



EXPLORING THE EFFECTIVENESS OF GAMIFICATION IN ENHANCING MATHEMATICS ENGAGEMENT AND ACHIEVEMENT AMONG SECONDARY SCHOOL STUDENTS IN IMO STATE

OGUGUO SIMPLICIUS CHIDIEBERE¹

&

OKOROJI ISIDORE IFEANYI²

Department Of Mathematics^{1&2},
School Of Sciences

Benjamin Uwajumogu (State) College Of Education,
Ihitte Uboma, Imo State, Nigeria.

Abstract

This study explores the effectiveness of gamification in enhancing mathematics engagement and achievement among secondary school students in Imo State, Nigeria. The research employed a quasi-experimental design, with 210 Junior Secondary School 2 (JSS2) students randomly assigned to either an experimental group receiving gamification-based instruction or a control group receiving traditional mathematics instruction. The results showed that the experimental group demonstrated a significant increase in mean scores between the pre-test and post-test, with a difference of 12.37, while the control group showed almost no change in mean scores. The ANCOVA analysis revealed a statistically significant difference in mean mathematics engagement scores between the experimental and control groups, with a p-value of 0.037. The findings suggest that gamification can be an effective tool in teaching and learning mathematics, leading to improved student outcomes. The study recommends the integration of gamification in mathematics education, professional development for teachers, and further research on the long-term effects of gamification.

Keywords: Gamification, Mathematics Education, Student Engagement, Achievement.

Introduction

Mathematics is a fundamental subject that plays a crucial role in the development of individuals and societies. It is a key driver of scientific, technological, and economic progress, and is essential for problem-solving, critical thinking and decision-making (OECD, 2022). Mathematics education is critical in shaping the future of individuals, communities, and nations, as it provides students with the skills and knowledge necessary to succeed in an increasingly complex and technological world (National Council of Teachers of Mathematics, 2022). Despite its importance, many students struggle with mathematics, leading to poor academic achievement. Research has shown that mathematics anxiety, lack of engagement, and ineffective teaching methods are some of the factors that contribute to students' poor performance in mathematics (Carey et al., 2022). The Trends in International Mathematics and

Science Study (TIMSS, 2020) has consistently shown that Nigerian students perform poorly in mathematics, ranking among the lowest in the world. This is a worrying trend that requires immediate attention from educators, policymakers, and stakeholders. To address this challenge, there is a need for innovative approaches to mathematics education that can engage students, promote deep understanding, and foster critical thinking and problem-solving skills.

Educators face challenges in tailoring the learning process to meet students' needs, motivation, and engagement. To bridge the gap between traditional teacher-centered approaches and student-centered instruction, effective instructional strategies and resources are essential. One promising approach is gamification, which involves applying game design principles to non-game contexts to boost



participation, engagement, loyalty, and competitiveness (Van Gaalen et al., 2021).

Gamification is an innovative teaching approach that leverages game design principles to captivate students' attention, enhance their confidence, and sustain their engagement (Kumar et al., 2022). By incorporating game elements into existing platforms, such as learning management systems or online forums, educators can foster learners' interest, loyalty, and participation.

Similarly, Gupta and Goyal (2022) listed several game elements that are used to satiate learners' desires in an educational context, including rewards, competition, criticism, gifting, leaderboards, teams, quests, social graphs, levels, virtual goods, achievement, challenges, chance, rivalry, cooperation, resource acquisition, turns, win, progression, emotions, consistent graphical experience, boss flight, collections, content unlocking, and altruism.

Engaging in video games can contribute to a child's cognitive and social growth. Research suggests that hands-on activities and interactive play can be more effective for learning than mere memorization (Hamari et al., 2020). Incorporating enjoyable elements into lessons can help sustain students' interest and boost their performance, even in subjects like mathematics that are often perceived as abstract and intimidating (Buckley & Doyle, 2022). Given the benefits of gamification, integrating game elements into math education can be a valuable approach.

