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Fostering Positive Attitudes In Mathematics Among Junior Secondary School Students Using Modern Mathematics Computer Games

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Technology integration in education has gained significant attention, particularly in mathematics instruction, as it offers innovative ways to enhance engagement and improve learning outcomes. A positive attitude toward mathematics is essential for students' motivation, confidence, and willingness to engage with the subject, ultimately influencing their academic performance. This study examined the impact of Modern Mathematics Computer Games (MMCG) on students' attitudes toward mathematics in Delta North Senatorial District, Nigeria. A quasi-experimental pretest-posttest non-equivalent control group design was adopted, involving 132 Junior Secondary School (JSS 2) students (58 males, 74 females) selected using a multistage sampling technique. The Mathematics Attitude Scale (MAS), validated with a reliability coefficient of 0.81, measured students' attitudes before and after an eight-week intervention. The experimental group was taught using MMCG, whereas the control group adhered to conventional teaching approaches. The gathered data were analysed using SPSS Version 28, utilising descriptive statistics (mean and standard deviation) and Analysis of Covariance (ANCOVA) to address research questions and evaluate hypotheses. Results revealed that students taught with MMCG showed a significantly higher improvement in attitude scores than those taught using traditional methods, with ANCOVA confirming a significant effect of the intervention ($F(1,127) = 42.624$, $p = .000$, $\eta^2 = .251$). Gender differences were not statistically significant ($p = .313$), indicating that MMCG was effective for both male and female students. The findings suggest that computer game-based learning enhances students' motivation, confidence, and interest in mathematics. The study recommends integrating MMCG into mathematics instruction to foster a possitive learning experience.

Keywords: Game-based learning, Modern Mathematics Computer Games, mathematics attitude, secondary education, students' attitude.

1. Introduction

Mathematics, the study of numbers, shapes, and their interrelationships, plays an essential role in everyday life and various fields such as engineering, economics, and technology (Mosia et al., 2024; Okeke et al., 2022a, 2022b, 2023, 2025). It equips individuals with critical problem-solving skills for financial management, design, and decision-making (Inweregbuh et al., 2020, Nzeadibe et al., 2019, 2020; Osakwe et al., 2023). Mathematics is also a key component of cognitive development, fostering logical reasoning, pattern recognition, and analytical thinking (Mosia et al., 2025c, 2025a, 2025b). However, despite its relevance, many students develop negative attitudes toward mathematics, significantly hindering their academic success and engagement with the ssubject (Hui & Mahmuds, 2021; Okeke et al., 2025).

The general concept of mathematics covers a wide range of subjects, from fundamental arithmetic to complex calculus. These concepts form the foundation for understanding more specialised fields like algebra, geometry, and statistics (Mosia & Egara, 2024). Unfortunately, traditional teaching methods osften fail to create an engaging and positive learning environment for students, leading to feelings of frustration, anxiety, and disengagement (Egara & Mosimege, 2024; Mosimege et al., 2022, 2023a, 2023b, 2023c, 2024; Nzeadibe et al., 2023). Teacher-centred approaches, in particular, tend to focus on rote memorisation and passive learning, leaving students with little room for active participation or conceptual understanding (Egara & Mosia, 2024, 2025; Egara et al., 2025; Osakwe et al., 2022).

Innovative teaching methods such as Modern Mathematics Computer Games (MMCG) have been explored as potential solutions to these challenges in recent years. MMCG uses computer-based games to present mathematical content in an interactive and dynamic way, designed to increase students' engagement and interest in the subject (Kebritchi et al., 2010; Kocabatmaz & Saraçoğlu, 2024). While MMCG has shown promise in improving mathematical achievement, its impact on students' attitudes toward mathematics has not been sufficiently studied. Positive attitudes are crucial for students' motivation and success, and a shift in attitude could lead to improved learning outcomes (White & McCoy, 2019).

