

INFLUENCE OF GAME-BASED LEARNING ON ACADEMIC PERFORMANCE IN MATHEMATICS OF SECONDARY SCHOOL STUDENTS IN ONDO STATE

¹AKINTEWE, B.N., & ²IKECHUKWU, M. F.

Department of Mathematics, Adeyemi Federal University of education, Ondo, Ondo State.

¹Correspondence email: akintewebn@aceondo.edu.ng. +2348034655108

²email: ikechukwumichaelfriday@gmail.com

Abstract

The study investigated the influence of game-based learning on the academic performance of secondary school students in mathematics within Ondo State. Utilizing a descriptive survey research design, the study focused on students within the Ondo West Local Government Area. A sample of 250 secondary school students was randomly selected to participate in the study. Data was collected through a structured questionnaire developed by the researchers, and both descriptive and inferential statistical tools were employed for analysis to include frequency counts and mean scores were used to address research questions, while a t-test was conducted to test the hypotheses at a significance level of .05. The findings of the study revealed the availability of various types of games used in teaching mathematics, including puzzle games for logic, sports games for algebra, role-playing games for simultaneous equations, action games for trigonometry, and adventure games for indices and logarithms. Significantly, the study indicated a positive influence of game-based learning on students' academic performance in mathematics within secondary schools. Furthermore, it found no significant difference between male and female students regarding the influence of game-based learning on academic performance in mathematics. Based on these findings, several recommendations were proposed, including the adoption of game-based learning as a teaching strategy across secondary schools, the organization of seminars and workshops to train teachers on effective teaching strategies, and the inclusion of game-based learning in the curriculum of trainee teachers. These recommendations aim to leverage the benefits of game-based learning to enhance mathematics education in secondary schools.

Keywords: Games, Game-based, Learning, Academic Performance, Mathematics

Introduction

Secondary education holds a pivotal position within Nigeria's educational framework, serving as the bridge between primary and tertiary institutions. Following primary education and preceding tertiary studies, it caters to students typically aged between 11 and 17. This educational stage not only nurtures future professionals but also lays the groundwork for exploring and delineating various fields or vocations.

Before Nigeria's independence up to 1982, secondary education spanned five years.

Following this period, those meeting the necessary criteria proceeded to a two-year Higher School Certificate program, enabling eligibility for university enrolment (Wahab, 2019). This structure comprised three years of junior secondary and two years of senior secondary education. Recognizing the imperative to integrate science, technical subjects and mathematics, the curriculum was expanded, extending the duration to six years. The significance of this educational phase cannot be overstated.

Mathematics holds not only significant importance within secondary education but is also

revered as the foundational pillar of all scientific disciplines. It encompasses the study of numbers, counting, and measurement, while also delving into logical reasoning and quantitative computations (Gouba, 2008). Regarded as indispensable for fostering scientific and technological advancements within a nation (Anaduaka & Okafor, 2013), Mathematics has been designated a core and compulsory subject by the Nigerian government at the secondary school level. Despite this acknowledgment, secondary school students in Nigeria often struggle to grasp the fundamentals of Mathematics (Akinsola, 2010). The efficacy of understanding mathematical concepts largely hinges on the teaching methodologies employed by educators in the classroom.

In secondary education, the adoption of non-traditional instructional strategies like game-based learning fosters creativity among students and facilitates first-hand comprehension of subject matter. Game-based learning entails leveraging games to reinforce learning objectives, motivate students, and cultivate engagement. Trybus (2015) described it as the application of gaming principles to real-life scenarios to immerse users in effective teaching-learning processes, engaging them in educational content through dynamic and playful means.

Furthermore, Sadeghi and Dousti (2013) highlighted the benefits of game-based learning, including enhanced learning efficacy, immediate feedback, repetition and practice of essential skills, student-centred learning, increased motivation, and enjoyment. By actively involving students in mathematical exercises through hands-on participation within a secure environment, game-based learning diminishes the perceived difficulty associated with learning secondary school Mathematics. However, despite the potential benefits of game-based learning, secondary school educators encounter challenges hindering its effective integration into mathematics instruction. One significant barrier is

the lack of sufficient knowledge among teachers regarding how to utilize games effectively, which can adversely impact student performance in mathematics (Demirbilek & Tamer, 2010). Additionally, students often perceive mathematics as a challenging subject, leading to avoidance of mathematics classes and subsequently, poor performance in both internal and external examinations.

