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Exploring Student Engagement in Mathematics: A Study on Interests, Concerns, and Motivation through an Interactive Game

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Abstract

In Malaysia, mathematics is often one of the least favored subjects among students, who struggle with fundamental concepts. This issue is particularly significant as mathematics is a core component of education and is essential for future academic and career opportunities. Addressing this challenge requires innovative approaches to foster student engagement and improve learning outcomes. This study investigates the potential of interactive learning methods to enhance student interest and understanding in mathematics, with a specific focus on the RoadMath game, an innovative tool designed to make learning mathematics more enjoyable and engaging. The study employs a quantitative methodology to assess the impact of the RoadMath game on student engagement with mathematics. Data was collected through questionnaires distributed to students in Johor Bahru, who interacted with the game at a UiTM Johor booth's set up during National Science Week. The questionnaires captured students' feedback on their interest in mathematics before and after playing the game, as well as their motivation and concerns related to the subject. The findings reveal that the majority of students found the RoadMath game enjoyable with highest mean scores (4.6), suggesting that interactive learning can indeed boost interest in mathematics. The game also served as a motivational tool, creating a more positive learning environment. These results indicate that incorporating interactive methods, such as educational games, into mathematics curricula could be a promising strategy for improving student engagement and proficiency in the subject. Based on the results, further research is proposed to explore the long-term effects of interactive tools like the RoadMath game on students' mathematical abilities and attitudes, as well as to assess the potential of integrating such games into classrooms at various educational levels to evaluate their broader impact on mathematics education.

Keywords: Interactive Learning, Mathematics Education, Student Engagement, Game-Based Learning.

Introduction

As students embark on their educational journey in Malaysia, they encounter a diverse range of experiences and obstacles. Among these, mathematics stands out as a particularly challenging subject, known for its intricate nature and requirement for sharp problem-solving skills (Liu, Wachira, Koc, & Pourdavood, 2022). Furthermore, a significant progress has been made in the development of Science, Technology, Engineering, and Mathematics (STEM) in the Malaysian Education Blueprint which the crucial aspect of this advancement is to raise awareness about improving the learning styles so that learning mathematics becomes more enjoyable and engaging. Hence, interactive learning is used as a method to improve students' mathematical skills and knowledge. Interactive learning in education, often referred to as active learning, involves students actively participating in the learning process. This approach encourages collaboration, critical thinking, and active engagement. As technology advances and the effective teaching methodologies improves, interactive learning has emerged as a powerful tool in contemporary education. This piece delves into the diverse applications of interactive learning in today's educational landscape and its potential to revolutionize the methods of instruction and knowledge absorption.

The realm of mathematics education faces a persistent challenge in fostering sustained student engagement and motivation. Traditional pedagogical approaches often struggle to captivate students, leading to disinterest, lack of participation, and diminished learning outcomes. Recognizing this issue, there is a critical need to explore innovative strategies that can invigorate mathematical learning experiences. In this study an innovative interactive game named RoadMath game was designed and showcased at the UiTM Pasir Gudang booth during the National Science Week held on 20th August 2023, at Larkin Indoor Stadium, Johor Bahru. It is a teaching and learning method designed to make mathematics more enjoyable and encourage students to love the subject instead of finding it difficult or disliking it.

This study aims to explore the mathematic learning engagement through an interactive educational game namely ‘RoadMath game’. In particularly, the purpose of this study are to assess students' proficiency in mathematics and to compare their feedback before and after playing the interactive game based on student interest, concerns, and motivation in the context of mathematical learning. Thus, it determining whether positively impacts on their interest in mathematics as well whether it serves as a motivational tool, fostering a positive learning environment.

By conducting a comprehensive assessment, this study endeavors to provide valuable insights into the efficacy of RoadMath game as a tool for enhancing mathematical engagement. The findings of this research will not only contribute to the advancement of educational technology, but also inform pedagogical practices aimed at creating more dynamic and motivating mathematics learning environments. This study will focus on a specific group of students from primary and secondary schools in Johor who visited the UiTM’s booth and engaged with the Roadmath game. Additionally, the study will delve into any challenges or concerns, students may encounter while using RoadMath game, aiming to identify potential areas for improvement. This paper is organized opening with a brief review on revolutionizing mathematics education, game base learning, an engaging mathematical game for enhanced learning, education game and constructivism learning theory for game-

based learning. It then followed by methodology of research and results are discussed. Lastly, all findings are summarised into conclusion section which then lead to a proposal of solution for the identified problems.