Additionally, gender differences have been found to influence students' attitudes toward mathematics (Egara & Mosimege, 2023; Sarfo et al., 2020). Historically, male students have been perceived as more proficient in mathematics (Ezinwanyi, 2018). However, recent research has shown that the gender gap in mathematics achievement is narrowing (Mosia & Egara, 2024; Osakwe et al., 2023). Despite this progress, gender-based stereotypes and biases still exist, which may shape students' experiences and perceptions of mathematics. Therefore, it is important to investigate the role of gender in students' attitudes toward mathematics, particularly in the context of innovative teaching strategies like MMCG.

Statement of the Problem

A significant issue in mathematics education is the negative attitude that many secondary school students have toward the subject. This negative attitude often leads to a lack of motivation, disengagement, and poor academic performance. Traditional teaching methods have been largely ineffective in improving students' attitudes, highlighting the need for more engaging and interactive approaches. MMCG has emerged as a potential tool to enhance students' interest and engagement in mathematics, but its impact on students' attitudes remains under-researched.

Therefore, there is a need to investigate how MMCG affects students' attitudes toward mathematics, considering both the teaching method and gender differences.

Theoretical Basis

This study is grounded in Constructivist Learning Theory (Piaget, 1950; Vygotsky, 1978) and Social Cognitive Theory (SCT) (Bandura, 1986), both of which provide a strong foundation for understanding how Modern Mathematics Computer Games (MMCG) influence students' attitudes toward mathematics. Constructivist Learning Theory suggests that learners actively build knowledge through their experiences rather than passively receiving information (Piaget, 1950). Vygotsky (1978) extended this view by emphasising the role of social interaction in learning, arguing that students develop understanding through collaborative engagement with peers and teachers. MMCG aligns with this theory by offering an interactive platform where students explore mathematical concepts through hands-on engagement, fostering deeper comprehension and positive attitudes. Unlike traditional instruction, game-based learning encourages active participation, intrinsic motivation, and perseverance in mathematical problem-solving.

Social Cognitive Theory (Bandura, 1986) further explains how students' attitudes toward mathematics are shaped by their experiences, social interactions, and self-efficacy. SCT asserts that learning occurs through the interaction of personal factors (such as beliefs and motivation), environmental factors (such as teaching methods and peer influence), and behavioural factors (such as engagement and persistence). MMCG fosters a social and interactive learning environment where students receive immediate feedback, collaborate, and build confidence in their mathematical abilities. The inclusion of gender as a variable in this study is also supported by SCT, which acknowledges that students' learning experiences and attitudes may be influenced by their social and cultural contexts. By integrating these two theories, this study provides a comprehensive understanding of how MMCG can enhance students' attitudes toward mathematics by making learning more engaging, interactive, and confidence-building.

2. Literature Review

Several studies have explored the impact of computer game-based learning on students' attitudes toward mathematics across different educational levels and geographical locations. These studies collectively suggest that game-based learning can enhance students' attitudes and, in some cases, academic performance. However, variations exist based on factors such as educational level, geographical setting, and the specific design of the games used.

Ezinwanyi (2018) investigated the effect of mathematics games on secondary school students' attitudes toward mathematics in Abia State, Nigeria. The study involved 180 Senior Secondary 2 (SS2) students, selected through stratified random sampling. Using a Mathematics Attitude Questionnaire and Analysis of Covariance, the findings revealed that mathematics games significantly improved students' attitudes toward the subject. Notably, boys showed greater gains in attitude scores than girls, indicating a gender disparity in the intervention's effectiveness.

Similarly, Çankaya and Karamete (2009)examined the impact of educational computer games on the attitudes of primary school students in Balikesir, Turkey. Their study involved 176 students from two schools and focused on ratio and proportion topics through researcher-developed games.

Paired samples t-tests and Pearson correlation analyses revealed that students' attitudes toward mathematics and educational games became more positive after gameplay.