Areagok (2021) explored how game-based teaching approaches found in various curricula affect academic attainment. The study used the meta-analysis method, which involved pooling similar studies on that issue or theme based on specific criteria and merging the quantitative data acquired. For this reason, 412 studies published between 2000 and 2020 were analysed, with 54 experimental studies on game-based teaching approaches included in the analysis. Data from 54 experimental investigations were examined using the Comprehensive Meta-Analysis Program (CMA) and MetaWin tools. The study found that game-based teaching approaches used in various curricula improve students' academic achievement when compared to traditional practices. The effect sizes of game-based curricula were shown to vary greatly depending on education level, treatment duration, sample size, and publication style.

Hui and Mahmud (2023) analysed journal articles published between 2018 and 2022 about the impact of Game-Based Learning in mathematics teaching and learning on students' cognitive and affective domains. The survey was conducted using a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) research technique utilizing the Scopus and Web of Science (WOS) databases, which yielded 773 papers on game-based learning (GBL) in mathematics. Depending on the subject topic, study technique, and analysis, only 28 open-access papers were chosen for further review. Two cognitive domains and five affective domains were found as being connected to the

effects of GBL on students' mathematical T&L. The study's findings demonstrate that GBL has a good impact on children who are learning mathematics. It consists of two cognitive domains (knowledge and mathematical abilities) and five affective domains (achievement, attitude, motivation, interest, and engagement). The study's findings are expected to improve the effectiveness of educators in the classroom.

Purpose of the Study

The primary purpose of this study was to assess the influence of game-based learning on the academic performance of students in mathematics within secondary schools in Ondo State. Specifically, the study sought to:

1. Determine the available games that teachers use in teaching mathematics in secondary schools.
2. Evaluate the advantages associated with the implementation of game-based learning for teaching mathematics in secondary schools.
3. Determine the influence of game-based learning on students' academic performance in mathematics in secondary schools.

Method of the Study

The study adopted a descriptive survey design, which is suitable for investigating the opinions of a representative population without manipulating variables. This design is well-suited for this research as it allows for the exploration of perceptions and attitudes without experimental manipulation.

The target population comprised of 2,454 senior secondary school students from five

randomly selected secondary school Ondo West Local Government Area of Ondo State.

A sample of 250 senior secondary school students was randomly selected from the target schools in Ondo West Local Government Area using a simple random sampling technique. This represents 10% of the target population being studied.

The survey instrument was a structured questionnaire developed by the researchers. The questionnaire comprised two sections: Section A collected demographic information, while Section B consisted of three parts. Part I, II, and III each contain five-item statements structured on a five-point Likert scale (Strongly Agree SA-5, Agree A-4, Neutral N-3, Disagree D-2, and Strongly Disagree SD-1). These sections sought responses from respondents regarding the availability of games used in teaching mathematics, the benefits of game-based learning in teaching mathematics, and the influence of game-based learning on students' academic performance in mathematics in secondary schools.

The instrument was reviewed by experts for validity and reliability. Comments and suggestions made by experts were used to produce final copy used for this study.

The copies of the questionnaire were administered to the respondents by the researchers and were collected immediately after the completion by the respondents.

Descriptive and inferential statistical tools were employed for data analysis. Frequency counts and mean scores were used to address research questions, while t-tests were conducted to test hypotheses at a significance level of .05.

Results and Discussion

Research Question 1: What are the available games that teachers use in teaching mathematics in

secondary schools?

Table 1: Available Games that Teachers Use in Teaching Mathematics in Secondary Schools

| S/N | ITEMS | SA | A | N | D | SD | Mean | Remarks |
|-----|---|-----|-----|----|----|----|------|---------|
| 1 | Puzzle games are available for use in teaching logic in secondary schools | 109 | 79 | 2 | 20 | 40 | 3.79 | Agreed |
| 2 | Sports games are available for use in teaching algebra in secondary schools | 43 | 123 | 30 | 36 | 18 | 3.55 | Agreed |
| 3 | Role-playing games are available for use in teaching simultaneous equation in secondary schools | 79 | 75 | 39 | 36 | 21 | 3.62 | Agreed |
| 4 | Action games are available for use in teaching trigonometry in secondary schools | 69 | 86 | 27 | 41 | 27 | 3.52 | Agreed |
| 5 | Adventure games are available for use in teaching indices and logarithms in secondary schools | 79 | 67 | 32 | 29 | 43 | 3.44 | Agreed |

Key: SA = Strongly Agreed, A = Agreed, N = Neutral, D = Disagreed, SD = Strongly Disagreed; Cut-off Point = 3.00

The data presented in Table 1 illustrates the availability of various games utilized by teachers for teaching mathematics in secondary schools. The majority of respondents concurred that puzzle games are accessible for teaching logic in secondary schools (mean = 3.79). Similarly, sports games were reported to be available for teaching algebra in secondary schools, with a mean score of 3.55. Role-playing games were indicated as accessible for teaching simultaneous equations in secondary schools,

with a mean score of 3.62. Furthermore, action games were cited as available for teaching trigonometry in secondary schools, with a mean score of 3.52. Lastly, adventure games were noted to be available for teaching indices and logarithms in secondary schools, with a mean score of 3.44.

