Seven Spells and Peer Tutoring: a Collaborative Mathematics Game Experience

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Abstract: Mathematics anxiety (MA) is a negative emotional response to the manipulation of numbers and the solving of mathematical problems, potentially hindering learning and leading to poor maths skills. Digital game-based learning, in which games are used for education, has been recognised as a potential tool for reducing MA and positively influencing learning, information assimilation, and retention. Peer tutoring is an active learning method that reduces MA in addition to benefiting students academically. This study assessed how 'Seven Spells', a digital maths game developed by our team, affects students' levels of MA and mathematics performance. We hypothesized that this game could be used in classrooms to control MA and potentialise mathematics learning when combined with peer tutoring. 55 children from two 4th classes in an Irish primary school participated in this study. Over a period of three weeks (two days/week), the groups played the 'Seven Spells' game with and without peer tutoring. A mathematics knowledge test, including content covered by the game, was administered at the beginning and end of the study to assess the children's mathematics skills. Game scores were also analysed. At the end of the study, the children participated in an interview, answering questions about the game and the peer tutoring experience. The average game scores increased significantly for the entirety of the children, and also for both groups separately. MA only decreased significantly in the no-peer tutoring group, suggesting that the peer tutoring approach, which was expected to reduce MA, was not successful. No statistically significant differences were found between the peer tutoring and the no-peer tutoring groups in terms of game scores, mathematics errors and MA, further pointing out that the peer tutoring approach was not successful either in reducing MA or in stimulating mathematics learning.

Keywords: digital game-based learning, mathematics, primary school, peer tutoring, mathematics anxiety

1. Introduction:

Mathematics anxiety (MA) is a negative emotional response in relation to mathematics (Buratta *et al.*, 2019; Carey *et al.*, 2017; Krinzinger, Kaufmann and Willmes, 2009) that can hinder mathematics learning and lead to poor mathematics skills, even affecting an individual's future career choice (Carey *et al.*, 2017; Wu *et al.*, 2012). The largest dataset on MA was made available by the Programme for International Student Assessment (PISA) in 2012 (Organisation for Economic Co-Operation and Development, 2013), comprising data from 34 countries: 59% of surveyed 15-to-16-year-old students reported often feeling worried about mathematics classes being difficult; 33% reported feeling very tense with mathematics homework; 31% declared getting nervous doing mathematics problems; 30% admitted feeling helpless when doing a mathematics problem, and an even bigger proportion – 61% - that they are worried about getting low grades in mathematics (Luttenberger, Wimmer and Paechter, 2018; Organisation for Economic Co-operation and Development, 2013).

To properly deal with MA, early identification and handling are crucial (Wu *et al.*, 2012). Digital game-based learning (DGBL), in which games are used for education, has been recognised as one potential tool for both reducing MA and influencing characteristics of the cognitive domain that may optimize learning, such as concentration, information assimilation, motor coordination and retention (Moyer-Packenham *et al.*, 2019; Rocha, Dondio and Tangney, 2016; Vanbecelaere *et al.*, 2019). DGBL can potentially contribute to creating an active, problem-based learning environment (Vanbecelaere *et al.*, 2019). Evidence indicates that the use of game interventions can facilitate knowledge transfer from the virtual to the real environment and elicit greater positive effects on mathematics learning and anxiety through learning activities as they are regarded as more enjoyable than traditional paper-based methods (Castellar *et al.*, 2015; Vanbecelaere *et al.*, 2019). DGBL has been linked to different educational theories, including behaviourism, cognitivism, humanism and constructivism; for this research, the latter view has been considered, with DGBL being used as an active and social process (Sanchez, 2019; Wu *et al.*, 2012). Based on Constructivism (Clarkson and Luca, 2002), peer Tutoring is another active learning methodology which benefits students in social and academic settings and has also been shown to reduce MA in middle school students (Moliner and Alegre, 2020).

The authors hypothesize that the usage of a mathematics game could potentialise mathematics learning and control MA, especially when combined with peer tutoring. Hence, this research aims to answer the following question: Does the use of a digital mathematics game (namely the digital cards game 'Seven Spells', previously developed by our team) combined with peer tutoring enhance mathematics learning and control MA in primary school children?