White and McCoy (2019) conducted an action research study in the United States with fifth-grade students using game-based lessons to teach ordered pairs. Through surveys, content tests, student interviews, and field observations, they found that game-based learning improved students' attitudes toward mathematics, fostered a growth mindset, enhanced problem-solving skills, and increased engagement. Achievement gains were also recorded across the unit.

Luo et al. (2022) investigated the effects of skill-based online math games on the performance and attitudes of 38 students in grades five through eight in the United States. While some students showed improvements, others exhibited no significant changes, highlighting the complexity of individual responses to digital game-based learning.

In Turkey, two recent studies further examined the effectiveness of educational digital games. Kocabatmaz and Saraçoğlu (2024) conducted a quasi-experimental study on third-grade students, comparing traditional teaching methods with Wordwall and Matific for teaching measurement units. Their findings indicated that digital games positively influenced students' academic achievement and attitudes toward mathematics. Similarly, using a quasi-experimental design, Dursun and Ulum (2024) investigated digital game-based learning among primary school students. The study found that integrating digital games into the mathematics curriculum significantly enhanced students' academic performance and attitudes compared to traditional instruction.

Building on these studies, the present study examines the effect of Multimedia Computer Games (MMCG) on junior secondary school students' attitudes toward mathematics in Delta State, Nigeria. Specifically, it aims to compare the attitudes of students taught mathematics using MMCG with those taught through traditional teaching methods and to investigate whether there is a difference in the attitudes of male and female students taught mathematics using MMCG. Unlike previous research, which has largely focused on primary or senior secondary students, this study centres on junior secondary learners, a group that has received less attention in existing literature. Additionally, investigating gender differences addresses a gap concerning the intersection of gender, educational technology, and mathematics education. The findings will provide insights for educators and policymakers looking to enhance mathematics instruction through multimedia computer games, particularly in similar educational contexts.

Research Questions

The study addressed the following research questions:

1. What differences exist in attitude scores between students taught mathematics with MMCG and those taught using conventional methods?
2. How do attitude scores differ between male and female students when MMCG is used to teach mathematics?
3. What is the combined effect of instructional methods and gender on students' attitude scores in mathematics?

Hypotheses

The following null hypotheses were tested at a 0.05 alpha level:

1. No significant difference exists in attitude scores between students taught mathematics using MMCG and those taught through traditional methods.

2. No significant difference exists in attitude scores between male and female students taught mathematics using MMCG.

3. No significant interaction effect exists between teaching methods and gender on students' attitudes toward mathematics.

3. Method Research

Design

The study employed a quasi-experimental pretest-posttest design with a non-equivalent control group. Intact classes were utilised, and participants were assigned to experimental and control groups without randomisation. The quasi-experimental approach was necessary as random assignment was not feasible within the school setting (Nworgu, 2015).

Population and Sample

The study's population comprised of 13,772 mathematics students (5,951 male and 7,821 female) in 165 public secondary schools within the Delta North Senatorial District, which includes 159 coeducational schools, three boys' schools, and three girls' schools (Delta State Post Primary Education Board, 2024). Only schools with functional ICT facilities and electricity were considered for the study to ensure the effectiveness of the intervention (modern mathematics computer games). A multistage sampling approach was employed to determine the sample. The first stage involved purposefully selecting four schools: two boys' and two girls' schools, all with the necessary ICT facilities and electricity. At the second stage, simple random sampling by balloting was used to assign one boys' and one girls' school to the experimental group, while the remaining two schools were designated as the control group. The final sample comprised 132 intact JSS 2 students, with 58 male and 74 female students selected from the four schools. This sample was representative of the broader student population in terms of gender. Using intact classes helped preserve the natural classroom environment, making the intervention more applicable to real-life teaching scenarios.

Instrumentation

The instrument employed for data collection was an adapted Mathematics Attitude Scale (MAS), originally developed by Aiken (1974), which measures students' attitudes toward mathematics. The MAS consists of items that assess four key dimensions: confidence, anxiety, motivation, and the usefulness of mathematics. The scale followed a 5-point Likert format, with response options ranging from Strongly Agree to Strongly Disagree.

