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# EFFECT OF GAME-BASED LEARNING STRATEGY ON UPPER BASIC SCHOOL STUDENTS' ACADEMIC PERFORMANCE AND ATTITUDE TOWARDS MATHEMATICS IN MOKWA LGA, NIGER STATE

**BY**

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## Abstract

*This study examined the effect of game-based learning strategy (GLS) on students' academic performance and attitudes toward mathematics in Mokwa Local Government Area, Niger State, Nigeria. The study proposed four null-hypotheses to test the pretest and post-test performance of students taught mathematics using game-based learning strategy and those taught using traditional classroom methods based on gender and attitude. Using a quasi-experimental pre-test-post-test control group design, data were collected from 65 Upper Basic II students across two purposively selected schools. Teacher-Made Mathematics Performance Test (TMMPT) with reliability coefficient of 0.79 (KR-21) and an Attitude towards Mathematics Questionnaire (AMQ). Data were analyzed using mean, standard deviation, and t-tests. Findings revealed that students taught with GLS significantly outperformed those taught with traditional methods ($t = 8.460$, $p < 0.05$). A statistically significant gender difference was found in performance, with male students performing better than their female counterparts under GLS ($t = 2.171$, $p < 0.05$). Students showed significant improvement from pre-test to post-test when exposed to GLS ($t = -19.586$, $p < 0.05$). Additionally, male students demonstrated significantly more positive attitudes toward mathematics after GLS instruction compared to female students ($t = 9.248$, $p < 0.05$). The study concludes that game-based learning strategy enhances mathematics performance, though gender differences warrant attention. It recommends that teachers be trained in GLS implementation, that gender-responsive game design be prioritized, and that curriculum planners integrate GLS into mathematics instruction to foster engaging and effective learning environments.*

***Keywords: Game-based learning, Mathematics performance Upper basic education and Instructional strategy***

## Introduction

Mathematics education is a cornerstone of the Nigerian basic education curriculum, serving as both a foundational requirement for scientific literacy and a critical determinant of future educational and career opportunities. The National Policy on Education (2013) emphasizes that mathematics at the basic level should develop learners' mathematical ability and confidence while providing a solid foundation for further study. Despite this recognition, student performance in mathematics remains persistently low, with national examinations consistently revealing widespread underachievement (Abdulkareem, 2021; Ismaila, et al, 2024). The Basic Education Certificate Examination (BECE) results over a five-year period (2015-2020) in Niger State illustrate this concerning trend. As shown in Table 1, the percentage of students achieving credit passes has remained below 60%, while a substantial proportion continues to perform at below-average levels.

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**Table 1*: Junior Secondary School Students' Performance in Mathematics at BECE (2015-2020)***

| Year | No. of Candidates | % with Grade A-C | % with Grade D | % with Grade F |
|---|---|---|---|---|
| 2015 | 40,430 | 57.50% | 32.76% | 8.71% |
| 2016 | 41,153 | 54.37% | 24.01% | 20.00% |
| 2017 | 41,721 | 57.57% | 28.21% | 14.28% |
| 2018 | 42,892 | 56.62% | 34.08% | 9.30% |
| 2019 | 43,435 | 56.37% | 33.90% | 8.90% |
| 2020 | 43,548 | 55.82% | 35.02% | 9.17% |

***Source**: Basic Education Certificate Examination Statistics, Niger State, 2020*

Several factors have been attributed to this persistent poor performance, including inadequate content delivery, lack of interest, mathematics phobia, and inappropriate teaching strategies (Justina et al., 2024; Nwachukwu & Johnson, 2020). Researchers have noted that mathematics lessons often involve excessive talking and writing, making the subject appear abstract and not engaging to learners (Chand et al., 2021). To address these challenges, educators have explored alternative teaching methods that promote active learning, engagement, and positive attitudes toward mathematics.

One such promising approach is game-based learning, which incorporates game design elements into instructional contexts to inspire and boost user engagement for knowledge acquisition (Zeynep, 2021). Game-based learning is an interactive activity founded on the principle that games, by their very nature, enhance learning through positive emotional experiences. Games do not merely entertain; they deepen connections and allow for greater learning by creating environments where students work toward goals, choose actions, and experience consequences in risk-free settings (Iji, 2020). Mathematical games structured activities governed by explicit rules that allow learners to explore mathematical ideas interactively have been shown to provide unique opportunities for integrating cognitive, affective, and social aspects of learning (Omeodu & Fredrick, 2020). Games such as the Mathematics Circle Race Game, Mathematics Palace Game, and Mathematics Matching Game have been developed by institutions like the National Mathematical Centre (National Mathematics Centre, 2002) to enhance mathematics learning at the secondary level. Previous Nigerian studies have demonstrated the effectiveness of various games, including card games for teaching percentages and fractions (Okigbo, 2008), geoboard-based games for geometry (Aremu, 1998), and game-enhanced strategies for overall mathematics achievement (Toinpere, 2024).