2. Methods

2.1 Research design

A number of Irish primary schools were invited to participate in the 'Happy Maths' programme, which uses the digital game 'Seven Spells' to support mathematics learning. These schools were contacted via email in which the procedure was detailed i.e. what would be tested, how the researchers would conduct the study and interact with the children and the experiment's duration. Of the schools that accepted the invitation, one was recruited to be part of this specific experiment. Each participant class (two classes, comprising 55 students in total) was visited six times, twice per week during school hours, with the visits being one hour in duration. The study's experimental design is shown in Table 1, which also details the procedures performed during each visit.

Table 1: Experimental design.

6 weeks						
Weeks	**Week 1**		**Week 2**		**Week 3**	
Days	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
Activities	- Game tutorial - modified Abbreviated Math Anxiety Scale - Mathematics questionnaire - Game session	- Game review - Game session	- Game review - Play with or without peer tutoring	- Game review - Play with or without peer tutoring	- Game review - Solo game session	- modified Abbreviated Math Anxiety Scale - Mathematics knowledge questionnaire - Interviews

Letters of consent were sent to the children's parents/guardians asking whether or not they permitted their child to participate in the experiment. These letters were distributed before the start of the study, so that both children and their parents had time to consider and agree/disagree to participate. Children were excluded from the study if their parents did not sign the informed consent or if they did not complete the questionnaires. Of the two participating classes (55 students), one class was randomly assigned to play the game with peer tutoring (27 students) and the other without peer tutoring (28 students).

The first visit consisted of a pre-test phase, in which the children completed two questionnaires. The first questionnaire was the modified Abbreviated Mathematics Anxiety Scale (mAMAS) (Carey *et al.*, 2017), a validated questionnaire that measures levels of MA in students from primary schools. The second questionnaire consisted of a list of mathematics questions related to the content covered by the 'Seven Spells' game and the Irish Mathematics curriculum. The goal of this questionnaire was to measure the children's performance on topics they should know according to their grade (4^{th} class for this experiment). After completing both questionnaires, the two groups were then introduced to the educational mathematics game 'Seven Spells' which covers more than 50 learning outcomes from the Irish Mathematics curriculum. The aim of this online card game is to capture number cards using mathematics abilities. Tablet computers were taken to the schools according to the number of participating children. All children received training in the form of an in-person tutorial given by one of the researchers, who explained the game's mechanics and advised the children throughout their gameplay. Note: children's game scores were collected from this first game session with the 'Seven Spells' game until the last game session on day 6 of week 3.

During the second visit, the game's rules were reviewed during a guided gameplay session with one of the researchers, after which the children played the game again. The third and fourth visits consisted of letting the children play the game, much like in the previous two visits; however, one of the groups did so in conjunction with peer tutoring, and the other one, without. For this experiment, a fixed, same-grade peer tutoring approach was used, meaning that the children maintained their roles throughout the entire intervention and were from the same grade. The tutors and tutees were chosen according to their average scores in 'Seven Spells' during the first two visits, in line with the work of (Alegre *et al.*, 2020; Campbell, 2019). Essentially, a list of the children's usernames was organized according to their scores, from highest to lowest. This list was then divided into two sections; the children who were part of the first section (which included the highest scores) were selected as

tutors, whilst the children in the second section (which included the lowest scores) were appointed as tutees. Tutors and tutees were then paired according to their position in the associated sections i.e. the child at the top of the first section was paired with the child at the top of the second section, and so on.

During the fifth visit, children from both groups took part in a last solo playing session, meaning that the tutors and tutees were separated. In the sixth and final visit, the children once again completed the mAMAS and the mathematics knowledge questionnaires. They were also invited to attend a short interview session concerning the game and the peer tutoring experience.

2.2 Participants

The participants in this study comprised two 4th class groups from a primary school based in Kildare, Ireland. The data included a sample of 55 4th class students. The source data collected during the six days of game play was extracted, cleaned and merged into a single large, anonymised dataset. Data cleaning was necessary due to children missing class or simply not answering questions on the questionnaire. Data cleaning was executed for each variable; game scores, mathematics knowledge and MA. This resulted in different sample sizes for different variables (Table 2).