To ensure validity, the adapted MAS was reviewed by a psychometrician and subject experts in mathematics education. Their feedback helped refine the instrument for the specific context of the study. The initial MAS consisted of 25 items. However, after expert validation and psychometric analysis, five items were removed due to redundancy and low item-total correlation. The final 20-item scale was used for administration. The reliability of the instrument was determined using the

Test-Retest method. After administering the MAS to 40 JSS 2 mathematics students in Delta Central Senatorial District, the instrument was re-administered two weeks later. The reliability coefficient obtained through Cronbach's alpha method was 0.81, indicating satisfactory internal consistency.

Experimental Procedure

The procedure was carried out in three main stages: pre-MAS (pretest), intervention, and post-MAS (posttest).

Pre-MAS Stage: At the study's outset, the MAS was administered to both the experimental and control groups. This pre-MAS assessed students' attitudes toward mathematics, focusing on their motivation, interest, and confidence. This pretest allowed for a baseline measurement of the students' attitudes, which was crucial for evaluating the effectiveness of the intervention. The pre-MAS was conducted in the first week of the study before the commencement of the teaching sessions.

Intervention Stage: The intervention stage lasted for 8 weeks, during which the experimental group received instruction through Modern Mathematics Computer Games designed to teach algebra concepts. These games incorporated interactive exercises on algebraic operations, equations, and variables. The experimental group participated in two lessons per week, each lasting 45 minutes, engaging with computer games under the guidance of their regular mathematics teachers.

In parallel, the control group continued with traditional algebra instruction, using textbooks, worksheets, and lecture-based teaching methods, following the same curriculum without interactive computer games. Both groups received equivalent instruction time and content coverage to ensure the fairness of the comparison.

Teachers supported the experimental group throughout the intervention by guiding students through game-based activities, answering questions, and facilitating discussions. The games were designed to be engaging, offering immediate feedback on students' performance and reinforcing algebraic concepts.

Post-MAS Stage: After the 8-week intervention, the post-MAS was administered to the experimental and control groups. The post-MAS measured any changes in students' attitudes toward mathematics that might have resulted from the intervention. The post-MAS aimed to assess shifts in students' interest, motivation, and self-confidence regarding algebra and mathematics in general.

Control of Extraneous Variables

To ensure the validity of the study, several extraneous variables were controlled. First, the same teacher was assigned to both the experimental and control groups to minimise any potential teacher-related bias. This helped to maintain consistency in teaching style and approach across both groups. Next, the instructional situation variable was controlled by ensuring that both groups received the same number of instructional hours, which provided equal exposure to the teaching content. The intergroup variable was addressed by carefully selecting schools with similar demographic and academic characteristics, ensuring that both groups had comparable backgrounds. Finally, the experimental and control groups were administered identical pre-MAS and post-MAS to control for the effects of the pretest-posttest. This ensured that any changes in attitudes or outcomes were due to the intervention rather than variations in testing procedures.

Data Analysis

The data collected for this study were analysed using SPSS Version 28. To answer the research questions, descriptive statistics, mean ($\bar{X}$) and standard deviation (SD) were computed to summarise the students' responses to the MAS at both the pretest and posttest stages for the experimental and control groups. These statistics helped determine the overall levels of students' attitudes toward mathematics before and after the intervention and the variability in these attitudes. To test the hypotheses and assess whether any observed differences were statistically significant, Analysis of Covariance (ANCOVA) was conducted. ANCOVA was chosen because it allows for the adjustment of pretest scores (pre-MAS) as a covariate, helping to control for initial group differences. The hypotheses were tested at a significance level of 0.05. This analysis helped determine whether the intervention (using modern mathematics computer games) significantly affected students' attitudes toward mathematics compared to the control group.

4. Results

The results are organised based on the research questions and null hypotheses that guided the study.

Research Question One

What differences exist in attitude scores between students taught mathematics with MMCG and those taught using conventional methods?