Mathematics is a crucial component of Nigeria's educational system, serving as a prerequisite for admission into post-secondary institutions and influencing students' career choices in science, technology, engineering, and mathematics (STEM) fields (Afolabi et al., 2022). The significance of mathematics extends beyond academic pursuits, as it permeates various aspects of human life, including social, economic, and technological domains. Mathematical skills are essential for effective functioning in diverse professions, enabling

individuals to navigate everyday challenges and make informed decisions (Okwu & Owolabi, 2020).

Moreover, mathematics education fosters cognitive development, enhances creative thinking, and contributes substantially to national growth and development (Ugwoke & Onwukwe, 2021). By acquiring mathematical skills, individuals can improve their problem-solving abilities, critical thinking, and analytical skills, which are valuable in various contexts. As such, mathematics education plays a vital role in shaping the future of individuals and societies.

In recent years, educators and researchers have explored innovative strategies to enhance student engagement and motivation in mathematics. One such strategy is gamification, the use of game design elements in non-game contexts (Dichev & Dicheva, 2020). Gamification is considered to have the potential to develop cognitive abilities, encourage problem-solving, and facilitate collaboration among students (Sailer & Homner, 2020). It can also increase student engagement and motivation, reducing math anxiety and making the subject more enjoyable (Buckley & Doyle, 2017). Furthermore, math games can cater to different learning styles by combining visual aids, physical interaction, and problem-solving, making them an inclusive way to teach and learn (Kiili et al., 2022).

There are various types of math games that can be used in education, including digital games and traditional games. Digital games offer interactivity, adaptability, and instant feedback, making them appealing to tech-savvy students (Dichev & Dicheva, 2020). Examples of digital math games include apps and online platforms such as Duolingo, Mathway, and Khan Academy. The study explores the effectiveness of gamification in mathematics education, with a focus on student engagement, and academic achievement.

Statement of the Problem

Secondary school students in Imo State, Nigeria, struggle with mathematics, leading to poor academic achievement. Traditional teaching



methods may not be engaging enough, contributing to students' disinterest and lack of motivation. This research work explores the effectiveness of gamification in enhancing mathematics engagement and achievement among secondary school students in Imo State, potentially providing a more engaging and interactive approach to learning mathematics.

Objective of the Study:

The objective of the study is to find out the effectiveness of gamification in enhancing mathematics engagement and achievement among secondary school students in Imo State.

Specifically, it sought to:

1. Compare mean mathematics achievement scores of students exposed to gamification-based instruction and that of students exposed to traditional method of instruction.
2. Compare the mean mathematics engagement score of students exposed to gamification-based instruction and that of students exposed to traditional method of instruction.

Research Questions

1. What is the difference in mean mathematics achievement scores between students taught using gamification-based instruction and those taught using traditional instruction?
2. What is the difference in mean mathematics engagement scores between students exposed to gamification-based instruction and those exposed to traditional instruction?

Hypotheses

The following null hypotheses is tested at 0.05 level of significance:

H₀₁: There is no significant difference in mean mathematics engagement scores between students exposed to gamification-based instruction and those exposed to traditional instruction.

Literature Review

Mathematics Engagement

Mathematics engagement is a multifaceted

concept that plays a crucial role in determining students' academic success and future career prospects in mathematics and related fields. It encompasses cognitive, emotional, and behavioral aspects, including students' interest, enjoyment, motivation, and participation in learning mathematics. When students are engaged in mathematics, they are more likely to develop a deep understanding of mathematical concepts, think critically, and solve problems effectively. Cognitive engagement involves students' investment in learning mathematics, using effective cognitive strategies, and regulating their own learning processes. According to Lo and Hew (2021), student engagement in mathematics flipped classrooms can enhance cognitive engagement, leading to improved academic achievement and motivation.

Emotional engagement is also a critical aspect of mathematics engagement. Students who are emotionally engaged in mathematics tend to develop a positive attitude towards the subject, which can foster their motivation and persistence. Research has shown that technology integration in mathematics education can increase student engagement and academic achievement, particularly for students who struggle with mathematics (Fuchs et al., 2021).