Research Question 2: What are the advantages of using game-based learning in teaching mathematics in secondary schools?

Table 2: Advantages of Using Game-based Learning in Teaching Mathematics in Secondary Schools

| S/N | ITEMS | SA | A | N | D | SD | Mean | Remarks |
|-----|--|-----|-----|----|----|----|------|---------|
| 1 | Game-based learning helps students in retaining learning insights in mathematics | 108 | 92 | 12 | 17 | 21 | 4.00 | Agreed |
| 2 | It makes the students to learn mathematics through familiar devices | 68 | 110 | 30 | 29 | 13 | 3.76 | Agreed |
| 3 | It stimulates the imagination of students in mathematics | 84 | 92 | 49 | 17 | 8 | 3.91 | Agreed |

| | | | | | | | | |
|---|---|----|----|----|----|----|------|--------|
| 4 | It helps the students to simplify the difficult concepts in mathematics | 63 | 94 | 47 | 28 | 18 | 3.62 | Agreed |
| 5 | It improves the students' retention of the topics learnt in mathematics | 78 | 78 | 38 | 21 | 35 | 3.57 | Agreed |

Key: SA = Strongly Agreed, A = Agreed, N = Neutral, D = Disagreed, SD = Strongly Disagreed; Cut-off Point = 3.00

Table 2 illustrates the benefits of employing game-based learning in teaching mathematics in secondary schools. The data shows that a significant portion of respondents agreed on various advantages associated with game-based learning. Specifically, the majority expressed agreement that game-based learning aids students in retaining learning insights in mathematics (mean = 4.00). Additionally, respondents indicated that game-based learning facilitates learning mathematics through familiar devices, with a mean score of 3.76. Furthermore, respondents agreed that game-based learning stimulates students' imagination in mathematics,

with a mean score of 3.91. Moreover, respondents reported that game-based learning assists students in simplifying difficult concepts in mathematics, with a mean score of 3.62. Finally, respondents acknowledged that game-based learning improves students' retention of topics learned in mathematics, with a mean score of 3.57.

Research Question 3: What is the effect of game-based learning on students' academic performance in mathematics in secondary schools?

Table 3: Influence of Game-based Learning on Students' Academic Performance in Mathematics in Secondary Schools

| S/N | ITEMS | SA | A | N | D | SD | Mean | Remarks |
|-----|--|-----|-----|----|----|----|------|---------|
| 1 | Game-based learning has positive impacts on students' academic performance in mathematics | 105 | 97 | 13 | 15 | 20 | 4.01 | Agreed |
| 2 | It improves the knowledge of students in mathematics | 74 | 108 | 28 | 29 | 11 | 3.82 | Agreed |
| 3 | It increases the mathematical skills of students in mathematics | 85 | 79 | 45 | 33 | 8 | 3.80 | Agreed |
| 4 | Game-based learning boosts the ability of students to reason and understand the underlying concepts in mathematics | 68 | 105 | 26 | 31 | 20 | 3.68 | Agreed |
| 5 | It motivates the students to find creative solutions and drive them to accelerate their learning in mathematics. | 93 | 71 | 31 | 25 | 30 | 3.69 | Agreed |

Key: SA = Strongly Agreed, A = Agreed, N = Neutral, D = Disagreed, SD = Strongly Disagreed; Cut-off Point = 3.00

Table 3 presents the influence of game-based learning on students' academic performance in mathematics in secondary schools. It reveals

that majority of the respondents agreed that game-based learning has positive influences on students' academic performance in mathematics

(mean = 4.01), It improves the knowledge of students in mathematics (mean = 3.82), it increases the mathematical skills of students in mathematics (mean = 3.80), game-based learning boosts the ability of students to reason and understand the underlying concepts in mathematics (mean = 3.68), it motivates the students to find creative solutions and drive

them to accelerate their learning in mathematics (mean = 3.69).