Table 1 Pretest and posttest mean attitude score of students in experimental and control groups

Group		Pretest		Posttest		Mean Difference
	N	$\bar{X}$	SD	$\bar{X}$	SD	
Experimental	63	59.1	6.2	67.8	7.4	8.7
Control	69	56.7	6.6	59.4	6.4	2.7

As shown in Table 1, the experimental group, which received instruction through MMCG, had

a higher posttest mean attitude score ($\bar{X}$ = 67.8, SD = 7.4) compared to their pretest score ($\bar{X}$ = 59.1, SD = 6.2), resulting in a mean difference of 8.7. Conversely, the control group taught using traditional methods exhibited a slight enhancement, with a posttest mean score of 59.4 (SD = 6.4) compared to a pretest mean score of 56.7 (SD = 6.6), yielding a mean difference of 2.7. These findings indicate that using MMCG had a more substantial positive effect on students' attitudes toward mathematics compared to traditional instruction.

Hypothesis One

No significant difference exists in attitude scores between students taught mathematics using MMCG and those taught through traditional methods.

Table 2 Analysis of Covariance (ANCOVA) of the difference in the mean attitude score of students

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Decision
Corrected Model	2759.983[a]	4	689.996	15.177	.000	.323	
Intercept	3799.790	1	3799.790	83.578	.000	.397	
Pretest MAS	329.418	1	329.418	7.246	.008	.054	
Group	1937.845	1	1937.845	42.624	.000	.251	Sig
Gender	46.626	1	46.626	1.026	.313	.008	NS
Group * Gender	62.187	1	62.187	1.368	.244	.011	NS
Error	5773.926	127	45.464				
Total	539268.000	132					
Corrected Total	8533.909	131					

a. R Squared = .323 (Adjusted R Squared = .302).

The results in Table 2 indicate a statistically significant difference in posttest attitude scores between the experimental (MMCG) and control (traditional teaching) groups, $F(1,127) = 42.624$, $p = .000$, $\eta^2 = .251$. Since the p-value (.000) is less than the threshold of 0.05, the null hypothesis is rejected, confirming that MMCG significantly improved students' attitudes toward mathematics compared to traditional teaching methods. The partial eta squared value (.251) suggests a large effect size, meaning that a considerable proportion (25.1%) of the variance in students' attitude scores can be attributed to the teaching approach.

Research Question Two

How do attitude scores differ between male and female students when MMCG is used to teach mathematics?

Table 3 Pretest and posttest mean influence of gender on students' attitude towards mathematics

Gender	N	Pretest $\bar{X}$	Pretest SD	Posttest $\bar{X}$	Posttest SD	Mean Difference
Male	58	58.1	6.3	64.4	7.5	6.3

Female	74	57.6	6.7	62.6	8.4	5.0

To examine the difference in attitude scores between male and female students taught mathematics utilising MMCG, the pretest and posttest mean scores were compared. The results in Table 3 indicate that male and female learners experienced an improvement in attitude scores after being taught mathematics using MMCG. Male learners had a higher mean difference (6.3) than female students (5.0), suggesting a marginally greater positive shift in attitude among males. However, further statistical analysis is required to assess if this difference is statistically meaningful.

Hypothesis Two

No significant difference exists in attitude scores between male and female students taught mathematics using MMCG.

The results presented in Table 2 show that gender did not have a statistically significant effect on students' attitude scores ($F(1,127) = 1.026$, $p = .313$), as the significance value exceeded the threshold of 0.05. Thus, Hypothesis Two is upheld, suggesting no significant difference in attitude scores between male and female students taught mathematics using MMCG.

Research Question Three

What is the combined effect of instructional methods and gender on students' attitude scores in mathematics?