Beyond cognitive outcomes, students' attitudes toward mathematics play a crucial role in their academic success. Research has established that positive attitudes are associated with greater engagement, persistence, and ultimately higher achievement in mathematics (Zeynep, 2021). However, traditional instructional methods often fail to foster positive attitudes, particularly among students who experience mathematics phobia or perceive the subject as difficult (Olarewaju et al. 2025). Game-based learning, with its emphasis on engagement, enjoyment, and low-stakes practice, holds potential for improving not only performance but also students' affective responses to mathematics. Despite this evidence, the adoption of game-based learning in Nigerian classrooms remains limited, particularly at the upper basic level in rural areas like Mokwa Local Government Area, Niger State. Teachers and students have not fully explored the benefits of game-based strategies using either traditional or digital game formats. Furthermore, questions remain regarding how gender interacts with game-based learning outcomes, as studies have reported conflicting findings on whether male and female students benefit equally from such approaches in terms of both performance and attitudes (Ajai & Ogungbile, 2024).

Jean Piaget's Cognitive Development Theory posits that children advance through distinct stages of intellectual development, with the formal operational stage (about ages 11 and above), being most relevant to Upper Basic II students (Johnson, 2018). At this stage, learners develop abstract thinking, logical reasoning, and problem-solving abilities, allowing them to handle complex mathematical ideas. Also, Piaget emphasized the processes of assimilation, accommodation, and adaptation, through which learners integrate new knowledge or adjust existing understanding to maintain cognitive balance. When all these are applied to learning, especially Mathematics, students often experience disequilibrium when faced with new concepts,

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which pushes them to reorganize their thinking. Game-based learning aligns with this theory because it allows students to actively engage, adapt to challenges, and construct new knowledge through interaction, problem-solving, and collaboration in a structured but flexible environment.

Game-based learning in Mathematics is an instructional approach that uses structured games and game elements such as rules, competition, rewards, and challenges to enhance learning experiences (Zeynep, 2021; Iji, 2020). Rather than serving only as entertainment, games create meaningful learning environments where students actively participate, make decisions, and learn from outcomes in a low-risk setting. Mathematical games such as puzzles, card games, and structured classroom activities help learners explore concepts like algebra, geometry, fractions, and probability in an engaging way. In Nigeria, several instructional games have been developed by the National Mathematical Centre (National Mathematics Centre, 2002) and other scholars, including coordinate games, ludo-based probability games, and algebraic card games, all designed to improve understanding and retention. Research consistently shows that such approaches improve performance, enhance problem-solving skills, and increase students' interest and engagement in Mathematics (Toinpere, 2024; Kankia, 2008; Justina et al., 2024).

Empirical studies also show that game-based learning positively influences students' academic performance and attitudes toward mathematics, although findings on gender differences remain mixed. Many researchers report that students taught with games outperform those taught using traditional methods due to increased engagement, motivation, and reduced Mathematics anxiety (Okigbo, 2008; Agwagah et al., 2019). However, while some studies find no significant gender differences in achievement using game-based strategies (Aremu, 1998; Toinpere, 2024), others suggest that gender may influence how students respond to different game types due to societal expectations and learning preferences (Ajai & Ogungbile, 2024). Additionally, game-based learning has been shown to improve students' attitudes toward mathematics by making learning more enjoyable and less abstract (Zeynep, 2021), though more research is needed to determine whether these positive attitudinal effects are equally experienced by male and female learners in contexts such as Nigerian schools.

**Statement of the Problem**

Mathematics remains a core subject in upper basic education, yet students' academic performance in the subject continues to be a concern in Mokwa Local Government Area, Niger State. Despite various interventions aimed at improving learning outcomes, many students still struggle to attain proficiency, as reflected in persistently low Basic Education Certificate Examination (BECE) results. One underexplored factor influencing performance is the instructional strategy employed in teaching mathematical concepts. Traditional classroom methods, characterized by teacher-centered lecture and rote memorization, may fail to engage learners or address the abstract nature of mathematical ideas. In Mokwa Local Government Area, anecdotal evidence suggests that mathematics instruction remains predominantly traditional, with limited incorporation of interactive or game-based elements an instructional gap that may contribute to persistent low achievement and negative attitudes toward mathematics among upper basic students. The problem, therefore, lies in the need to determine whether game-based learning strategy can significantly improve students' mathematics performance and attitudes compared to traditional methods, and whether gender influences the effectiveness of this approach. Without this understanding, educators may continue to rely on instructional strategies that fail to engage learners or support meaningful mathematical understanding. This study is therefore motivated by the urgent need to bridge this gap by investigating the effect of game-based learning strategy on upper basic school students' performance in and attitudes toward mathematics in Mokwa LGA, Niger State. This study therefore investigated the effect of game-based learning strategy on upper basic school students' academic performance and attitudes toward mathematics in Mokwa Local Government Area, Niger State. Specifically, the research aimed to:

1. Determine the difference in the post-test performance of students taught mathematics using game-based learning strategy (GLS) and those taught using traditional classroom methods.
2. Examine the difference in the post-test performance of male and female students taught mathematics using GLS.
3. Assess the difference in the pre-test and post-test performance of students taught mathematics using GLS.

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4. Examine the difference in the attitudes of male and female students toward mathematics when taught using GLS.

**Research Hypotheses**

The following null hypotheses were tested at $p \leq 0.05$ level of significance.

$H0_1$: There is no significant difference in the post-test performance of students taught mathematics using game-based learning strategy (GLS) and those taught using traditional classroom methods.

$H0_2$: There is no significant difference in the post-test performance of male and female students taught mathematics using GLS.

$H0_3$: There is no significant difference in the pre-test and post-test performance of students taught mathematics using GLS.

$H0_4$: There is no significant difference in the attitudes of male and female students toward mathematics when taught using GLS.

**Methodology**

This study adopted a quasi-experimental pre-test-post-test control group design. The population comprised 12,203 upper basic students from thirty-five secondary schools in Mokwa Local Government Area, Niger State. A sample of 65 Upper Basic II students was purposively selected from two schools based on criteria including teacher qualifications and willingness to participate. The schools were randomly assigned to experimental and control groups: School A (experimental) had 35 students (18 males, 17 females), while School B (control) had 30 students (11 males, 19 females). Two instruments were used for data collection. The Teacher-Made Mathematics Performance Test (TMMPT) comprised 20 objective questions covering Simple Linear Equations, Linear Inequalities, Plane Shapes, and Angles, with a maximum score of 20. The Attitude towards Mathematics Questionnaire (AMQ) consisted of 15 items on a 5-point Likert scale measuring enjoyment, perceived value, and self-confidence in mathematics (maximum score 75). The experimental group was taught using three games adapted from the National Mathematical Centre: Mathematics Circle Race Game (board game), Mathematics Palace Game (card matching), and Mathematics Matching Game (puzzle-style problem-solving). All instruments and game materials were validated by three experts, and revisions were made based on their feedback. Reliability was established through a pilot study with 20 students, yielding KR-21 coefficient of 0.79 for TMMPT and Cronbach's alpha of 0.86 for AMQ.

The research was conducted in four phases over four weeks: pre-test administration, treatment (12 lessons of 40 minutes each), and post-test administration. The experimental group received game-based instruction while the control group received traditional lecture methods. Extraneous variables were controlled through identical content coverage, equal instructional time, comparable teacher qualifications, and consistent testing conditions. Data were analyzed using descriptive statistics (mean, standard deviation) and inferential statistics (independent and paired samples t-tests) at 0.05 significance level, with effect sizes (Cohen's d) calculated for significant findings. All analyses were conducted using SPSS version 25.

**Results**

**Hypotheses Testing**

**$H0_1$: There is no significant difference in the post-test performance of students taught mathematics using game-based learning strategy (GLS) and those taught using traditional classroom methods**

**Table 2: Independent Samples t-Test Comparing GLS and Control Group Post-Test Scores**

| Group | N | Mean | SD | Df | T | p-value | Decision |
|---|---|---|---|---|---|---|---|
| GLS | 35 | 17.00 | 2.46 | 63 | 8.460 | 0.000 | Rejected |
| Control | 30 | 12.80 | 1.24 | | | | |

Table 2 presents the independent samples t-test comparing post-test performance of students taught with GLS and those taught with traditional methods. The GLS group had a mean score of 17.00 (SD = 2.46), while the control group had a mean score of 12.80 (SD = 1.24). The calculated t-value of 8.460 with 63 degrees of freedom is statistically significant at $p = 0.000$ ($p < 0.05$). Therefore, the null hypothesis is rejected, indicating

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that students taught with game-based learning strategy performed significantly better than those taught with traditional methods. The effect size (Cohen's d = 2.13) indicates a large practical significance.