Literature Review

In this section, there will be a detailed explanation of why the interactive game was developed and how it can enhance students' mathematical skills.

Revolutionizing Mathematics Education

Children's math underachievement is a persistent and serious issue (Dowker, 2019), and according to Gross (2007), 21% of 11-year-olds do not meeting the expected mathematics proficiency upon leaving primary school, with an additional 5% falling below numeracy skills typically achieved by a 7-year-old. These challenges persist even as people grow older. It's estimated that one out of every five adults possess numeracy skills that fall below what's needed for everyday situations (Cragg & Gilmore, 2014). Proficiency in mathematics is pivotal for thriving in Western societies, and lacking in this area can have a more substantial impact on opportunities in life than struggling with literacy. The study by Cragg and Gilmore (2014) also states that by considering the significant impact on both the economy and society, it's crucial to gain a detailed understanding of the processes involved in learning and applying mathematics.

As reported by Steinmayr and Spinath (2009), Donlan et al. (2007), Mayes et al. (2009), Yunos et al (2021), there are numerous elements that influence how well someone performs in mathematics, such as their attitude, motivation, language abilities, IQ, alongside social and educational factors. While there is evident that having specific numerical skills and knowledge is essential for succeeding in mathematics, other cognitive aspects play a significant role. Hence, the RoadMath game was innovated to tackle these mathematical challenges among students from primary and secondary schools.

Game Based Learning

Another significant area of discussion is game-based learning (GBL), which refers to educational settings that incorporate games for skill, competence, and knowledge acquisition (Qian & Clark, 2016). GBL serves as a learning methodology fostering effective learning, stimulating cognitive processes, capturing students' attention, and enhancing problem-solving skills (De-Marcos et al., 2016; Sousa & Rocha, 2019). Gamification involves incorporating game-design elements and principles into non-game contexts (Tukiman et al., 2021, Mahat et al., 2018; Chiu & Hsieh, 2017). By integrating these game characteristics into various activities or processes, certain problems can be addressed more effectively. Therefore, using gamification in learning statistics can potentially enhance student engagement and motivation.

The utilization of games to enhance educational processes has been extensively explored in the literature (Hainey et al., 2016; Zainuddin et al., 2020). The categories or variables of games that are widely considered include: the primary purpose of the game, whether it is digital or non-digital, the game genre, the platform, and the outcomes of the game (Hainey et al., 2016). Non-digital games, like board games, provide numerous

community interactions similar to digital games but do not necessitate computers, thereby rendering them accessible to a diverse range of classrooms (Berland and Lee, 2012).

RoadMath as an Engaging Mathematical Game for Enhanced Learning

RoadMath game is an engaging race competition designed for two to six players per session. The game revolves around a cityscape with a unique twist: a traffic light. Here, the colour of the road markings — green, yellow, and red — indicates the difficulty level of the accompanying mathematical questions: EASY, MEDIUM, and HARD, respectively. The traffic light box, a pivotal component, contains numbered balls (1-6), determining how many steps players move. The game commences with all players positioned at the START point. Each participant takes turns drawing balls from the traffic light box, progressing along the path while tackling mathematical challenges. To maintain their current position, players must answer each question correctly, earning them valuable points. The winner will be decided by the accumulation of total points as well as being the first player to reach the FINAL position.

Lecturers at College of Computing, Informatics and Mathematics (KPPIM) UiTM Pasir Gudang initially developed this game in collaboration with two intern students from Universiti Teknologi Malaysia (UTM) and a master's student from UiTM Pasir Gudang. Drawing inspiration from the popular board game "Snake Checkers Game," they enhanced it to be more engaging, incorporating mathematical elements. This way, students playing the game could enjoy the entire experience without feeling overwhelmed by mathematical problem-solving.

Mathematical Engagement and Educational Game

Most students find games engaging and enjoyable, even if they are complex or challenging. This is why educational games can be a fantastic way to get students involved in their studies while also having fun. Since mathematics is often considered one of the less favored subjects, incorporating mathematical elements into a game can indirectly improve students' mathematical skills. Mathematical engagement is defined as the level of interest, motivation and active participation a student exhibits in the process of learning mathematics (Fredricks, Phyllis, & Alison, 2004). As reported by Papanastasiou et al. (2017), a successful gaming is viewed as a closely connected collection of skills and capabilities that also bolster a variety of other proficiencies. These include proficiency in online research, determination in tackling difficult issues, adeptness in processing information, effective communication, inventive output, as well as offering peer support and assistance for the benefit of the entire group.

