods of paper and pencil (Castellar et al., 2014).

American School Foundation of Monterrey in Mexico (ASFM) is an international, co-educational school led by American curriculum with demographics being 88 percent Mexican affluent students and the rest encompassing 15 other nationalities. Average class sizes in the elementary school are from eighteen to twenty-two students. In recent years, ASFM has introduced several games into the math curriculum based on this research. Because this is new, we were curious how the use of games in the math curriculum would affect our third- and fifth-grade students' attitudes and understanding of different math concepts.

Current attitudes among students on math are varied, but many students view math with dread or nervousness. Some students and parents believe that there are people that are born with the innate ability to understand math concepts easily and without practice, referring to them as "math people." This common misconception that skills in mathematics are hereditary is harmful to students' achievement, especially for children from ethnic-minority backgrounds and girls, who are already stereotyped as being less intelligent (Chestnut, 2018). This can cause parents to excuse their student's poor math grades and skills because they, as the parents, "are not math people," making a conjecture that math skills are genetic.

By focusing on math being a skill that is learned and acquired through critical thinking and repetition, we could help change the view of math for students. The inclusion of games in

the curriculum can benefit more than just math skills. It can boost students' attitudes and give them a positive outlook on learning. According to Stanford research, "Having a positive attitude acts directly on your memory and learning system" (Digitale, 2018). Including games can also help students develop and improve social skills and teach cooperation with others. The hope is for students to play these games at home, thereby strengthening the community by relieving stress, improving brain function, stimulating the mind and increasing creativity, and improving relationships and connections with others (Robinson et al., 2020).

In our experience, learning activities that are fun, such as games, puzzles, and projects are often pushed out of the lesson plans due to time constraints, an increased amount of standards/concepts to teach, and various interruptions throughout each day. Teachers often put more value on lectures and explanation of concepts, rather than on the exploration and understanding.

The focus of this research was to see if the math games that we integrated in the curriculum are worthwhile. If so, it would provide teachers with the evidence to include them in their instruction. The question that we asked was, "Does playing math games help improve students' attitudes toward mathematics?" Research was conducted using surveys and comparing those results to students' summative assessment scores.

Review of Literature

In a 2020 survey conducted by EdWeek Research Center, 67 percent of teachers stated that math anxiety was a challenge for their students (Sparks, 2022). This math anxiety has many effects on students' abilities to learn math. It leads students to choose poor study habits, causing them to freeze during tests due to a lack of preparedness. This disposition builds on itself and creates ongoing problems for students' math and problem-solving capabilities. "Mathematics

anxiety has been consistently shown to be negatively associated with mathematics performance" (Bertram, 2020).

Although math anxiety is correlated with poor performance, math anxiety affects students across the board. For students that place average and above-average performance in math skills, the students that have high math anxiety spend less time practicing the math skill and more time reading their textbooks and looking over already solved problems.

According to Sparks, it is important that teachers explain the advantages and disadvantages of various study habits, allowing students to realize if their methods of studying may be ineffective. To better prepare students for exams and alleviate math anxiety, teachers should offer several partially worked and unworked practice problems. By giving challenging problems in the forms of games and puzzles instead of graded homework assignments, teachers can boost students' confidence in math. Finally, teachers can encourage students to display a calm and positive demeanor on the day of the exam.

This idea of giving challenging problems in the forms of games and puzzles is further confirmed by Rutherford in her article "Why Math Games Are Important" (Rutherford, 2015). Math games are engaging, motivating, and fun for learners. They encourage conceptual thinking and problem-solving that deepen understanding of mathematical concepts. Repetition and the ability to find multiple strategies increase math fluency in students.

Game-based learning offers students the opportunity for more self-guided learning and lower risk-taking to feel more comfortable challenging themselves (Bertram, 2020). Having this active learning environment builds students' self-motivation and self-regulation creating intrinsic motivation for their learning. This generates a positive impact on students' motivation, engagement, emotions, and attitudes toward learning math. Another benefit to game playing is

teachers can quickly assess students' progress on concepts and pull those who struggle out for individual or small group interventions. These games are tools that can be easily taken and enjoyed at home with the family, allowing parents to get a deeper understanding of their children's mathematical reasoning skills and build a stronger at-home bond.