Behavioral engagement is characterized by students' participation in mathematics-related activities, including their attendance, effort, and persistence. Engaged students are more likely to attend classes regularly, participate in class discussions, and complete homework assignments. A study by Jahan and Ferdousi (2019) found that mathematical games can increase student achievement and motivation in mathematics.

Concept of Gamification

Gamification is a dynamic and innovative approach that has gained significant attention in recent years. At its core, gamification involves the strategic use of game design elements and mechanics in non-game contexts, such as education, to enhance engagement, motivation, and learning outcomes (Dichev & Dicheva,



2017). By incorporating game-like features, educators can create an interactive and enjoyable learning experience that fosters a positive attitude towards learning. According to Hamari et al. (2014), gamification involves leveraging the motivational power of games to promote learning and engagement. This approach recognizes that games have the ability to captivate and motivate individuals, and seeks to harness this power to achieve educational goals. By incorporating elements such as points, badges, and leaderboards, educators can create a learning environment that is both fun and challenging, encouraging students to participate actively and engage with the material.

The primary goal of gamification is to promote learning and engagement by leveraging the motivational power of games. By doing so, educators can increase student motivation, enjoyment, and overall learning outcomes. As noted by Hamari et al. (2014), gamification can make learning more enjoyable and interactive, leading to a more positive and productive learning experience. In educational settings, gamification can take many forms, from simple point systems to complex simulations. Regardless of the specific approach, the underlying principle remains the same: to use game design elements to promote learning and engagement. By harnessing the power of games, educators can create a more engaging, interactive, and effective learning experience for students.

Concept of Mathematics Education

Mathematics education is a vital component of the educational system, playing a crucial role in shaping students' understanding of mathematical concepts, theories, and applications. According to a recent study by Kurnianto, et al (2022), mathematics education provides students with the knowledge, skills, and problem-solving abilities necessary for success in various fields, including science, technology, engineering, and mathematics (STEM). By developing students' mathematical literacy and critical thinking skills, mathematics education can empower students to become informed and engaged citizens. Effective mathematics education requires a

comprehensive approach that incorporates various teaching methods, resources, and assessments to meet the diverse needs of students. As noted by Wijaya, et al (2023), a comprehensive approach to mathematics education involves using a range of teaching methods, resources, and assessments to promote deeper understanding and engagement with mathematical concepts. By catering to the diverse needs of students, educators can foster a supportive and inclusive learning environment that promotes academic success.

The primary goal of mathematics education is to develop students' mathematical literacy and critical thinking skills, enabling them to apply mathematical concepts and principles to real-world problems. According to a study by Prahmana, et al (2022), mathematical literacy involves more than just procedural fluency; it requires students to think critically and make connections between mathematical concepts and their applications. By developing students' mathematical literacy and critical thinking skills, mathematics education can empower students to become informed and engaged citizens, capable of making informed decisions in their personal and professional lives.

Mathematics education is a critical component of the educational system, providing students with the knowledge, skills, and problem-solving abilities necessary for success in various fields. By adopting a comprehensive approach that incorporates various teaching methods, resources, and assessments, educators can promote deeper understanding and engagement with mathematical concepts, ultimately developing students' mathematical literacy and critical thinking skills (Wijaya, et al 2023).

Gamification in Mathematics Education

Gamification in mathematics education involves using game design elements and mechanics to enhance student engagement, motivation, and learning outcomes in mathematics. By incorporating game-like features, such as points, badges, and leaderboards, educators can create an interactive and enjoyable learning experience for students. According to Looi, Chen, Ng,



Wong, Poon, and Chuah (2022), gamification can be an effective approach to teaching and learning mathematics, particularly when implemented with a pedagogical focus. They emphasize the importance of aligning gamification with learning objectives and outcomes to maximize its effectiveness.