Table 2: Number of participants and students included in the analyses of each variable.

Variable	Control group No Peer Tutoring	Peer Tutoring	Total
Game Scores	25	20	45
Mathematics knowledge	26	22	48
MA	28	22	50

2.3 Data collection

All results were collected and inputted into a database for analysis. Data was compared considering the initial level of mathematics knowledge and MA and the different groups (the control i.e. non-peer tutoring) group and the peer tutoring group). The project's dataset was analysed to investigate possible correlations and causality between the game intervention, peer tutoring, game scores, mathematics knowledge and MA indicators, identifying whether the peer tutoring interventions had a statistically significant effect on the participating children.

Data from this project cannot be made publicly available because it consists of information about MA and the mathematics knowledge of minors. Thus, data was password-protected with only participant researchers having access to it. Additionally, the children's participation was anonymised: researchers only had access to their usernames, which were assigned as an ID to give access to the game, answer the pre- and post-questionnaires, and be assigned their game scores. The teachers were responsible for completing a spreadsheet which linked the children's usernames to their data and questionnaire results. All data was extracted and analysed using only the game usernames.

2.3.1 Game scores

Game scores were collected from each child and inputted into the 'Seven Spells' database during the game sessions. For this variable, both the highest and the average scores achieved by each child were considered.

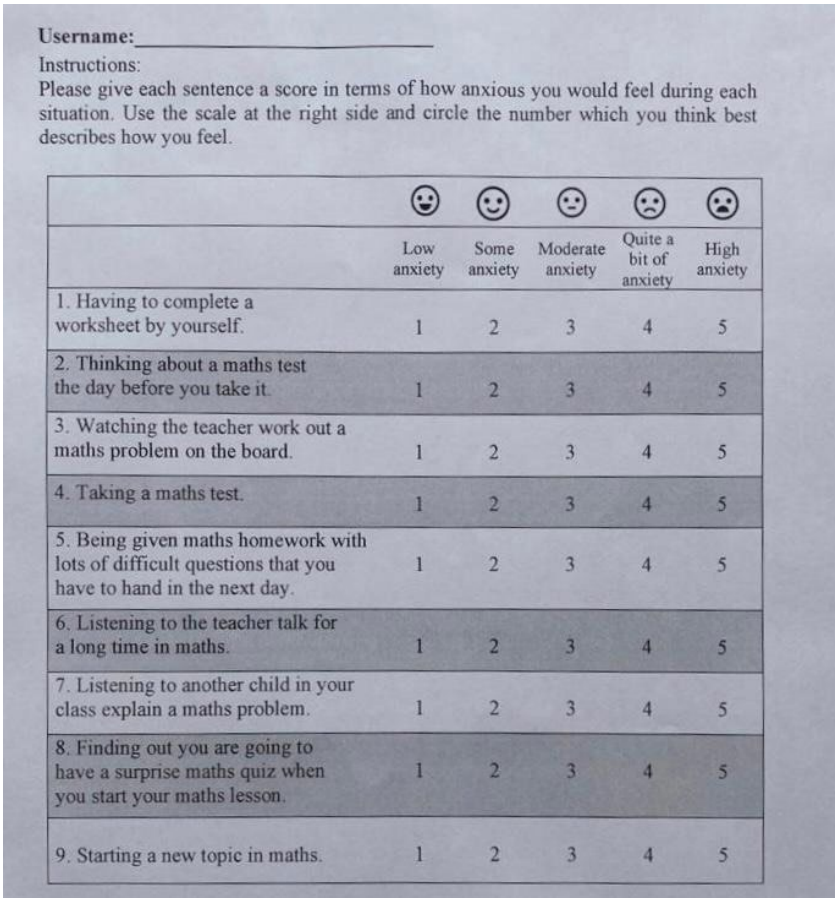
2.3.2 Mathematics knowledge

For mathematics knowledge, a short list of mathematics questions – including content covered both by the 'Seven Spells' game and the Irish Mathematics curriculum according to their grade – was given to each child to complete. The children had ten minutes to finish the questionnaire. For the data analysis, the number of mathematics errors was captured: lower numbers meant that the children committed fewer mistakes, while higher numbers meant a greater number of mistakes.