All in all, by teachers incorporating well-designed math games into their learning curriculum, it allows students' learning to be more interactive. These games provide multiple opportunities to acquire knowledge and playfully practice skills in an independent manner. With these games, students can create real-world connections to the math concepts being taught and at the same time, practice social skills with their peers. Finally, these experiences create positive attitudes toward mathematics, thereby decreasing math anxiety and reducing the correlation between math anxiety and low achievement (Bertram, 2020).

Research Purpose and Questions

The purpose of our research was to understand the effects on students' attitudes towards math after math games have been implemented into the curriculum.

Research Questions:

1. Does playing math games help improve students' attitudes towards mathematics?
2. Does the enjoyment of math correspond with higher math scores?

Hypothesis:

1.The implementation of engaging math games in the curriculum will improve students' attitudes towards mathematics.

2. Students who indicate an enjoyment of math will have correspondingly higher math scores.

Definition of Terms:

In this study the following terms will be defined as:

Variables:

The variables in our research will be the teaching of math games in third- and fifth-grade classrooms, students' attitudes towards math, and students' math scores.

Independent: Teaching of games to third- and fifth- grade students

Dependent: **1.**Math scores

2. Attitude towards math

Math attitude: The liking or disliking of mathematics

Math Game: A learning activity that has a play-like, interactive structure

Methodology

We conducted the research using qualitative and quantitative data. To collect the data, we utilized two schools: the American School Foundation of Monterrey (ASFM) and Colegio Jorge Washington (COJOWA) in Cartagena, Colombia. We chose COJOWA due to a history of having taught there before, it is also a Pre-K through 12th grade international school, and math games have been implemented in its curriculum for the past few years as well. The first set of surveys we administered was for students' perceived aptitude toward math. That survey was given to third- and fifth-grade students at both ASFM and COJOWA at the beginning of the year and before winter break. The other set of surveys we gave to our third- and fifth-grade students at ASFM for their general feeling toward math on a specific math unit. These surveys were conducted before and after a unit in the first semester. Due to differences in timing and units, we were unable to give the unit surveys to the students of COJOWA. These surveys help look at the broader view of the attitudes towards math throughout the year and the smaller impact the games

have on a specific unit. We also looked to see if there are any correlations between students' attitudes towards math and their individual scores. The scores were taken as a summative assessment at the end of the unit and compared to the students' survey results on their specific attitudes towards math.

We used multiple surveys to conduct our research and collect data. By surveying the students several times throughout the study, we hoped to glean more accurate results. The surveys are written in kid-friendly language that both third and fifth graders can understand. When giving the unit surveys, third-grade students' surveys asked about their comfort level with multiplication; whereas the fifth-grade students' surveys discussed their comfort level of fraction addition and subtraction.

Questions about student attitudes about math for the beginning and end of semester survey:

1) When you hear the word "math" what words come to mind?
2) Do you think you are good at math? (Scale of 1-5) Why?
3) Do you believe that some people are good at math and some people are not? (Yes or No)
4) Do you enjoy math class? (Scale of 1-5) Why?
5) What is your attitude towards math? (Scale of 1-5)

Questions about student attitudes towards math at the beginning of the unit:

1) How do you feel about (insert unit topic here)? (Scale of 1-5)
2) What do you think of when you hear the word (insert unit topic here)?
3) How confident are you at explaining your thinking of (insert unit topic)? (Scale of 1-5)

Questions about student attitudes toward math at the end of the unit:

1) How do you feel about (insert unit topic here)? (Scale of 1-5)
2) How confident are you at explaining your thinking of (insert unit topic)? (Scale of 1-5)

3) What did you like about this unit? Why? This is the same as question one - why?
4) What did you dislike about this unit? Why?

Project Timeline

June 2021: Informed our administration of the research.

August 2021: Gave students the beginning-of-the-year survey.

October 2021: Gave students the beginning-of-the-unit survey.