According to Tukiman et al (2024), lecturers or educators need to enhance their teaching methods such as through GBL to understand the students regarding the difficult topic in mathematics learning. A FUYOH Math learning strategy via Mnemonic Technique have been introduced by Ng et al (2023), as learning method strategy and engagement in empowering student’s mathematics learning skill. Educational games, like computer games, board games, and interactive activities, are lively tools that help students get interested in and use mathematic ideas (Kebritchi, Hirumi, & Bai, 2010). These games offer many different ways to learn and improve skills. In addition, they also looked at many studies about using computer games for teaching mathematics. They found that these games helped students get more interested in mathematics, understand concepts better, and become better problem solvers

(Ng et al., 2023). This was because the games made learning mathematics more fun, enjoyable and hands-on. In 2019, Yeh et al. conducted a study aimed at enhancing both the mathematics achievement and interest of 215 elementary school students. They implemented a game-based learning approach named Math Island. The findings revealed a significant improvement in students' performance concerning both calculation and word problems. Notably, both low-achieving and high-achieving students displayed a heightened interest in mathematics, indicating the efficacy of the Math Island approach across diverse learning profiles.

Moreover, instructional games such as RoadMath game foster a fresh learning environment that aligns more closely with the habits and interests of students and most importantly, they are deemed as potent instruments for instructing intricate and challenging procedures. This is achieved through active engagement rather than mere verbal explanation, fostering personal motivation and gratification, catering to various learning styles and aptitudes, solidifying mastery skills, and offering an interactive, decision-driven context (Kebritchi, Hirumi, & Bai, 2010).

Constructivism Learning Theory for Game-Based Learning

Games encourage motivation and involvement and are an essential part of human culture and society (Bozkurt & Durak, 2018). The completion of specific learning objectives through game material and play is referred to as "game-based learning." It also involves integrating problem-solving areas and difficulties that provide learners—who are also players—a feeling of accomplishment (Qian & Clark, 2016). It is used as game elements in non-game contexts that can affect motivation and behaviour including academic achievement (Deterding et al., 2011) and cognitive learning (Connolly et al., 2012; Vlachopoulos & Makri, 2017). In this context, RoadMath game is considered a game-based learning, which also applies the constructivism learning theory.

In the realm of educational psychology, constructivism stands as a foundational theory that has greatly influenced teaching practices and learning methodologies. Rooted in the belief that learners actively construct their understanding and knowledge of the world through experiences and reflection, Constructivism has gained significant traction in educational settings worldwide. This theory posits that learning is an active, iterative process where individuals build upon their existing knowledge and mental models to make sense of new information and experiences (Bereiter, 1994).

Methodology

This section delves into the study's methodology, covering details such as the number of respondents, their respective schools, details about the questionnaire and the analytical methods employed.

Procedure of the Study

This study utilizes a quantitative approach, encompassing a sample of 81 students aged between 6 and 16 years old from diverse schools in Johor which are SK Ayer Manis, SK Batu 24, SK Convent Muar, SK Felda Tenggaroh 3, SK Kampung Melayu, SK KG Maju Jaya, SK Larkin 2, SK LKTP Bukit Batu, SK Taman Cendana, SK Taman Seri Pulai, SK Pulai Perdana, SK Tebrau Bakar Batu, SM Islam Hidayah JB, SM Sains Sembrong, SM Sains Sultan Iskandar, SMK Aminuddin Baki, SMK Tun Fatimah Hashim and SMKAJB. This study employed a simple random

sampling technique, utilizing a questionnaire as the primary data collection instrument. The questionnaire contained 13 same questions for each part; A (before) and B (after) playing the interactive game which is RoadMath game and another 3 questions about students' experience of playing a similar game, their preference of playing interactive games and also their level of expertise in mathematics. Various question formats, including ranking and yes-no listing, were incorporated into the questionnaires.

The questionnaires were made in the form of forms and were distributed to the students who played the RoadMath game at UiTM Johor, Pasir Gudang Campus booth's during the National Science Week event in Indoor Stadium Larkin, Johor Bahru on 20th August 2023. The questionnaires were distributed in physical form rather than being answered online, as it is much easier for students to complete them since they are not permitted to use electronic devices during school hours.