Hypotheses Testing

HO₁: There is no significant effect of game-based learning on students' academic performance in mathematics in secondary schools

Table 4: Summary of t-test Analysis on Significant Influence of Game-based Learning on Students' Academic Performance in Mathematics in Secondary Schools

| Variables | N | Mean | St. D. | df | t-calc. | t-table | Decision |
|----------------------|-----|------|--------|-----|---------|---------|-------------|
| Game-based learning | 250 | 3.80 | .708 | 248 | 2.849 | 1.984 | Significant |
| Academic performance | 250 | 3.62 | .705 | | | | |

Table 4 provides a summary of the t-test analysis regarding the significant influence of game-based learning on students' academic performance in mathematics in secondary schools. The analysis indicates that the calculated t-value (2.849) exceeds the critical t-value (1.984) at a significance level of .05, with degrees of freedom (df = 248). Consequently, the null hypothesis, which posits that there is no significant effect of game-based learning on students' academic

performance in mathematics in secondary schools, is rejected. Thus, it can be inferred that there is a significant influence of game-based learning on students' academic performance in mathematics in secondary schools.

HO₂: There is no significant difference between the responses of males and females regarding the influence of game-based learning on students' academic achievement in mathematics within secondary schools.

Table 5: Summary of t-test Analysis on Significant difference between Male and Female responses on the Influence of Game-based Learning on Students' Academic Performance in Mathematics in Secondary Schools

| Variables | N | Mean | St. D. | df | t-calc. | t-table | Decision |
|-----------|-----|------|--------|-----|---------|---------|-----------------|
| Male | 103 | 3.81 | 1.103 | 248 | .155 | 1.984 | Not significant |
| Female | 147 | 3.79 | .925 | | | | |

Table 5 presents a summary of the t-test analysis concerning the presence of a significant difference between male and female responses regarding the influence of game-based learning on students' academic performance in mathematics in secondary schools. The analysis indicates that the calculated t-value (.155) is lower than the critical t-value (1.984) at a significance level of .05, with degrees of freedom (df = 248). Therefore, the null hypothesis, which posits that there is no significant difference between male

and female responses on the influence of game-based learning on students' academic performance in mathematics in secondary schools, is accepted. Consequently, both male and female respondents share similar views and opinions regarding the effect of game-based learning on students' academic performance in mathematics in secondary schools.

Discussion of Findings

Finding of the study revealed the available games that teachers use in teaching mathematics

in secondary schools. It was revealed that puzzle games are available for use in teaching logic, sports games are available for use in teaching algebra, role-playing games are available for use in teaching simultaneous equation, action games are available for use in teaching trigonometry, and adventure games are available for use in teaching indices and logarithms in secondary schools. The finding of this study is in disagreement with the study of Oluwatayo, et.al. (2020) who revealed that teachers do not use the available games such as circle race game, binary tic tac game geo-board game among others to teach mathematics in schools.

The study showed the benefits of using game-based learning in teaching mathematics in secondary schools. It was revealed that game-based learning helps students in retaining learning insights in mathematics, makes the students to learn mathematics through familiar devices, stimulates the imagination of students in mathematics, helps the students to simplify the difficult concepts in mathematics and also improves the students' retention of the topics learnt in mathematics. This finding is in agreement with the study of Pratama and Setyaningrum (2018) who revealed that students, who were exposed to the game-based learning within problem-solving method, obtain positive effect on cognitive and affective aspects. Through this research, it provided evidence that the use of educational games could support and increase the mathematics learning outcome.

The finding of the study discovered the influence of game-based learning on students' academic performance in mathematics in secondary schools. It was revealed that game-based learning has positive influence on students' academic performance in mathematics, improves the knowledge of students in mathematics, increases the mathematical skills of students in mathematics, boosts the ability of students to reason and understand the underlying concepts in mathematics and also motivates the students to

find creative solutions and drive them to accelerate their learning in mathematics. This finding is in agreement with the study of Areagok (2021) who revealed that game-based teaching practices applied in different curricula affect the students' academic achievement positively compared to traditional practices. Also, the study of Dele-Ajayi, et al (2019) is in agreement with this finding. Their study revealed that results demonstrate significant improvements in attitude to and engagement with mathematics across the target group, after two weeks of using SpeedyRocket. Learners became co-creators of their own knowledge, sharing ideas, forging new learning pathways, competing, and cooperating with one another. Furthermore, the findings from this study provide insights into the changes that occur in the dynamics of the traditional classroom through the introduction of digital technology, especially in settings where it has not been previously used.

The study showed that there is a significant influence of game-based learning on students' academic performance in mathematics in secondary schools. Hence, game-based learning has influence on students' academic performance in mathematics in secondary schools. This finding is in consonance with the study of Hui and Mahmud (2023) who revealed that game-based learning positively impacted students when they are learning mathematics. It is comprised of two types of cognitive domain (knowledge and mathematical skills) and five types of affective domain (achievement, attitude, motivation, interest, and engagement). The findings of this study are anticipated to encourage educators in the classrooms more effectively.