Studies have suggested that gamification could be a positive impact on student motivation and engagement in mathematics education, making learning mathematics more enjoyable and relevant to students' lives (Hamari, Koivisto, & Sarsa, 2014; Hwang, Wu, Chen, & Tu, 2020). Hamari, Koivisto, and Sarsa (2014) found that gamification can increase student motivation by providing a sense of autonomy, competence, and relatedness. Hwang, Wu, Chen, and Tu (2020) further noted that gamification can promote a positive attitude towards mathematics, leading to improved learning outcomes. By leveraging game design elements, educators can create a more engaging and interactive learning environment that fosters a positive attitude towards math. Gamification can also provide immediate feedback, promoting healthy competition, and fostering a sense of accomplishment (Buckley & Doyle, 2016). Buckley and Doyle (2016) found that gamification can increase students' motivation by providing a sense of challenge and accomplishment. By incorporating game design elements and mechanics into mathematics education, educators can create a more enjoyable and motivating learning experience for students, ultimately leading to improved learning outcomes.

Theoretical Framework

Gamification in education is underpinned by several theories that provide a foundation for understanding its effectiveness in promoting student engagement, motivation, and learning outcomes. Two prominent theories that have been applied to gamification in education are Self-Determination Theory (SDT) and Social Cognitive Theory (SCT).

Self-Determination Theory (SDT) posits that human behavior is motivated by three innate

psychological needs: autonomy, competence, and relatedness. According to Deci and Ryan (2000), these three needs are essential for human growth, well-being, and optimal functioning. Autonomy refers to the need to have control over one's actions and decisions, competence refers to the need to feel effective and capable, and relatedness refers to the need to connect with others. When these needs are satisfied, individuals are more likely to be motivated and engaged. In the context of gamification, SDT suggests that game design elements can satisfy these three psychological needs. For example, providing students with choices and opportunities for self-directed learning can satisfy their autonomy needs, while feedback and progress tracking can satisfy their competence needs.

Social Cognitive Theory (SCT) suggests that human behavior is influenced by observing others, imitating their actions, and receiving reinforcement. According to Bandura (1986), individuals learn new behaviors and attitudes by observing others, and they are more likely to adopt these behaviors if they are reinforced with rewards or praise. Observational learning, imitation, and reinforcement are key components of SCT. In the context of gamification, SCT suggests that game design elements can leverage observational learning, imitation, and reinforcement to promote student learning and engagement. For example, models of successful behavior, opportunities for practice, and reinforcement through rewards and feedback can promote student learning and motivation.

Recent studies have applied these theories to the design and implementation of gamification in mathematics education. For example, Kyewski and Krämer (2020) found that gamification elements that satisfy students' autonomy needs can enhance their motivation and engagement in mathematics. By providing students with choices and opportunities for self-directed learning, gamification can promote autonomy and motivation. Similarly, gamification elements that provide feedback and reinforcement can satisfy students' competence needs and promote motivation and engagement. Finally, SDT and



SCT provide a theoretical foundation for understanding the effectiveness of gamification in promoting student engagement, motivation, and learning outcomes. By leveraging game design elements that satisfy students' psychological needs and provide opportunities for observational learning, imitation, and reinforcement, gamification can promote student learning and motivation in mathematics education.

Empirical Review

A recent study explored the impact of game elements on intrinsic motivation. Li et al. (2023) investigated the effects of leader boards on students' motivation and found that gamification conditions improved performance metrics without relying on additional rewards. This suggests that well-designed gamification elements can foster intrinsic motivation, even in competitive settings. Recent research has identified key game elements that enhance student engagement and motivation. According to a study by Zainuddin et al. (2020), narrative, challenges, progression, and feedback are essential game elements that promote student engagement. Additionally, gamification can be used to create interactive and immersive learning experiences, encouraging students to be active participants in the learning process and making it more enjoyable. A recent study explored the impact of multimedia elements on student learning outcomes. According to Chen et al. (2022), the use of interactive elements, feedback, and rewards in digital learning environments significantly improved students' academic performance in science subjects. The study highlights the potential of multimedia elements in enhancing student learning outcomes.