2.3.3 Mathematics Anxiety (MA)

The modified Abbreviated Mathematics Anxiety Scale (mAMAS) (Carey *et al.*, 2017) was used to measure the children's MA. In this questionnaire, children answered nine questions about MA using a 5-point Likert scale to indicate their feelings during each situation i.e. they circled the number that best described their feelings (Figure 1). Each number is paired with a brief description of how anxious they felt in each situation (1: "Low anxiety"; 2: "Some anxiety"; 3: "Moderate anxiety"; 4: Quite a bit of anxiety"; 5: High anxiety"), along with a simple emoji to

better illustrate that feeling. The minimum possible score for the questionnaire is nine, which would indicate low MA. The maximum possible score of 45 points, would indicate high levels of MA.



Username:_____

Instructions:

Please give each sentence a score in terms of how anxious you would feel during each situation. Use the scale at the right side and circle the number which you think best describes how you feel.

	Low anxiety	Some anxiety	Moderate anxiety	Quite a bit of anxiety	High anxiety
1. Having to complete a worksheet by yourself.	1	2	3	4	5
2. Thinking about a maths test the day before you take it.	1	2	3	4	5
3. Watching the teacher work out a maths problem on the board.	1	2	3	4	5
4. Taking a maths test.	1	2	3	4	5
5. Being given maths homework with lots of difficult questions that you have to hand in the next day.	1	2	3	4	5
6. Listening to the teacher talk for a long time in maths.	1	2	3	4	5
7. Listening to another child in your class explain a maths problem.	1	2	3	4	5
8. Finding out you are going to have a surprise maths quiz when you start your maths lesson.	1	2	3	4	5
9. Starting a new topic in maths.	1	2	3	4	5

Figure 1: The modified Abbreviated Mathematics Anxiety Scale (mAMAS).

2.3.4 Interviews

The children were recruited to participate in interviews on the last day of the experiment, where they were asked a set of open-ended questions about the game intervention and the peer tutoring experience. For the purpose of this experiment, a qualitative analysis was conducted with the answers given to questions in relation to the effect of using 'Seven Spells' in the classroom and the peer tutoring approach.

The following questions were asked:

- Did you learn anything new while playing 'Seven Spells'?
- How did you feel when playing with someone else? Did you prefer playing in a pair or alone? Why?
- Was it clear that in your pair, one was a tutor and the other was a tutee? Or did you feel like there were no specific roles and both helped one another?

2.4 Data analysis

Data analysis was carried out through statistics techniques using IBM SPSS Statistics version 28. Descriptive and inferential statistical tests were realized to draw possible conclusions concerning the advantages of 'Seven Spells' and the peer tutoring interventions, and their effects on mathematics knowledge and MA.

2.5 Ethics

All experiments conducted in this study were submitted to the Technological University Dublin Ethics Committee, and all researchers involved in this project applied to be vetted by the National Vetting Bureau, required for those who will carry out relevant work with children. Applicants received a background check, examining if there was any criminal record or specified information about them. All our approaches to user data comply with the General Data Protection Regulation (GDPR).

2.6 The 'Seven Spells' game

The game used in this experiment is entitled 'Seven Spells', a digital card game previously developed by our team, where players capture cards presented on a digital board. To do so, they match numbers using mathematics' abilities. 'Seven Spells' covers more than 50 learning outcomes from the Irish Mathematics curriculum, including arithmetic operations – addition, subtraction, division and multiplication – and numeric tables.

Examples of gameplay can be seen in Figures 2 and 3, which demonstrate the digital board, the red cards that must be captured by the player and the players' cards, which can be blue – the numbers themselves, used by players to capture red cards – or yellow – the so-called "spell cards", used to capture cards from the board or to modify both blue and red cards, allowing the player to capture them. Both images also show "special" blue cards, the "total" – a card that can capture more than one red card, as long as the numbers on said cards sum up to the number shown on the blue "total" card – and the "max" – which can be used to capture not only cards that are equal, but also less than that number. On the left, the player can also see their username, profile picture, score, number of moves and position in the overall leader board.