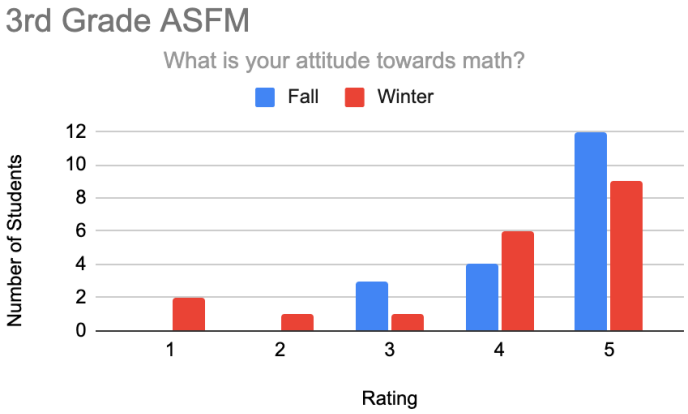
November 2021: Gave students the end-of-the-unit survey. Students also took the summative assessment of the unit at this time.

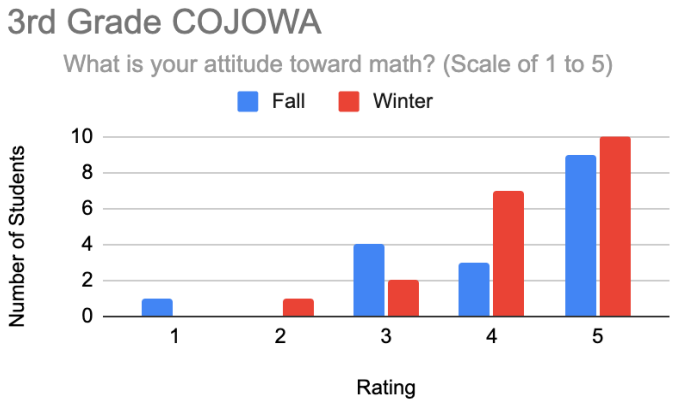
December 2021: Gave students the end-of-the-semester survey.

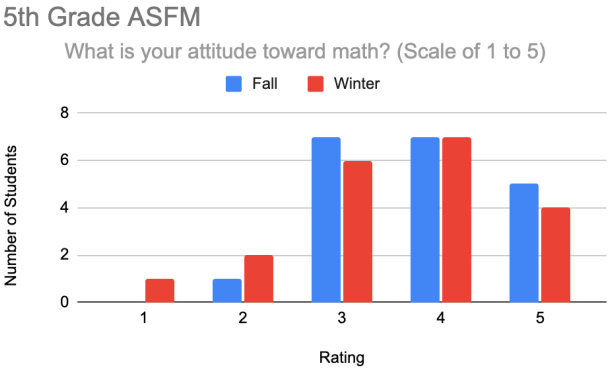
January 2022: We began to analyze the data and look for any correlations between the survey results and the summative assessment scores.

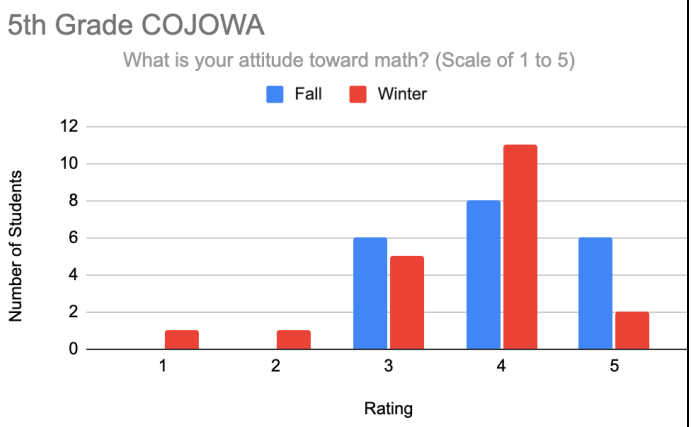
Findings

After the data from the surveys and summative assessments were collected, we compared the results from the beginning- and end-of-semester surveys to see if attitudes in math had changed. This was done by making a table for each class and examining the before and after attitudes for every student, as shown below.