Shute (2008) study on gamification and problem solving skills in mathematics revealed a significant improvement in students' ability to analyze problems and develop solutions. The study, which involved 120 students, showed a 25.6% increase in problem-solving skills among students who played a mathematics game designed to enhance these skills. Notably, the treatment group, which played the game, outperformed the control group, which received

traditional instruction, with a mean score of 85.2% compared to 68.5% for the control group. This study highlights the potential of gamification to enhance problem-solving skills in mathematics. However, careful design and implementation of gamification are crucial to ensuring its effectiveness in mathematics education.

A review of existing literature by Dichev and Dicheva (2017) found that gamification designs that were aligned with learning objectives and incorporated meaningful rewards and feedback were more likely to be effective. Out of 20 studies reviewed, 75% reported positive outcomes when gamification was designed and implemented carefully. This emphasizes the importance of thoughtful design and implementation in gamification. Moreover, balancing extrinsic rewards with intrinsic motivation is essential to ensuring the effectiveness of gamification in mathematics education. A meta-analysis by Sailer and Homner (2020) found that gamification designs that incorporated intrinsic motivation had a larger effect size (0.73) compared to those that relied solely on extrinsic rewards (0.34). Furthermore, gamification designs that balanced extrinsic rewards with intrinsic motivation had a larger effect size (0.85) compared to those that did not (0.51). This highlights the importance of considering both extrinsic and intrinsic motivators in gamification design.

These studies demonstrate the potential of gamification to enhance mathematics education, but none expressly explored the effectiveness of gamification in enhancing mathematics engagement and achievement among secondary school students in Imo State. In conclusion, this study intends to explore the effectiveness of gamification by leveraging game design elements and mechanics, educators can promote student motivation, engagement, and learning outcomes in mathematics.

Methodology

Research Design

This research employed a quasi-experimental design to explore the effectiveness of



gamification in enhancing mathematics engagement and achievement among secondary school students in Imo State. This design is most appropriate because in-tact classes are used for the study. True experimental design also allows for cause – effect ascertainment. In this quasi-experimental design, two groups were compared: an experimental group that receives the gamification intervention (G-teach) and a control group that received traditional mathematics (T-teach) instruction. The experimental group participated in mathematics lessons that incorporate gamification elements, such as Solitaire card, Ludo, and Snake and Ladder games, designed to promote engagement, motivation, and achievement. Meanwhile, the control group was on normal traditional mathematics instruction without any gamification elements.

Area of the Study

This research work is carried out within the Imo State secondary school system. Imo State is located in the southeastern region of Nigeria, boasts a well-established network of secondary schools, both public and private, that offer mathematics as a fundamental component of their curriculum.

Population of the Study

The population for this study comprises all public Junior Secondary School 2 (JSS2) students numbering 2,100 in Imo State, Nigeria. These students are at a pivotal stage in their educational journey, and their engagement and achievement in mathematics can have a profound impact on their future academic and career prospects.

Sample and Sampling Techniques

For this study, a sample of 210 JSS2 students was selected from twenty one (21) secondary schools in Imo State. The selection process involves a multi-stage sampling technique to ensure representation from different areas of the state. First, using stratified sampling, Imo State was divided into three with each senatorial district forming a stratum: Owerri, Orlu, and Okigwe. By applying the simple random sampling without replacement, seven schools were randomly

selected from each stratum, resulting in a total of twenty one (21) schools.

Within these selected schools, by applying the simple random sampling without replacement, 10 JSS2 students were selected from each school and randomly assigned to either an experimental group, which received the gamification intervention, or a control group, which received traditional mathematics instruction.

Instrument for Data Collection

This study utilized two instruments for data collection: the Mathematics Achievement Test (MAT) and the Mathematics Engagement Questionnaire (MEQ). The MAT is a researcher-developed test that assesses students' understanding and proficiency in mathematics, covering topics that were taught. It was administered as both a pre-test and post-test to measure achievement. The MEQ, on the other hand, is a self-report instrument designed to measure students' engagement levels in mathematics, assessing behavioral, emotional, and cognitive engagement.

Validity of the Instrument

Both instruments were face and content validated by two experts in Statistics and Measurement and Evaluation from Federal University of Technology Owerri(FUTO) and Michael Okpara University of Agriculture, Umudike(MOUAU).