Specifically, Figure 3 shows examples of moves, and that more than one move can be made in the same turn, and that each move is highlighted by yellow arrows pointing from the player's card towards the red card(s) on the board. The order of the moves is also shown on the cards' upper left. When a player has done all the moves they want, they should press the "GO!" button to finish their turn. There is also an "Undo" button, where the player can restart their turn. If the player wants to end their match prematurely, they can press the "End" button. Figure 3 also shows the "Master", a fictional character who explains what each card does when a player presses it.

The player has only 40 cards on their deck and should aim to capture the most opponent cards to reach higher scores. Each card the player uses is part of their deck. When there are no more cards on the deck and no more moves a player can do with the cards that are on the board, the match is over. Throughout the match, the player is able to get more cards in two ways: performing a "mega move" – which is any move worth more than 30 points – or reaching a points milestone (every 100 points). When these events happen, the player is able to pick one of 4 possible cards, while still being able to see the boards, which allows for an informed decision about the best card for the situation. An example of a "mega move" and the subsequent card choice can be seen in Figure 4. Players can also change their cards by pressing the "Change card" button, as shown in Figure 5; they can then click one of the cards on the green area, which will be discarded and replaced with one of the cards in the player's deck; the player can also press "don't change" to give up on the idea.

Apart from the in-person game tutorial delivered by the researchers, students would also see a short refresher of the rules at the beginning of every match, as shown in Figure 6.

Figure 2: "Seven Spells" gameplay.

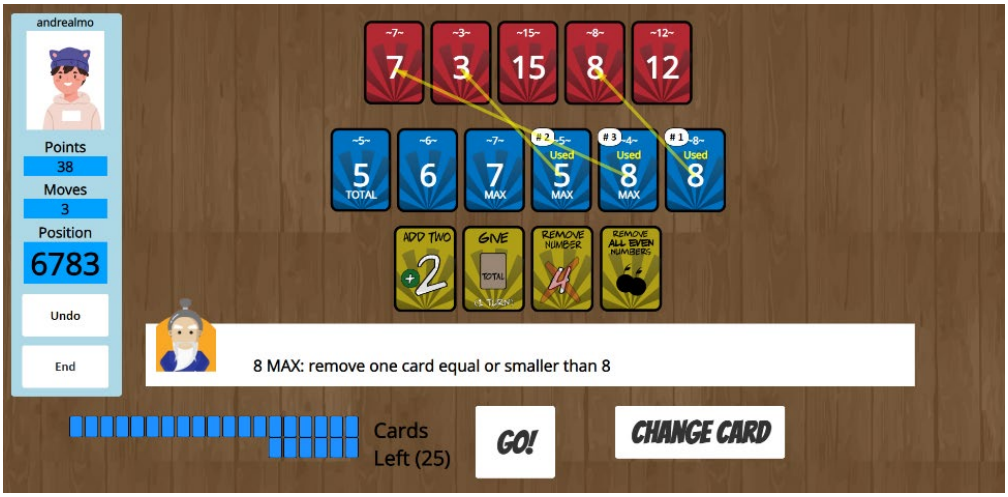


Figure 3: "Seven Spells" gameplay showing the players' moves.

Figure 4: A "mega move" in "Seven Spells", leading to an extra card choice.

