



Effect of Gamification Teaching Method on Academic Performance in ... Umar, N. M., Et. al., (2026)

Effect of Gamification Teaching Method on Academic Performance in Set Theory Concept among Senior Secondary School Students' in Kebbi Metropolis, Kebbi State, Nigeria

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Abstract

This study examined the effect of the gamification teaching method on senior secondary school students' academic performance in set theory in Kebbi State, Nigeria. Specifically, the study sought to determine the difference in academic performance between students taught set theory using the gamification method and those taught using the demonstration method, as well as to examine the difference in performance scores of male and female students taught set theory using the gamification method. To address these, a non-randomized control group, pretest–posttest quasi-experimental design was used. The sample consisted of 357 SSII students selected from four public secondary schools. Data were collected using the Students' Set Theory Performance Test (SSTPT) with a reliability of 0.84. Mean and standard deviation were used to answer the research questions, while an independent sample t-test was used to test the hypotheses at 0.05 significance level. Findings showed that students taught with gamification performed significantly better than those taught with the demonstration method. Results also indicated no significant difference in the performance of male and female students taught with gamification. The study concludes that gamification is an effective alternative to demonstration method and recommends its use for teaching Set Theory, and further studies can be conducted on other mathematics topics.

Keywords: Performance, Gamification, Demonstration, set-theory

Introduction

Set Theory is a foundational topic in the Nigerian senior secondary school mathematics curriculum, designed to develop students' logical reasoning, problem-solving skills, and understanding of mathematical relationships (Salah, 2025). It serves as a prerequisite for topics such as algebra, probability, statistics, and logic, and it frequently appears in external examinations such as the West African Senior School Certificate Examination (WASSCE). The curriculum recognizes Set Theory as essential because it enables students to interpret symbols, classify objects, and analyze relationships systematically. More broadly, Set Theory is a fundamental branch of mathematics that underpins areas such as algebra, topology, and computer science, where concepts like union, intersection, and Cartesian products are applied (Hrbacek & Jech, 2017; Oden & Demkowicz, 2017). It strengthens critical and abstract thinking skills that are necessary for STEM-related disciplines (Szabo, Körtesi, Guncaga, Szabo & Neag, 2020). However, despite its importance, many students struggle with its abstract concepts, which often results in misconceptions and poor performance in examinations (Oladejo, Olateju, Okebukola, Agboluaje, Sanni, Shabani & Ebisin, 2023). In Nigeria, mathematics



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is a core subject, and Set Theory is introduced early because it develops logical reasoning and problem-solving skills (Okotie & Agir, 2024). However, traditional teaching methods often fail to actively engage students, leading to low understanding and poor performance (Makinde & Yusuf, 2017; Akanmu, 2019; Sholihah, 2024). Reports from WAEC Chief Examiners (2018–2024) show recurring difficulties in Set Theory, with many students unable to interpret set notations correctly, construct accurate Venn diagrams, or apply set operations properly. Researchers attribute these challenges to the abstract nature of the topic, inadequate instructional materials, and over-reliance on teacher-centered approaches (Awuah, 2018; Shankar, 2021; Bainbridge et al., 2022; Okpara & Ezeador, 2024). To address these concerns, gamification has emerged as an innovative instructional approach that integrates game elements such as Hula Hoops, points, and rewards to increase motivation and participation (Pawa et al., 2020; Saleem, Noori & Ozdamli, 2022). In teaching Set Theory, Hula Hoops can be used to physically model sets, where overlapping hoops clearly represent union, intersection, and complement, thereby transforming abstract concepts into concrete and visual experiences. This hands-on strategy allows students to actively manipulate set relationships, helping to reduce misconceptions. Studies indicate that gamification enhances conceptual understanding, collaboration, and problem-solving skills (Arufe Giráldez et al., 2022; Zainuddin et al., 2020; Thampy et al., 2023), and improves overall engagement and comprehension (Samala et al., 2024). However, some studies report that gamification may not always lead to significant academic improvement and may produce gender differences if poorly implemented (Hanus & Fox, 2015; Parajuli & Thapa, 2017). Therefore, when carefully designed and properly applied, innovative tools such as Hula Hoops can make abstract Set Theory concepts more meaningful and engaging, helping to address persistent learning difficulties.

In Nigeria, several scholars have emphasized the importance of gamified instructional strategies in improving mathematics learning. For example, Attah, Ogunlade, and Otemuyiwa (2024) found that gamification significantly enhanced teaching effectiveness and students' learning outcomes in mathematics compared to conventional methods, and they recommended its adoption to reduce the abstract nature of mathematics topics. Similarly, Aliyu, Lawal, Muhammad, and Lamido (2025) reported that students exposed to gamified instruction demonstrated higher motivation and better conceptual understanding than those taught using traditional approaches. Gamification is particularly relevant in rural areas such as Kebbi State, where limited instructional resources and predominantly teacher-centered methods have contributed to persistent poor performance in mathematics (Fakai et al., 2024). In response, the Kebbi State Universal Basic Education Board (SUBEB) has organized workshops, mathematics clubs, and community-based programmes to strengthen students' problem-solving skills (Bala & Abdulwahab, 2024). Ideally, the teaching and learning of Set Theory at the senior secondary level should enable students to develop strong foundational skills in mathematics. Students are expected to understand key concepts such as union, intersection, complement, and Venn diagrams in order to perform well in examinations and progress into STEM-related fields. However, the reality in Kebbi State shows that many students lack these basic skills. They often struggle to interpret set symbols, construct accurate Venn diagrams, and apply set notation correctly. WAEC Chief Examiners' Reports (2019) consistently highlight these recurring weaknesses. The continued reliance on traditional, teacher-centered methods has left many students passive and disengaged, limiting deep understanding and real-life application of Set Theory concepts. The consequence of these challenges is widespread low achievement in mathematics, reduced confidence among learners, and continued poor performance in national examinations. This situation raises serious concerns for parents, educators, school administrators,