Reliability of the Instrument

A test-retest method used to ascertain the reliability of the instruments. The validated instruments was distributed to 20 JSS2 students in Ahiazu Mbaise Local Government Area of Imo State who were not part of the study sample. After two weeks, the same instruments were re-administered to the same group of respondents and the scores obtained from the two tests were computed using the split half reliability. A split half value of 0.87 was obtained, indicating that the items within each instrument will reliably measure mathematics achievement and engagement.

Experimental Procedures

The experimental procedure involved several



steps. First, the researcher obtained permission from the Imo State Ministry of Education and the selected schools to conduct the study. The Mathematics Achievement Test (MAT) and Mathematics Engagement Questionnaire (MEQ) were administered to both the experimental and control groups as pre-tests before the intervention by two trained research assistants. The research assistants were special education teachers that studied mathematics and are skillful in games. They possess a minimum qualification of Nigerian Certificate in Education (NCE) with at least four years of teaching experience. These teachers were adequately trained on research ethics and were briefed with the essence of the study.

The experimental group received mathematics instruction (Double lesson periods) for eight weeks incorporating gamification elements, such as Solitaire card, Ludo, and Snake and Ladder games. During this period, the control group received traditional mathematics instruction without gamification elements. Two trained research assistants assisted the researcher in administering the MAT and MEQ to both groups,

ensuring that the instruments were properly distributed and collected. After the intervention period, the MAT and MEQ were administered as post-tests to both groups to measure mathematics achievement and engagement. The research assistants helped in supervising the administration of the instruments, collecting the completed instruments, and ensuring that the data were accurately recorded.

Method of Data Analysis

The collected data were analyzed using a combination of descriptive and inferential statistics. Mean and standard deviation, were used to summarize the demographic characteristics of the students. Also paired sample t-test was used to compare the mean scores of the experimental and control groups on the Mathematics Engagement Questionnaire (MEQ). Additionally, Analysis of Covariance (ANCOVA) was employed to compare the post-test scores of the two groups with pretest serving as covariate. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) software, with a significance level set at 0.05.

Results

Table1: Mean and standard deviation scores of control and treatment groups.

Statistics	Control Group (N=60)		Diff Mean	Experimental group (N = 60)		Diff Mean
	Pre-Test	Post-Test		Pre-Test	Post-Test	
Total Score	846.0	845.0	-	707.0	1449.0	-
Maximum Score	20.0	20.0	-	17.0	30.0	-
Minimum Score	8.0	9.0	-	7.0	15.0	-
Mean Score	14.1	14.1	0.0	11.78	24.15	12.37
Standard Deviation	3.63	3.62	-	2.46	3.75	-

The analysis results presented in Table 1 provide valuable insights into the effectiveness of gamification in teaching and learning mathematics. The control group, which did not receive the gamification treatment, showed almost no change in mean scores between the

pre-test (14.1) and post-test (14.1), with a difference of 0.0. This suggests that the traditional teaching method used for the control group did not lead to any significant improvement in student performance. In contrast, the experimental group, which received



the gamification treatment, showed a significant increase in mean scores between the pre-test (11.78) and post-test (24.15), with a difference of 12.37. This indicates that the use of gamification in teaching mathematics had a positive impact on student performance, leading to a substantial improvement in scores.

The results also highlight the difference in performance between the control and experimental groups. While the control group's mean scores remained stable, the experimental group's mean scores increased significantly, suggesting that gamification was effective in improving student outcomes. The standard deviation scores also provide insight into the

variability of student performance within each group. The experimental group's standard deviation increased from 2.46 to 3.75, indicating a slightly wider range of scores in the post-test. Overall, the results suggest that gamification can be a effective tool in teaching and learning mathematics, leading to significant improvements in student performance.

Hypotheses

H₀₁: There is no significant difference in mean mathematics engagement scores between students exposed to gamification-based instruction and those exposed to traditional instruction.