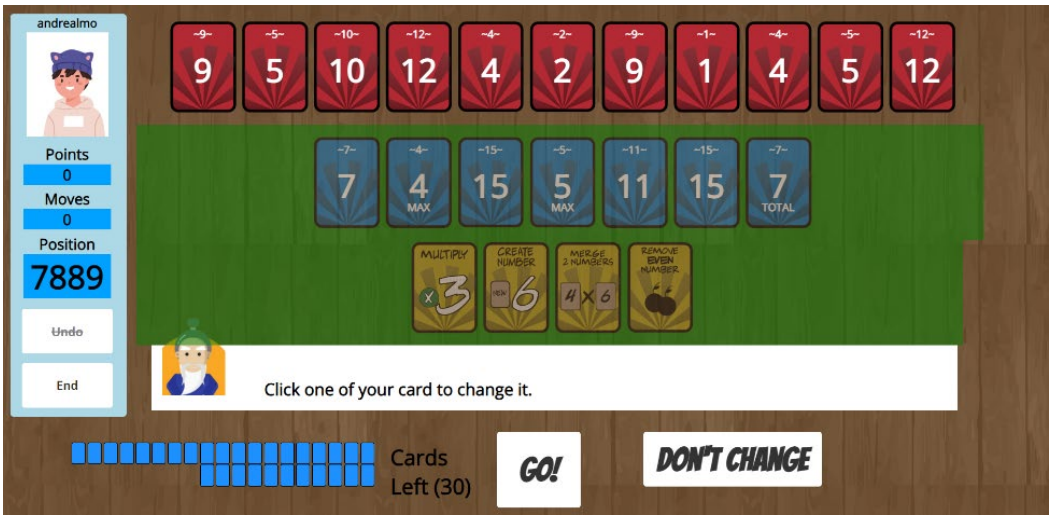


Figure 5: The "change card" button, allowing the player to replace one of the cards in the green area with one of the cards on the deck.

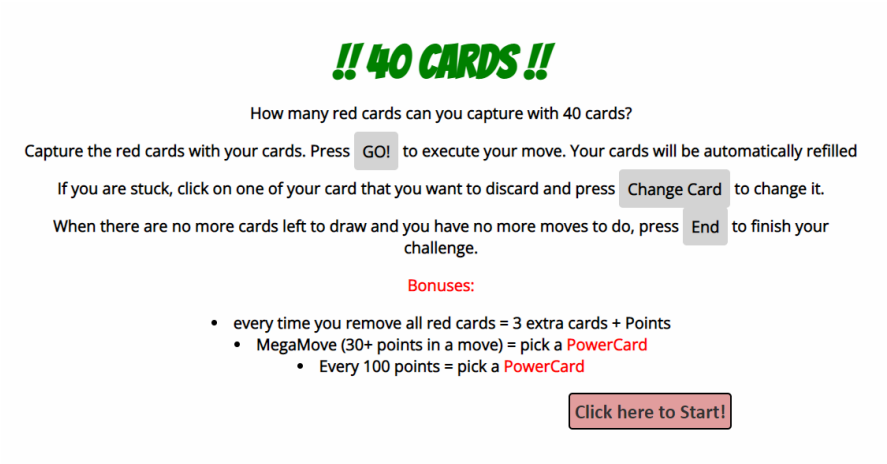


Figure 6: A refresher of "Seven Spells" rules, as seen by students at the beginning of every match.

3. Results

Descriptive statistics for game scores (highest and average), mathematics errors and MA, both before (pre) and after (post) the peer tutoring intervention for the two groups, is shown in Table 3. This includes both measures of central tendency – the average – and measures of variability (minimum, maximum and standard deviation).

Table 3: Descriptive statistics of game scores (highest and average), mathematics errors and mathematics anxiety.

Variable	Minimum			Maximum			Average			Standard deviation		
	No Peer Tutoring	Peer Tutoring	Total	No Peer Tutoring	Peer Tutoring	Total	No Peer Tutoring	Peer Tutoring	Total	No Peer Tutoring	Peer Tutoring	Total
Highest game score (pre)	116	131	116	736	1072	1072	366,4	294,6	332,6	215,0	148,8	201,6
Highest game score (post)	72	92	72	1380	820	1380	369,2	313,2	342,9	285,8	142,8	254,3
Average game score (pre)	36	76	36	391	783	783	178,4	180,8	179,5	151,8	58,4	134,1
Average game score (post)	71	85	71	822	633	822	300,2	259,5	281,1	179,7	109,6	164,0
Mathematics errors (pre)	0	0	0	16	12	16	3,8	3,0	3,4	4,4	1,9	3,9
Mathematics errors (post)	0	0	0	17	12	17	2,7	2,6	2,6	3,9	2,4	3,5
Mathematics anxiety (pre)	9	11	9	40	33	40	21,5	18,8	20,3	8,5	8,1	8,3
Mathematics anxiety (post)	9	9	9	29	34	34	17,2	16,3	16,8	6,9	7,4	7,0

Data on game scores, mathematics errors and MA were tested for normality using the Shapiro-Wilk test. Since data was not normally distributed, as shown in Table 4, all subsequent statistical tests were non-parametric.