**$H0_2$: There is no significant difference in the post-test performance of male and female students taught mathematics using GLS.**

**Table 3: Independent Samples t-Test Comparing Male and Female Post-Test Scores within GLS Group**

| Gender | N | Mean | SD | Df | T | p-value | Decision |
|---|---|---|---|---|---|---|---|
| Male | 18 | 17.83 | 1.58 | 33 | 2.171 | 0.037 | Rejected |
| Female | 17 | 16.12 | 2.93 | | | | |

Levene's test for equality of variances: F = 4.892, p = 0.034 (equal variances not assumed)

Table 3 presents the independent samples t-test comparing post-test performance of male and female students taught with GLS. Male students had a mean score of 17.83 (SD = 1.58), while female students had a mean score of 16.12 (SD = 2.93). The calculated t-value of 2.171 with 33 degrees of freedom is statistically significant at p = 0.037 ($p < 0.05$). Therefore, the null hypothesis is rejected, indicating that male students performed significantly better than their female counterparts when taught with game-based learning strategy. The effect size (Cohen's d = 0.73) indicates a moderate to large practical significance.

***$H0_3$: There is no significant difference in the pre-test and post-test performance of students taught mathematics using GLS.***

***Table 4: Paired Samples t-T Comparing Pre-Test and Post-Test Scores within GLS Group***

| Test | N | Mean | SD | Df | t | p-value | Decision |
|---|---|---|---|---|---|---|---|
| Pre-Test | 35 | 10.00 | 2.06 | 34 | -19.586 | 0.000 | Rejected |
| Post-Test | 35 | 17.00 | 2.46 | | | | |

Table 4 presents the paired samples t-test comparing pre-test and post-test performance of students taught with GLS. Students had a mean pre-test score of 10.00 (SD = 2.06) and a mean post-test score of 17.00 (SD = 2.46), showing a mean gain of 7.00 points. The calculated t-value of -19.586 with 34 degrees of freedom is statistically significant at p = 0.000 ($p < 0.05$). Therefore, the null hypothesis is rejected, indicating that game-based learning strategy produced significant improvement in students' mathematics performance from pre-test to post-test. The effect size (Cohen's d = 3.31) indicates a very large practical significance.

**$H_{04}$: There is no significant difference in the attitudes of male and female students toward mathematics when taught using GLS.**

**Table 5: Independent Samples t-Test Comparing Male and Female Attitude Scores within GLS Group**

| Gender | N | Mean | SD | Df | T | p-value | Decision |
|---|---|---|---|---|---|---|---|
| Male | 18 | 43.50 | 1.89 | 33 | 9.248 | 0.000 | Rejected |
| Female | 17 | 32.88 | 4.47 | | | | |

Levene's test for equality of variances: F = 12.456, p = 0.001 (equal variances not assumed)

Table 5 presents the independent samples t-test comparing attitude scores of male and female students after exposure to GLS. Attitude was measured using a 10-item questionnaire with a 5-point Likert scale (maximum score = 50). Male students had a mean attitude score of 43.50 (SD = 1.89), while female students had a mean score of 32.88 (SD = 4.47). The calculated t-value of 9.248 with 33 degrees of freedom is statistically significant at p = 0.000 ($p < 0.05$). Therefore, the null hypothesis is rejected, indicating that male students demonstrated significantly more positive attitudes toward mathematics than their female counterparts after game-based learning instruction. The effect size (Cohen's d = 3.05) indicates a very large practical significance.

**Discussion of the Findings**

The findings of this study provide strong empirical support for the effectiveness of game-based learning (GBL) in improving students' performance and attitudes toward Mathematics, while also contributing nuanced insights into the ongoing debate on gender differences. First, the study revealed a significant difference in the post-test performance of students taught using game-based learning strategy and those taught through

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traditional methods, with students in the GBL group performing significantly better. This finding is consistent with earlier studies which affirm that game-based approaches enhance students' engagement, motivation, and conceptual understanding, thereby leading to improved academic performance (Okigbo, 2008; Agwagah et al., 2019). The observed large effect size further strengthens the argument that GBL is not merely an alternative instructional strategy but a highly impactful pedagogical approach. Similarly, Zeynep (2021) noted that the interactive and enjoyable nature of game-based learning reduces the abstractness of mathematical concepts, thereby facilitating deeper understanding. However, while most empirical studies align with this finding, some scholars could have cautioned that the effectiveness of GBL may depend on factors such as the type of game, instructional design, and teacher competence, suggesting that its impact may not be uniformly significant across all contexts (Toinpere, 2024). Nonetheless, the present finding reinforces the growing consensus on the superiority of learner-centered and activity-based instructional strategies over conventional methods.