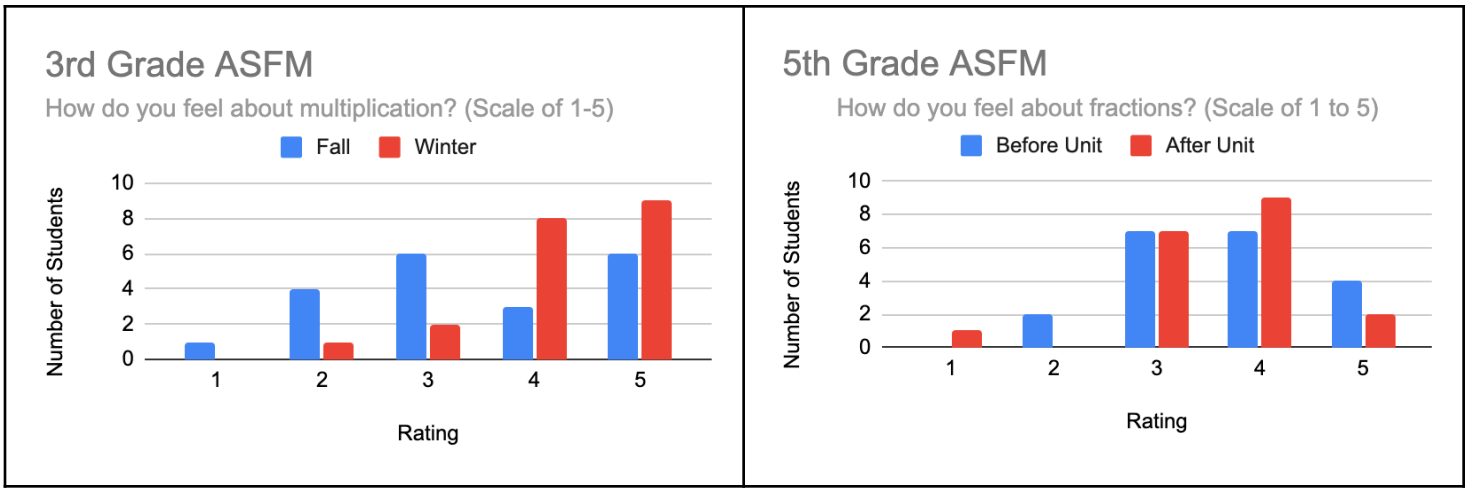




When analyzing the data, we were surprised. As shown in the graphs above, three of the four surveyed classrooms demonstrated a decline in attitudes towards math. Reading over the results and the explanations our students provided, some of them commented that math was fun but difficult. Others said they enjoyed math due to all the games and different strategies given. Finally, several students stated that math is sometimes boring. The third grade class at COJOWA revealed more positive attitudes towards math, as evidenced by their comments. One example is from a student who rated his attitude a five. "I put that number because math is important. You are going to see math in all your life." Many of these third-grade students wrote that math is fun because you get to learn something new everyday. Only one student commented that math is

sometimes boring. The students in this third-grade class had an obvious growth mindset which aided in both their attitude and enjoyment of math.

In the other part of the survey that we conducted, the third-grade students were surveyed at the start and end of the multiplication unit. The fifth grade students were surveyed at the start and end of their fraction unit. These are the results we found.



For the third-graders' results, we had a positive upward correlation about their feeling of multiplication from the beginning to the end of the unit. We were expecting this because at the beginning of the unit they had not practiced multiplication before so it was new, unknown, and intimidating for them. Learning the symbol for multiplication was exciting for them! At the end of the unit, most of them felt closer to mastery, accomplished in tackling a new task, and increased their attitudes towards multiplication as shown in the data.

The fifth-graders' data were a bit different. At the start of their fractions unit, they had already had some exposure and preconceived ideas about fractions. Although this was their first exposure to unlike denominators and borrowing with mixed numbers for subtraction, this was their first time getting to work with fractions hands on. The lessons they had been previously

taught were all online due to the pandemic, and they never got to use the manipulatives that are usually included in the unit to give them a solid foundation of fractions.