Table 4: Normality test for game scores, mathematics errors and MA.

	Shapiro-Wilk		
Variable	**W**	**df**	**p**
Highest game score (pre)	.852	43	<.001
Highest game score (post)	.780	43	<.001
Average game score (pre)	.731	43	<.001
Average game score (post)	.887	43	<.001
Mathematics errors (pre)	.671	43	<.001
Mathematics errors (post)	.730	43	<.001
Mathematics anxiety (pre)	.924	43	.007
Mathematics anxiety (post)	.892	43	<.001

The Wilcoxon signed-rank test was performed for both groups, to compare game scores (highest and average), mathematics errors and MA before and after the peer tutoring intervention. Table 5 shows these results; differences in the average game scores were the only variable with significant change for all the children.

Table 5: Wilcoxon signed-rank test for all children.

	Wilcoxon signed-rank	
Variable	**W**	**p**
Highest game scores	1149	0.49
Average game scores	1797	<0.05
Mathematics errors	1080	0.14
Mathematics anxiety	954	0.02

The Wilcoxon signed-rank test was also realized separately for the two groups in terms of game scores (highest and average), mathematics errors and MA, before and after the peer tutoring intervention to check for the possible effects of the intervention. As shown in Table 6, only the average game scores showed significant increase for both groups. However, MA only decreased significantly for the no-peer tutoring group.

Table 6: Wilcoxon signed-rank test for the two groups separately.

	Wilcoxon signed-rank			
	No peer tutoring		Peer tutoring	
Variable	**W**	**p**	**W**	**p**
Highest game scores	265	0.13	290	0.77
Average game scores	511	0.004	388	0.02
Mathematics errors	275	0.12	261	0.59
Mathematics anxiety	241	0.03	224	0.19

Finally, the difference for each variable – game scores (highest and average), mathematics errors and MA was calculated for each of the children. The Wilcoxon signed-rank test was then used to compare the differences found for the variables in the control group (i.e. non-peer tutoring) versus the peer tutoring group. Table 7 presents the results of such tests. According to the p-values, there was no significant difference between the conditions.

Table 7: Wilcoxon signed-rank test for the differences between variables.

	Wilcoxon signed-rank	
Variable	**W**	**p**
Highest game scores	201	0.26
Average game scores	248	0.98
Mathematics errors	256	0.54
Mathematics anxiety	246	0.41

Additionally, two pairs of children – consisting of two tutees and two tutors – were interviewed at the end of the experiment. The pair of tutees felt they learned something new while they were playing 'Seven Spells' but did not elaborate on how or why. Both described the experience of playing with someone else as something positive, using the words "*fun"* and "*nice"*. They also preferred playing as a pair over playing alone. When asked why they preferred playing as pairs, one of the children stated that they preferred this experience "*because if you get stuck you can see what the other person is doing"*. Both tutees answered that there was no clear role in their pairs; according to one of the interviewed children, "*both helped each other"*.

The pair of tutors recognised they also learned while playing the game. One of them reported: *"Yeah, I think, like, strategies. Just using my brain to think of different things. When I started, I only got like a hundred points. Now it turns out I got a thousand points. When you play a bit more you work your way up. I think I learned some more maths, because I multiply faster. And I don't really add up numbers all the way up to 99. Before I was just clicking on all the cards and just hoped to get the high numbers, but now I count up to these numbers."* The other child stated *"Like, at first I would do two points in a move, but now I can do twelve, twenty four."* When asked what they liked about the peer tutoring experience, Tutor 1 answered that; "*It's exciting*". Tutor 2 continued: "*It's fine. I like it because I noticed that when you are playing, like, you think of only one way but then you see, like, when you chat with somebody else they give you another idea, and then you combine your ideas and then you find an even more powerful way to do it.*" Both tutors, however, preferred playing alone. One of the students said "*I just kind of prefer the independence to do things by yourself... like, you might get into an argument*". Tutor 2 complemented the experience saying that : "*Sometimes you want to do that, like, I want to do that move. And I want to do this other move…*". Tutor 1 continued with: "*But you both are using the same card, so if one uses that card, you can't use the same one."*