Second, the study found a significant difference in the performance of male and female students taught using GBL, with male students outperforming their female counterparts. This finding aligns with the position of Ajai and Ogungbile (2024), who argued that gender differences in learning outcomes may arise due to societal expectations, exposure to competitive environments, and differential responses to game types. Their study suggests that certain game formats may inadvertently favor male students, particularly when they emphasize competition over collaboration. In contrast, this finding contradicts earlier studies which reported no significant gender differences in academic achievement when game-based strategies are employed (Aremu, 1998; Toinpere, 2024). These contrasting findings indicate that gender-related outcomes in GBL environments remain inconclusive and may be influenced by contextual variables such as cultural norms, classroom dynamics, and the nature of the instructional games used. Therefore, while the present study provides evidence of gender disparity, it also underscores the need for more gender-sensitive instructional designs in game-based learning environments.

Third, the study established a significant improvement between the pre-test and post-test performance of students exposed to GBL, indicating that the intervention had a substantial positive effect on learning outcomes. This finding is in strong agreement with previous empirical studies which emphasize that game-based learning promotes active participation, immediate feedback, and sustained engagement, all of which contribute to improved academic achievement (Okigbo, 2008; Agwagah et al., 2019). The very large effect size recorded in this study further corroborates the transformative potential of GBL as an instructional intervention. This result also aligns with constructivist perspectives, which posit that learners achieve better outcomes when they are actively involved in the learning process. However, some studies suggest that repeated exposure and familiarity with the game environment may be necessary before significant gains are observed, implying that short-term interventions may yield varying degrees of effectiveness. Despite this, the magnitude of improvement observed in this study provides compelling evidence of the efficacy of GBL in Mathematics instruction.

The study found a significant difference in the attitudes of male and female students toward Mathematics when taught using GBL, with male students demonstrating more positive attitudes. This finding is partially supported by Zeynep (2021), who reported that game-based learning generally improves students' attitudes toward Mathematics by making the subject more engaging and less intimidating. However, while Zeynep (2021) emphasized overall attitudinal improvement among learners, the present study introduces a gender dimension, revealing that such positive attitudes may not be equally distributed. This aligns with Ajai and Ogungbile (2024), who suggested that gender differences in perception and engagement may influence students' attitudes toward instructional strategies. Conversely, the finding contradicts studies that reported no significant gender differences in students' attitudes when exposed to innovative teaching methods (Aremu, 1998; Toinpere, 2024). These inconsistencies suggest that attitudinal outcomes, like achievement, are context-dependent and may be shaped by factors such as students' prior experiences, societal conditioning, and the inclusiveness of the learning environment.

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## Conclusion

This study examined the effect of game-based learning strategy on upper basic school students' academic performance in and attitudes toward mathematics in Mokwa Local Government Area, Niger State. The findings demonstrate that game-based learning is significantly more effective than traditional classroom methods in improving students' mathematics performance. Students exposed to GLS showed substantial gains from pre-test to post-test, confirming the strategy's potential to enhance learning outcomes. However, the study also revealed significant gender differences in both performance and attitudes, with male students benefiting more from and responding more positively to the game-based approach. Male students not only achieved higher scores but also reported more positive attitudes toward mathematics after the intervention. This finding underscores the need for careful attention to gender dynamics when implementing innovative instructional strategies. Game-based learning, while powerful, may not automatically produce equitable outcomes; intentional design and facilitation are required to ensure that all students benefit. The study establishes game-based learning as an effective instructional strategy for improving upper basic students' performance in mathematics. The findings support Piaget's cognitive development theory by demonstrating that interactive, engaging learning environments facilitate cognitive growth and conceptual understanding. At the same time, the gender differences observed highlight the importance of considering how instructional innovations interact with social and cultural factors to produce differential outcomes for male and female students.

## Recommendations

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

2. Mathematics teachers should receive comprehensive training on the design, selection, and implementation of game-based learning activities. Training should include not only how to use games but also how to facilitate inclusive participation and address gender dynamics that may emerge during game-based activities.
3. Schools and curriculum planners should formally integrate game-based learning strategy into the mathematics curriculum at the upper basic level. This integration should include specific guidance on which games are appropriate for which topics, how to implement them effectively, and how to assess learning outcomes from game-based activities.
4. Government and educational stakeholders should allocate resources for the development and distribution of mathematical games to schools, particularly in rural areas where access to innovative instructional materials may be limited. This could include establishing a repository of validated games aligned with the curriculum.

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