The data was transformed into Microsoft Excel and then analyzed using SPSS Software. This study utilized an independent sample t-test to determine the means, and observed the differences between before and after the students played the RoadMath game. For this study, only questions 1 to 9 and question 13 were selected from the questionnaire, as they primarily focus on students' feedback regarding the game.

Mathematical Formula

There are three distinct methods to calculate the mean for grouped data: the direct method, assumed mean method, and step deviation method. In this study, the direct method is the most appropriate choice, given the relatively small dataset comprising only 30 sets of data. The formula to calculate the mean before and after students engaged with the RoadMath game is presented in Equation (1.1) and (1.2) below.

Direct Method

Suppose $x_1, x_2, x_3, \dots, x_n$ be n observations with respective frequencies $f_1, f_2, f_3, \dots, f_n$.

$$\overline{x} = \frac{f_1x_1+f_2x_2+f_3x_3+\cdots+f_nx_n}{f_1+f_2+f_3+\cdots+f_n} \quad (1.1)$$

$$\overline{x} = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i} \quad (1.2)$$

where

$\sum f_i x_i$ = sum of all the observation

$\sum f_i$ = sum of frequencies

Operational Framework

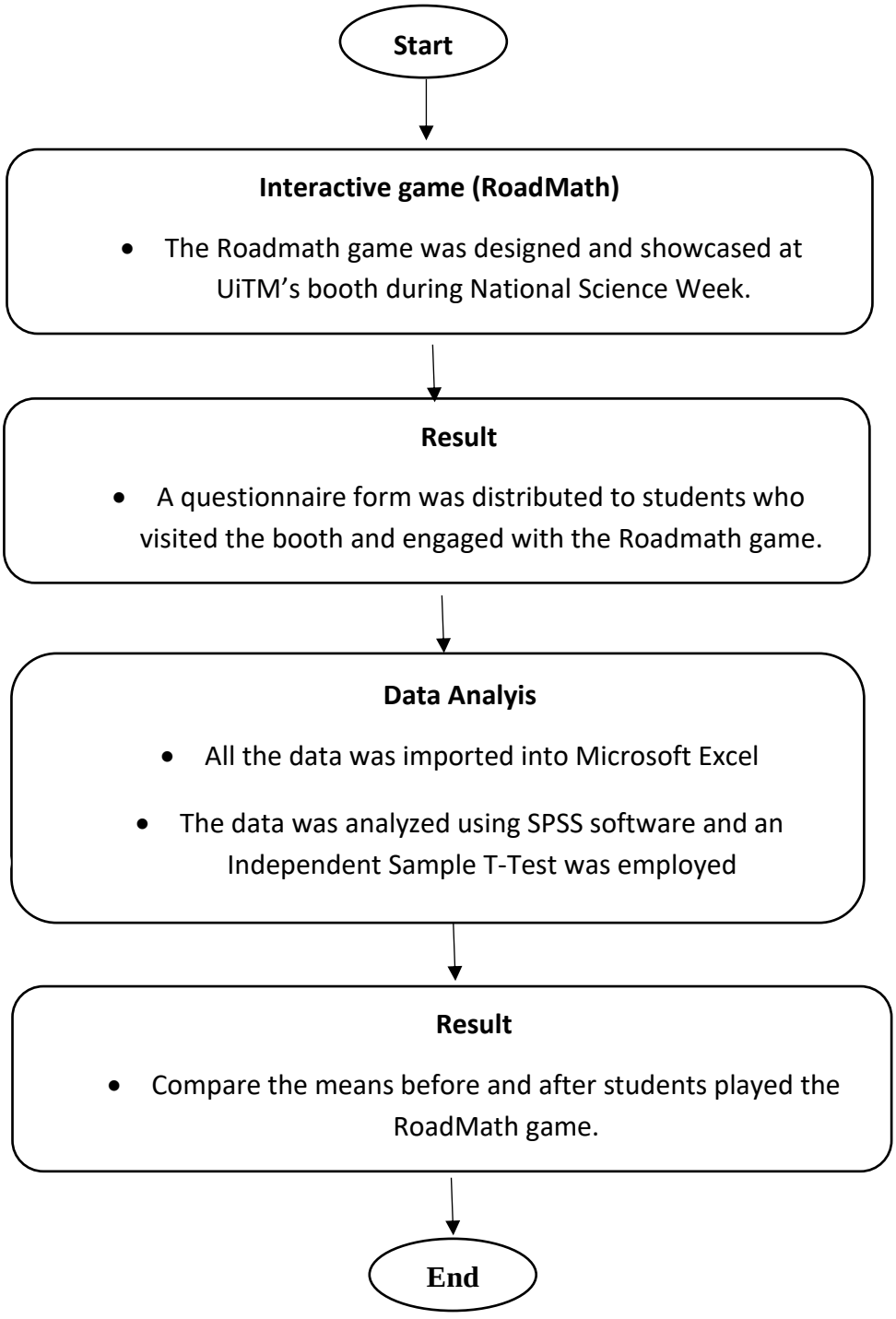

Figure 1. Flowchart Operational Framework for RoadMath game

The flowchart operational framework for the RoadMath game involves the structured design and implementation of the game to enhance mathematical learning through interactive and engaging methods. Figure 1 states the operational framework for RoadMath game. There are four main stages, which start with the design of RoadMath game with procedures and then featured at UiTM's booth. Later, a survey is conducted among all school students who participated in RoadMath game during National Science Week, followed by the analysis of the data by SPSS software and independent sample T-test. Lastly, the results on

the perception of the students toward mathematics, before and after they play the RoadMath game are determined.

Results and Discussion