Table 4 Pretest and posttest mean interaction effect of instructional methods and gender on students' attitude score in mathematics

Group	Gender	N	Pretest $\bar{X}$	Pretest SD	Posttest $\bar{X}$	Posttest SD	Mean Difference
Experimental	Male	30	59.3	6.3	69.2	4.8	9.9
	Female	33	58.9	6.2	66.5	9.1	7.6
Control	Male	28	56.8	6.1	59.3	6.5	2.5
	Female	41	56.6	7.0	59.5	6.4	2.9

Note: N = Number of Respondents, $\bar{X}$ = Mean, SD = Standard deviation

The results in Table 4 indicate that male and female learners in the experimental group (MMCG) showed greater improvement in attitude scores than in the control group. Male students in the experimental group had the highest posttest mean attitude score (69.2), while female learners in the same group also improved significantly (66.5). In contrast, the control group showed minimal improvement, with posttest mean scores of 59.3 for males and 59.5

for females. This suggests that the MMCG instructional model positively influenced students' attitudes toward mathematics, regardless of gender. However, male learners exhibited a slightly higher increase in attitude scores compared to female students.

Hypothesis Three

No significant interaction effect exists between teaching methods and gender on students' attitudes toward mathematics.

The results in Table 2 show that the interaction effect of teaching method and gender on students' attitude scores was not statistically significant, $F(1,127) = 1.368$, $p = .244$, partial $\eta^2 = .011$. Since the p-value (.244) exceeds the threshold of .05, we fail to reject the null hypothesis. This implies that while both male and female learners benefited from the MMCG approach, there was no significant difference in how the teaching method influenced the attitude scores of male and female learners. Simply put, gender did not moderate the effect of MMCG on students' attitudes toward mathematics.

5. Discussion

The outcomes of this study reveal that learners exposed to Modern Mathematics Computer Games (MMCG) demonstrated significantly improved attitudes toward mathematics compared to those who received traditional instruction. This positive shift may be attributed to the interactive, engaging, and feedback-rich nature of MMCG, which enhances motivation and sustains interest in mathematics. Unlike conventional instruction, which often relies on passive learning and rote memorisation, MMCG encourages active exploration, problem-solving, and immediate feedback, fostering a more enjoyable and meaningful learning experience.

This result is consistent with prior studies highlighting the effectiveness of game-based learning in improving students' attitudes toward mathematics. Studies by Çankaya and Karamete (2009) and White and McCoy (2019) found that integrating educational games into mathematics instruction led to increased engagement, motivation, and enjoyment, ultimately fostering a more positive disposition toward the subject. Similarly, Kocabatmaz and Saraçoğlu (2024) reported that digital games such as Matific and Wordwall significantly enhanced students' attitudes toward mathematics. However, other studies, such as Luo et al. (2022), have found mixed results, with some students showing no significant changes in attitudes, highlighting the complexity of individual responses to game-based learning.

From a theoretical perspective, these findings are strongly supported by Constructivist Learning Theory (Piaget, 1950; Vygotsky, 1978) and Social Cognitive Theory (Bandura, 1986). Constructivist Learning Theory posits that students actively develop knowledge through experience and engagement rather than merely receiving information. MMCG aligns with this theory by providing hands-on engagement with mathematical concepts, enabling students to explore relationships and patterns directly. Vygotsky's (1978) extension of constructivism further emphasises the role of social interaction in learning. Through collaboration, discussion, and shared problem-solving, MMCG creates a dynamic environment where students develop a deeper understanding of mathematical principles in a socially supportive setting.

Social Cognitive Theory (Bandura, 1986) complements this perspective by explaining how students’ attitudes are shaped by their interactions with their environment, including peers, teachers, and digital tools. The immediate feedback MMCG provides reinforces learning, builds self-efficacy and sustains motivation. Furthermore, the immersive nature of MMCG reduces anxiety and fear of failure, creating a positive reinforcement cycle that enhances students’ willingness to engage with mathematics.