4. Discussion

4.1 Game scores, Mathematics Errors and MA

The increase in average game scores was the only significant difference found among all children between the pre- and post-conditions. Independent of the intervention being made with or without peer tutoring, this result was to be expected as the children played the 'Seven Spells' game throughout all six sessions of the experiment, thus becoming familiar with the game's rules and strategies. This was further proved to be true when the increase in average game scores was again significant, but for both groups separately. MA, however, only showed a significant decrease for the no-peer tutoring group. Literature points out that peer tutoring interventions reduce MA (Moliner and Alegre, 2020); thus, this result may indicate that the peer tutoring approach used in this experiment was not successful.

No significant differences were found for any of the measured variables – game scores (highest and average), mathematics errors and MA – between the peer tutoring and the no-peer tutoring group, also suggesting that the peer tutoring intervention had no success in reducing children's MA and stimulating mathematics academic achievement. Another expectation – that players with the higher scores would teach the game's rules and strategies to lower-achieving players – was not met.

Even though there was no statistical significance, there was a decrease in the average of mathematics errors in the mathematics questionnaires applied in the first and last days of experiments. This points towards the game's potential as a mathematics teaching tool; more studies are necessary to confirm this tendency.

4.2 Interviews

The interviews showed that the children positively evaluated the game for their learning. Both tutors and tutees considered the peer tutoring experience to be positive and fun; the tutors, however, elaborated more on their responses. Both tutors, for instance, focused their comments about the learning provided by the game on its strategies and scores, reflecting the quantitative observation that the increase in the average scores was the most significant result. Although the two interviewed tutors viewed the peer tutoring approach positively, they also showed a preference for playing alone. Another important result is that the tutees pointed that there were no clear roles for tutors and tutees in their pairs: this absence of a clear demarcation of roles may have contributed to the lack of success of the peer tutoring approach in terms of learning.

4.3 Limitations

This study has several limitations. Due to lack of time and available classes, the experiment only involved two fourth class classes, both playing the 'Seven Spells' game, one with peer tutoring and another without. This prevented a comparison with other control groups; groups which would receive no intervention, groups who would receive a non-game audio-visual educational mathematics intervention, or traditional, paper-based peer tutoring sessions. The lack of a bigger sample has impacted on data distribution and the significance and generalisability of the results. Furthermore, due to time constraints, the team was limited in the number of interviews which were conducted. Through holding more interviews, it would be interesting to perform a thematic analysis, investigating possible patterns in the children's responses to DGBL and the peer tutoring approaches, and how their opinions relate to their own MA, mathematics errors and game score results.

4.4 Conclusion and Future Research

Mathematics is critical to employment in the science, technology and engineering sectors (Watkins & Mazur, 2013). Studies show that the earlier a child develops a more formal understanding of mathematics related concepts, the easier it is for them to build on these concepts in subsequent mathematical education and perform better (NAEYC, 2020). However, Maths Anxiety (MA) negatively impacts the manipulation of numbers and the solving of mathematical problems, potentially hindering learning and leading to poor maths skills.

One intervention to addressing MA is digital game-based learning. The effectiveness of games as a learning support is well established in mathematics education (Cohrssen & Niklas, 2019; Es-Sajjade & Paas, 2020). In this study, we assessed the effects of applying a digital mathematics game in conjunction with peer tutoring, which is an active learning strategy, like DGBL. The results showed that the average game scores increased significantly for all children and groups, as expected, since students played the game throughout six 1-hour sessions. However, MA only decreased significantly in the no-peer tutoring group. No statistically significant differences were found between the peer tutoring and the no-peer tutoring groups in terms of game scores, mathematics

errors and MA; in this experiment, peer tutoring was not successful in reducing MA or stimulating mathematics learning. Further research needs to be done on the effects of peer tutoring used in conjunction with an educational game intervention for MA and mathematics learning. Studies need to include other control groups and bigger samples.

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