This section presents the results obtained from the analysis conducted for each question. Out of the initial 81 respondents in this survey, it was observed that 38.8% of the data contained missing information. Consequently, only 50 sets of data are deemed valid for analysis. Among these, a subset of 30 data was selected for further analysis as it enough to run data analysis to represent the whole samples. The respondents comprise students from a range of schools in Johor, encompassing both primary and secondary levels. Their ages fall within the range of 6 to 16 years old.

In order to investigate the interest, concern and motivation of students towards learning mathematics based on interactive games, the most important question is to ensure their level of mathematical skills, which can range from very weak, weak, moderate, good or very good.

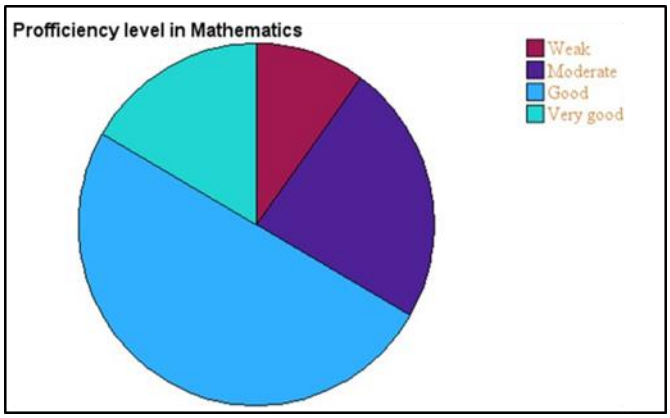

Figure 2. Pie chart of student's proficiency level in Mathematics.

The data presented in Figure 2 and Table 1 indicate that a mere 16.7% of students excel in mathematics, with 50% performing at a good level. Approximately 23.3% of students fall within the moderate range, while roughly 10% are classified as weak in the subject. This highlights that some students may require extra assistance to boost their performance in mathematics.

Table 1
Students' feedback on their level of proficiency in mathematics

	Frequency	Percent	Valid Percent	Cumulative Percent
Very good	5	16.7	16.7	76.7
Good	15	50.0	50.0	50.0
Moderate	7	23.3	23.3	100.0
Weak	3	10.0	10.0	60.0
Total	30	100.00	100.0	

The first question of the questionnaire is about motivating students to engage in teamwork practices. Table 2 shows the result.

Table 2
Teamwork and self-discipline

	Before/ After	N	Mean	Standard Deviation	Standard Error Mean
1. Teamwork and self-discipline	Before	30	2.03	1.377	0.251
	After	30	4.30	1.022	0.187

According to Table 2, there is a noticeable increase in the mean value before and after the interactive game. Prior to the game, the mean was 2.03, but it rose to 4.3 afterward. This indicates that, on average, the values in the dataset have significantly improved, indicating that the game has effectively enhanced teamwork among the students. This is because the RoadMath game involves a small number of players which is up to 5 players at one time, and these players were not restricted to assist each other. In addition, teamwork may create a supportive environment for individuals to discuss and solve the main issues together.