This will be tested at 0.05 level of significance:

Table 2: ANCOVA summary table for hypothesis

Source	Sum of Squares	Df	Ms	F	Sig.	Decision
Adjusted Mean	19.210	1	19.210	1.378	0.037	0.025
Error	808.440	58	13.939			
Total	827.650	59				

The analysis results in table 2 indicates that the null hypothesis of no significant difference in mean mathematics engagement scores between students exposed to gamification-based instruction and those exposed to traditional instruction can be rejected. The ANCOVA summary table shows that the F-statistic is 1.378 with a corresponding p-value of 0.037, which is less than the specified level of significance (0.05). This suggests that there is a statistically significant difference in mean mathematics engagement scores between the two groups. Furthermore, the decision column indicates a value of 0.025, which reinforces the conclusion that the difference is significant. Therefore, it can be inferred that gamification-based instruction has a positive impact on mathematics engagement scores, leading to a significant difference in mean scores compared to traditional instruction.

Discussion

The findings of this study provide strong evidence for the effectiveness of gamification in

teaching and learning mathematics. The results presented in Table 1 show that the experimental group, which received gamification-based instruction, demonstrated a significant increase in mean scores between the pre-test and post-test, with a difference of 12.37. In contrast, the control group, which received traditional instruction, showed almost no change in mean scores. This suggests that gamification was effective in improving student performance and engagement in mathematics. The ANCOVA analysis presented in Table 2 further supports this finding, indicating a statistically significant difference in mean mathematics engagement scores between the experimental and control groups. The p-value of 0.037 is less than the specified level of significance (0.05), leading to the rejection of the null hypothesis. This finding is consistent with previous research that suggests gamification can enhance student engagement and motivation in mathematics.

Conclusion

This study concludes that gamification-based



instruction has a positive impact on student performance and engagement in mathematics. The results of this study demonstrate that students who received gamification-based instruction showed significant improvement in their mean scores compared to those who received traditional instruction. The study also found a statistically significant difference in mean mathematics engagement scores between the experimental and control groups, with the experimental group showing higher engagement scores. Overall, the findings of this study suggest that gamification can be an effective tool in teaching and learning mathematics, leading to improved student outcomes.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Integration of Gamification in Mathematics Education: Mathematics

educators should consider incorporating gamification elements into their teaching practices to enhance student engagement and performance.

2. Professional Development for Teachers: Teachers should receive professional development opportunities to learn how to effectively integrate gamification into their mathematics instruction.
3. Further Research: Further research should be conducted to explore the long-term effects of gamification on student performance and engagement in mathematics.
4. Development of Gamification-Based Resources: Educational resources and materials that incorporate gamification elements should be developed and made available to mathematics educators to support their teaching practices.

References

- Afolabi, F. O., Oloyede, E. O., & Adebule, S. O. (2022). Mathematics education and career choices of secondary school students in Nigeria. *Journal of Educational Research and Development*, 11(1), 1-12.
- Alsadoon, R. (2023). The impact of gamification on student motivation and engagement in mathematics. *Journal of Educational Computing Research*, 67(4), 419-437.
- Buckley, P., & Doyle, E. (2022). Gamification and student engagement: A systematic review. *Journal of Educational Technology Development and Exchange*, 14(1), 1-20.
- Buckley, P., & Doyle, E. (2016). Gamification and student motivation. *Interactive Learning Environments*, 24(6), 1162-1175.
- Carey, E., Devine, A., Hill, F., & Szűcs, D. (2022). The relationship between math anxiety and math achievement: A systematic review. *Journal of Educational Psychology*, 114(3), 549-565.
- Chen, Y., Wang, Y., & Wang, J. (2022). The effect of multimedia elements on student learning outcomes in science education: A meta-analysis. *Journal of Educational Multimedia and Hypermedia*, 31(1), 5-24.
- Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuit: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11(4), 227-268.
- Dichev, C. D., & Dicheva, D. (2020). The gamification of education: A critical analysis. *Journal of Educational Computing Research*, 62(4), 419-437.
- Dichev, C., & Dicheva, D. (2017). The gamification of education: A critical analysis. *Educational Technology*, 57(4), 37-43.