Finding of the study discovered that there is no significant difference between male and female responses on the influence of game-based learning on students' academic performance in mathematics in secondary schools. Hence, both male and female respondents have the same views/opinions on the effect of game-based

learning on students' academic performance in mathematics in secondary schools.

Conclusion and Recommendations

The study reports the influence of game-based learning on the academic performance of secondary school students in mathematics. From the data gathered and analyzed, it shows that using game-based learning as stimulating strategy for the teaching of mathematics had a significant influence on the academic performance of secondary school students in mathematics. The use of game-based learning made teaching and learning more fun, competitive, collaborative and challenging which assisted the students to actively focus and master the concept taught in mathematics faster.

Based on the findings and conclusions drawn from the study, the following recommendations are proposed:

1. **Implementation of Game-Based Learning:** The adoption of game-based learning should be integrated into the teaching strategy across all secondary schools for mathematics instruction. This approach can enhance student engagement and understanding of mathematical concepts.
2. **Teacher Training Programs:** Seminars and workshops should be organized for secondary school teachers to familiarize them with effective teaching strategies, including game-based learning. Additionally, teacher training curriculum should explicitly incorporate game-based learning methods to prepare future educators.
3. **Curriculum Development:** Nigerian secondary school curriculum planners should include game-based learning as a formal component of effective teaching strategies. By incorporating this approach into the curriculum, it can further support and enhance student learning outcomes.

4. **Specialized Training:** Efforts should be made to train and encourage specialists in the design and implementation of game-based learning for instructional purposes. This would ensure the development of high-quality and effective educational games tailored to the needs of students.
5. **Professional Development Initiatives:** Professional associations such as the Nigerian Union of Teachers (NUT) and the Educational Media Technologist Association of Nigeria (EMTAN) should organize seminars, workshops, symposia, and in-service training sessions to update educators' knowledge on the benefits and implications of game-based learning.
6. **Gamification of Lessons:** Teachers are encouraged to incorporate gamification techniques into their lesson contents to enhance student motivation, engagement, and academic performance in the classroom. By making learning more interactive and enjoyable, gamification can effectively support student learning outcome

References

- Akinsola, E. F. (2010). Correlation between parenting styles and sexual attitudes of young people in Nigeria: Comparison of two ethnic groups. *Gender and Behaviour*, 8(1), 2771-2788.
- Anaduaka, U.S., & Okafor, C.F. (2013). The universal basic education (UBE) programme in Nigeria: Problems and prospects. *Journal of Research in National Development*, 11(1), 152-157.
- Dele-Ajayi, O., Strachan, R., Pickard, A. J., & Sanderson, J. J. (2019). Games for teaching mathematics in Nigeria: What happens to pupils' engagement and traditional classroom dynamics? *IEEE Access*, 7, 53248-53261.

- Demirbilek, M., & Tamer, S. L. (2010). Math teachers' perspectives on using educational computer games in math education. *Procedia-Social and Behavioural Sciences*, 9, 709-716.
- Gouba, L. (2008). The importance of mathematics in everyday life. *African Institute for Mathematical Sciences*, 6 Melrose Road, Muizenberg 7945, South Africa
- Hui, H. B., & Mahmud, M. S. (2023). Influence of game-based learning in mathematics education on the students' cognitive and affective domain: A systematic review. *Frontiers in Psychology*, 14, 1105806.
- Oluwatayo, J. C., Anyikwa, N. E., & Obidike, N. D. (2020). Challenges of game-based learning strategies in teaching mathematics in primary schools in Nkanu west local government area of Enugu State. *Journal of Early Childhood and Primary Education*, 2(1), 15-26.
- Pratama, L. D., & Setyaningrum, W. (2018, September). Game-Based learning: The effects on student cognitive and affective aspects *Journal of Physics: Conference Series*, 1097(1), 0121-131.
- Sadeghi, K., & Dousti, M. (2013). The effect of length of exposure to call technology on young iranian efl learners' grammar gain. *English Language Teaching*, 6(2), 14-26.
- Trybus, J. (2015). Game-based learning: What it is, why it works, and where it's going. *New Media Institute*, Received from <http://www.newmedia.org/game-based-learning-what-it-is-why-it-works-and-where-its-going.html>
- Wahab, T.A. (2019). Higher education in Nigeria: A status report. *Higher Education Policy*, 16, 259-281.