The second question is about whether this game has built self- confidence among the students and the result is presented in the Table 3 below.

Table 3
Build self-confidence

	Before/ After	N	Mean	Standard Deviation	Standard Error Mean
2. Build self-confidence	Before	30	2.20	1.349	0.246
	After	30	4.53	0.900	0.164

Based on Table 3 above, the RoadMath game has effectively bolstered students' self-confidence, as evidenced by the 2.33 increase in the mean score. Although some students faced challenges, particularly with the more difficult questions, this did not deter them from confidently tackling these questions within the allotted time.

The following question in the questionnaire addresses students' interest in mathematics. It aims to assess whether the RoadMath game successfully engage students in the enjoyment of solving mathematical problems, particularly for those who may have previously struggled in this subject.

Table 4
Attract students' interest in mathematics

	Before/ After	N	Mean	Standard Deviation	Standard Error Mean
3. Attract students' interest in mathematics	Before	30	2.37	1.377	0.251
	After	30	4.37	1.033	0.189

Prior to engaging with the RoadMath game, students exhibited a limited interest in mathematical calculations, as evidenced by the low mean of 2.37 in Table 4. However, following their participation, there was a notable shift, indicating a newfound enthusiasm for mathematics. This transformation is statistically significant, with the mean surging to 4.37, demonstrating a substantial improvement.

Table 5
Increase students' motivation

	Before/ After	N	Mean	Standard Deviation	Standard Error Mean
4. Increase students' motivation	Before	30	2.33	1.348	0.246
	After	30	4.57	0.898	0.164

The fourth question is about students' motivation towards learning Mathematics, with the corresponding results presented in Table 5 above. As demonstrated, the RoadMath game has notably enhanced and boosted students' motivation to engage with the subject even though they initially perceived Mathematics as a challenging subject to grasp. This is proven by the mean displayed in the table above, which has risen from 2.33 to 4.57. This positive shift may be attributed to the support provided by both peers and the overseeing facilitators during the game.

The fifth question explores the students' enjoyment and interest in the RoadMath game. It seeks to understand if they found it engaging and fun to play and the result is shown in Table 6 below.

Table 6
The joy of students playing RoadMath game

	Before/ After	N	Mean	Standard Deviation	Standard Error Mean
5. Having fun	Before	30	2.20	1.400	0.256
	After	30	**4.60**	0.814	0.149

Similar to previous questions, the mean of this specific question in the questionnaire has also increased from 2.2 to 4.6, indicating that it has achieved its objectives. This demonstrates that a majority of the students thoroughly enjoyed playing RoadMath game while answering the given questions.

The next table (Table 7) displays the results for question 6, which is about students' concerns regarding their inability to answer the given questions.

Table 7
Students' concerns regarding their inability to answer the given questions

	Before/ After	N	Mean	Standard Deviation	Standard Error Mean
6. Concern not able to answer the questions	Before	30	1.90	1.125	0.205
	After	30	4.37	1.159	0.212

According to the results in Table 7 above, a significant majority of students expressed concerns about their ability to answer the given questions, as evidenced by the low mean score of 1.9. However, after experiencing the game, there was a substantial increase in the mean score to 4.37, indicating a significant shift. They discovered that they didn't need to be overly concerned about answering all the questions.

Table 8
Game design is easy to understand

	Before/ After	N	Mean	Standard Deviation	Standard Error Mean
7. Game design is easy to understand	Before	30	2.10	1.213	0.222
	After	30	4.40	1.003	0.183

Table 8 presents the findings for question 7, addressing the ease of understanding in the game design. Initially, respondents rated the design of the RoadMath game at a modest 2.1, suggesting some initial confusion, likely due to it being their inexperience with the game. Nevertheless, after actively engaging in the game, the mean score significantly improved to 4.4, indicating that participants found the game design to be straightforward and comprehensible.

Question 8 is about students' boredom level of the RoadMath game. The result is as shown in the Table 9 below.

Table 9
Students' level of boredom towards the game

	Before/ After	N	Mean	Standard Deviation	Standard Error Mean
8. The game is boring	Before	30	1.57	0.774	0.141
	After	30	4.00	1.414	0.258

This question bears a resemblance to question 5, albeit from a less favourable standpoint. The initial results suggest that, prior to engaging in gameplay, students may have anticipated boredom, possibly stemming from their limited interest in mathematics, as reflected by the remarkably low mean of 1.57, the lowest recorded mean thus far. However, post-gameplay, they discovered that the game was far from dull. The noteworthy increase in the mean, which now stands at 4, supports this observation.