Despite the overall positive impact of MMCG, the study did not find a significant difference in attitudinal gains between male and female learners. This contrasts with Ezinwanyi’s (2018) study, which reported greater gains in attitude among male students. One possible explanation for this non-significant gender difference is the increasing accessibility and normalisation of digital games among male and female students, reducing historical gender gaps in technology engagement. Additionally, the structured nature of MMCG, with guided challenges and immediate feedback, may have provided an equalising effect, ensuring that both genders benefited similarly from the intervention.

Similarly, the study found no significant interaction effect between gender and the teaching method, indicating that MMCG was equally effective for male and female learners. This finding suggests that the benefits of MMCG are not gender-dependent but rather universally applicable, supporting the notion that well-designed digital learning tools can cater to diverse learner populations. The lack of interaction effect aligns with Social Cognitive Theory, which asserts that the interplay of personal, behavioural, and environmental factors shapes learning outcomes. In this case, the interactive and supportive structure of MMCG may have minimised potential gender-based differences in engagement and attitudinal change.

6. Conclusion and implications

This study demonstrates that Modern Mathematics Computer Games (MMCG) effectively enhance students’ attitudes toward mathematics by fostering engagement and motivation. The findings reveal no significant gender differences or interaction effects, indicating that MMCG provides an equitable learning experience for both male and female students. Aligned with constructivist and social cognitive theories, these results underscore the importance of interactive and socially engaging learning environments in shaping learners’ perceptions.

The results of this study carry important implications for mathematics education, instructional design, and policy. Given that MMCG has been shown to be successful in encouraging positive attitudes towards mathematics, teachers could consider including game-based learning in their lesson plans. By making learning more interactive and engaging, MMCG has the potential to increase students’ motivation and persistence, ultimately enhancing their overall experience and performance in mathematics.

Additionally, the non-significant gender differences and interaction effects indicate that male and female learners benefit equally from MMCG. This reinforces the need for inclusive digital learning strategies that accommodate diverse learners and reduce potential gender disparities in mathematics education. Ensuring all students access innovative and engaging instructional methods can contribute to a more equitable learning environment. Finally, from a curriculum development perspective, incorporating digital game-based learning tools into mathematics syllabi can help improve student engagement and conceptual understanding. However, successful implementation requires adequate teacher training to ensure educators can effectively integrate these tools into their instructional practices.

7. Limitations and Future Research Directions

This study has a few limitations, even though it offers insightful information about how MMCG affects students' attitudes towards mathematics. First, the results may not be as generalisable to other areas, grade levels, or educational contexts because the study concentrated on a particular sample inside a predetermined educational framework. Future studies should consider bigger and more varied sample sizes to improve the results' external validity. Second, this study examined students' attitudes toward mathematics without measuring long-term retention or academic achievement. While positive attitudes are crucial for learning, future studies should explore whether MMCG improves mathematical understanding and problem-solving skills over time. Lastly, the study did not account for individual differences, such as students' prior digital literacy, socioeconomic background, or learning styles, which may influence the effectiveness of game-based learning. To have a more comprehensive picture of how various student demographics react to MMCG, future research could examine these characteristics.

8. Recommendations

To improve the efficacy of MMCG in mathematics instruction, the following suggestions are put forth considering the study's findings:

1. Educational policymakers and curriculum developers should consider incorporating MMCG as a complementary instructional tool in mathematics curricula. Educators can enhance student engagement and foster positive attitudes toward mathematics by aligning game-based learning with existing syllabi.

2. Training programs should be designed to equip mathematics teachers with the necessary skills to integrate MMCG into their teaching practices effectively. Professional development workshops should focus on strategies for selecting, implementing, and assessing the impact of game-based learning on learners' outcome.

3. Developers of MMCG should design games that accommodate diverse learning needs, allowing for differentiated instruction. Adaptive learning features that adjust to students' skill levels and provide targeted support can help maximise the effectiveness of game-based learning.

4. While no significant gender differences were found in this study, efforts should be made to design games that appeal to both male and female students. Inclusive and culturally relevant game narratives can ensure that all learners find the content engaging and relatable.

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