Following this, we looked for any correlations between the results of the unit surveys and the unit summative assessment scores. This was achieved by matching each student's attitude towards the math unit and his/her assessment score. We predicted that in most cases, the students with the higher scores would have a more positive attitude towards math. We were correct with our predictions with a few students as outliers. One of the higher achieving ASFM third graders had a lower score in attitude than expected but commented that, "Math is boring because it is easy and we do it everyday." This is valuable data that leads us to believe that he was not being challenged enough and could have benefited from more extension activities.

Other Project Considerations

In our hypothesis, we expected students' attitudes to be impacted in a positive way with the implementation of games into the mathematics curriculum. This improvement of attitudes, not just in the unit but throughout the semester and year, would improve students' outlook on math and their enjoyment of learning. We also believed that the students who have the more positive attitudes and enjoyment of mathematics will be the students with higher achievement levels on summative assessments. We had hoped that this would support our new math curriculum and demonstrate to our colleagues the benefits of making time in our busy schedules to allow our students time to play math games.

One of our concerns about the limitations of our study was that due to online instruction because of Covid, we still did not know what the next school year would look like. There were still discussions of it starting online, possibly being hybrid, and less likely being fully in person

learning. This would impact students' attitudes towards school, with many of them already finishing the previous school year feeling fatigue from distance learning. If we had started the school year online or hybrid, this would make playing games less interactive. This would reduce the community benefits and life skills that are provided with the games, like team building and communication.

This school year was heavily impacted by Covid. At the beginning of the year, we were told we were going to be back in person with split day schedules and the students in two cohorts. We had one day where we met half of our class for them to drop off their supplies before we were notified that everything was going to be forced back online. So not only were we working with the challenge of returning online, but only half of our students had the appropriate materials to learn because the other half dropped them off at school. The hope of returning to school with in-person learning was interrupted and many students and teachers were heartbroken being back online. This lasted for a month before we had our next schedule change.

Our schedule changed so many times within the next couple of months that it was hard to feel stability in the classroom. Every schedule change offered its pros and cons, and we tried our best to remain adaptable. Many students and teachers were absent during this time because of having Covid, being in close contact with someone who had Covid, or they planned a trip assuming school would still be online. This was frustrating and hard for teachers to track students down. With specialist teachers gone, many teachers lost their planning time having to keep their class in their room or cover for someone else.

We believe that these changes and the environment of our school heavily affected our students' attitudes towards learning. At first, they were also excited to be back in the school. This was at the time when we gave them their first survey, “Fall- What is your attitude towards

math?" In general, they were just excited to be back to school and learn anything with their friends. The second survey was administered in December right before winter break, "Winter- What is your attitude towards math?" In hindsight, no wonder their attitudes dropped. In any elementary school, that is not a high time for morale. Then on top of it all, we had gone through more schedule changes than we can count. With all of the adjustments, the students became fatigued from uncertainty as well as the teachers.

A final consideration to take into account is the fact that ASFM has been using math games in the classroom for at least the past four years. This could have skewed the results due to not starting off with students who had a more traditional learning environment in previous years.

Conclusion

In analyzing the data, we did not find conclusive evidence as to whether playing math games in school enhances students' attitudes towards math. Although the data suggests a decline in attitudes, there were too many variables affecting the outcome to charge playing math games as the reason. There were several scheduling changes during the school year, and most students were academically behind in math due to having online classes the previous year. Students naturally struggled more in understanding the math standards because of the gaps in learning that had accumulated during this time.

While addressing the question of whether or not students' math scores correlate with their attitudes towards math, we found that the majority of students with a higher understanding of math concepts in a unit had a more positive attitude towards math. This did depend, however, on if there was any prior knowledge of a concept or if there were any gaps in learning from previous

years. Those students without a solid base in a concept taught the prior year logically struggled to comprehend the new ideas being presented.

In conclusion, further studies in these topics are needed. With any subsequent studies done on how math games affect students' attitudes towards math, a recommendation would be to ensure the study happens during a regular school year where a high absenteeism rate and schedule changes are not expected. Consideration should also be given to the time of year surveys are conducted and to the concepts being taught. In conclusion, our study was inconclusive as to whether playing math games improved students' attitudes towards math or not.

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