Next is question 9, a survey of time allocated for students to answer the questions given and the result is shown in Table 10 below.

Table 10
Time allocated to answer the questions

	Before/ After	N	Mean	Standard Deviation	Standard Error Mean
9. Time allocated is enough	Before	30	2.10	1.213	0.222
	After	30	4.30	1.119	0.204

The mean for question 9 before students started the game is 2.2 lower than after they have played the game. It means that the four-minute time frame provided for students to answer each question proved sufficient. Only a small number of students struggled to answer accurately within the allocated time.

Last, but not least is question 13. This particular question assesses the overall impact of the game, encompassing improvements in students' interest, skills, knowledge, and motivation towards mathematics. Essentially, it serves as a summary of all the preceding inquiries.

Table 11
Overall performance

	Before/ After	N	Mean	Standard Deviation	Standard Error Mean
13. Overall performance	Before	30	2.00	1.259	0.230
	After	30	4.30	1.317	0.240

The presented Table 11 illustrates the result for question 13. A notable increase of 2.3 in the mean is observed, rising from an initial score of 2 to a final score of 4.3. In summary, RoadMath game has successfully met its objectives in enhancing students' interest, skills, knowledge, and motivation in learning mathematics.

Conclusion

The purpose of this study is to assess students' initial perceptions and concerns towards learning mathematics with interactive games like RoadMath game, evaluate the impact of RoadMath game on their interest and engagement levels, analyse its influence on skill development and performance in mathematical problem-solving, and assess whether it serves as a motivational tool, fostering a positive learning environment. The analysis conducted indicates that the RoadMath game has had a positive impact on the majority of students, as evidenced by the consistent increase in mean scores across all questions.

Based on the results, it was found that the levels of teamwork engagement, self-confidence and interest in mathematics experienced by students were higher after playing the RoadMath game. Since students nowadays are active, thus, their learning method should be student centered where students take an active role in their education, with teachers

serving more as facilitators rather than traditional lecturers. Apart from that, the findings are aligned with the study from Martín-Hernández et al (2021), where students' confidence and teamwork are well developed through game based learning.

Thus, it is evident that RoadMath game effectively engages students in the learning process. After gameplay, the substantial increase in mean score swiftly dispelled the initial apprehension noted in question 5 regarding potential boredom. This demonstrates the game's ability to captivate students' attention and sustain their interest in mathematical concepts.

Furthermore, the study underscores the pivotal role of time management in enhancing students' performance. The majority of participants generally deemed the allotted 4-minute duration for each question as sufficient, as revealed by the findings from Question 9. This suggests that RoadMath game not only stimulates interest but also promotes efficient problem-solving skills within a structured timeframe. Additionally, the comprehensive question 13, evaluating the overall impact of RoadMath game, provides compelling evidence of the game's success. The remarkable surge in mean score from 2 to 4.3 demonstrates a substantial positive influence on students' interest, skills, knowledge, and motivation towards learning mathematics. This clearly attests to the efficacy of interactive games as an educational tool. The presence of this game evidently positively influences students' outcomes in mathematics learning (Walan & Gericke, 2021).

In conclusion, the study affirms that interactive games hold great potential in transforming the learning experience for students of mathematics. By alleviating initial apprehensions, promoting efficient time management, and significantly enhancing overall engagement and motivation, RoadMath game emerges as a valuable asset in the educational landscape. Based on these findings, this study suggests that educational institutions could enhance mathematics engagement by implementing interactive learning methods like RoadMath game. These findings advocate for the continued integration of interactive gaming platforms as an effective pedagogical strategy to foster a deeper and more enduring interest in mathematics among students. The government should implement a widespread integration of interactive games in all schools, with a special emphasis on kindergarten and primary levels. Early education plays a pivotal role in shaping students' future skills, and this initiative can effectively address the prevalent issue of students finding mathematics challenging and difficult to grasp. Further research is also proposed to expand on exploring the long-term effects of interactive learning tools like RoadMath game on students' mathematical abilities and their attitudes toward the subject. Additionally, future studies could investigate the potential of integrating such games into classroom settings across different educational levels to determine their broader impact on mathematics education among students.

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