- Fredricks, J. A., Filsecker, M., & Lawson, M. A. (2016). Student engagement, context, and adjustment: A multidimensional approach. *Journal of Educational Psychology*, 108(4), 461-474.
- Fuchs, L. S., Fuchs, D., Prentice, K., Burch, M., Hamlett, C. L., Owen, R., & Jiménez, B. A. (2021). The effects of technology-based mathematics interventions on mathematics achievement and mathematics behavior outcomes: A meta-analysis. *Journal of Educational Psychology*, 113(1), 1-24
- Gupta, P., & Goyal, P. (2022). Is Game-Based Pedagogy Just a Fad? A Self-Determination Theory Approach to Gamification in Higher Education. *International Journal of Educational Management*, 36(3), 341-356
- Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work?—A literature review of empirical studies on gamification. *Proceedings of the 47th Hawaii International Conference on System Sciences*, 3025-3034.
- Hamari, J., Koivisto, J., & Sarsa, H. (2020). Does gamification work? A literature review of empirical studies on gamification. *Journal of Educational Multimedia and Hypermedia*, 29(1-2), 5-23.
- Jahan, I., & Ferdousi, R. (2019). The impact of mathematical games on student achievement and motivation. *Journal of Mathematics Education*, 12(2), 29-42
- Kiili, K., Lindstedt, A., & Nina, P. (2022). Exploring the role of gamification in enhancing student engagement and motivation in mathematics. *Journal of Educational Multimedia and Hypermedia*, 31(1-2), 5-23.
- Kumar, S., Kumar, A., & Singh, R. (2022). Gamification in education: A systematic review. *Journal of Educational Computing Research*, 66(4), 419-443
- Kurnianto, F. A., Fitriani, N., & Agustina, I. (2022). The effectiveness of mathematics education in developing students' problem-solving skills. *Journal of Mathematics Education*, 11(1), 1-15.
- Li, M., Dong, Y., & Li, X. (2023). The impact of leaderboards on intrinsic motivation in gamified learning environments. *Journal of Educational Computing Research*, 67(4), 419-437
- Lo, C. K., & Hew, K. F. (2021). Student engagement in mathematics flipped classrooms: Implications of journal publications from 2011 to 2020. *Frontiers in Psychology*, 12, 672610.
- Looi, C. K., Chen, W., Ng, F. K., Wong, L. H., Poon, J. K., & Chuah, K. M. (2022). Gamification in mathematics education: A systematic review. *Educational Technology & Society*, 25(1), 134-147.
- Okwu, E. I., & Owolabi, J. (2020). Mathematics skills and employability in the 21st century workforce. *Journal of Mathematics and Science Education*, 18(2), 1-15.
- Prahmana, R. C. I. & Zulkardi, Z., (2022). Designing Mathematics Learning Trajectory for Elementary School Students. *Journal on Mathematics Education*, 13(1), 69-86.
- Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review*, 32(1), 77-112.
- Shute, V. J. (2008). Focus on form: A design principle for video games that support learning. *Journal of Educational*



Psychology, 100(2), 227-236.

Educational and Social Research,
11(3), 1-10.

Shute, V. J., Wang, L., & Rahimi, S. (2021).
Stealth assessment in game-based
learning: A review of the literature.
Journal of Educational Data Mining,
13(1), 1-27.

Wijaya, T. T. & Ying, Z. (2023). Mathematics
Education Research Trends: A
Bibliometric Analysis. *Mathematics*,
11(4), 971.

TIMSS. (2020). TIMSS 2020 international
results in mathematics and science.
Boston College.

Zainuddin, Z., Shujahat, M., Haruna, H., & Chu,
S. K. W. (2020). The impact of
gamification on learning outcomes: A
systematic review. *Journal of
Educational Computing Research*,
62(4), 419-437.

Ugwoke, S. C., & Onwukwe, E. O. (2021).
Mathematics education and national
development: A review. *Journal of*