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and policymakers who expect improved outcomes in mathematics education. Although international studies suggest that gamification can enhance understanding and performance in abstract mathematical topics, limited empirical evidence exists within the context of Kebbi State. Therefore, this study seeks to fill this gap by investigating the effect of the gamification teaching method on senior secondary school students' academic performance in Set Theory in Kebbi State, Nigeria. Due to security challenges in some parts of the state, the study was limited to selected schools within Kebbi State metropolis, where it was safer and more accessible to conduct the research.

Research Objectives

1. Determine the difference in the academic performance score of senior secondary school students taught set theory using gamification method and those taught using Demonstration method in Kebbi State, Metropolis.
2. Examine the difference performance scores of male and female students taught set theory using gamification method among Senior Secondary in Kebbi State, Metropolis.

Research Questions

1. What is the difference in the academic performance score of senior secondary school students taught set theory using gamification method and those taught using Demonstration method in Kebbi State, Metropolis?
2. What is the difference in the performance scores of male and female students taught set theory using gamification method among Senior Secondary in Kebbi State, Metropolis?

Research Hypothesis

1. There is no significant difference in the academic performance score of senior secondary school students taught set theory using the gamification method and those taught using Demonstration method in Kebbi State, Metropolis.
2. There is no significance difference in the mean academic performance scores of male and female students taught set theory using gamification method among Senior Secondary Students in Kebbi State, Metropolis.

Methodology

The researcher employed a non-randomized control group, pretest–posttest quasi-experimental design. The population comprised 6882 Senior Secondary School Two (SS2) students in Kebbi State Metropolis. Among them, 3958 are male students and 2924 are female students. From the population, a sample of 357 SS II students were obtained using Krejcie and Morgan's table (1970) for sample size determination. Four (4) schools were randomly selected using simple random sampling technique. Intact classes were used in each school to avoid distortion in their normal school settings. The detail of the sample is presented in table 1.

Table 1: Sample of the Study

S/N	School	Group	Number of students
1	School A	Experimental	58
2	School B	Experimental	74
3	School C	Control	150
4	School D	Control	75
			357

Students' Set Theory Performance Test for SSII (SSTPT) instrument was used for data collection in this study. The SSTPT was used to measure students' performance in set theory. It consisted of 30 objective test items adopted from relevant external examination bodies (WAEC, NECO JAMB). Each item had four options (A–D), with one correct answer carrying one mark, giving a maximum score of



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30 marks. The items were structured to reflect the six levels of Bloom’s taxonomy, thereby ensuring balanced coverage of content. To establish validity and reliability, the instrument was reviewed by experts in mathematics education and subjected to a pilot study in one of the secondary school parts of the population but out of sample using 40 students. The analysis yielded (Reliability=0.84), confirming their suitability for the main study. A pretest was administered to determine the equivalence of groups before treatment. The treatment lasted for six weeks, after which a posttest was conducted using the same instrument to evaluate the effectiveness of the instructional strategies. After marking session, the scores obtained from the study were subjected to analysis using SPSS Statistics. Descriptive statistics of mean and standard deviation were used to answer research questions, while independent sample T-test was used to test the null hypotheses at $\alpha = 0.05$ level of significance. The results revealed the following;

Research Question One

What is the difference in the academic performance score of senior secondary school students taught set theory using gamification method and those taught using Demonstration method in Kebbi State, Nigeria? The result of the analysis is presented in table 2.

Table 2: Mean Academic Performance Scores of SS2 Students taught Set Theory using Gamification Method and those taught with Demonstration Method

Group	N	Mean	Std. Deviation	Mean difference	95% Confidence Interval of the Difference	
					Lower	Upper
Gamification	132	21.40	3.852	6.655	5.820	7.489
Demonstration	225	14.75	3.880			
Total	357					

Table 2 shows the mean academic performance scores of SS2 students who were taught set theory using the gamification method and those taught with the demonstration method. The result indicated that students in the gamification group had a higher mean score (21.40) compared to those in the demonstration group (14.75). This means that, on average, students exposed to gamification performed better in the test than those taught with the demonstration method. The standard deviations for both groups are almost the same (3.852 and 3.880), suggesting that the spread of scores within each group was similar. The mean difference between the two groups is 6.655, and the 95% confidence interval (5.820 to 7.489) shows that this difference is meaningful and not due to chance.

Research Question Two

What are the mean academic performance scores of SS2 male and female students taught set theory using gamification method in Kebbi State, Nigeria?

The result of the analysis is presented in Table 3.

Table 3: Mean Academic Performance Scores of Male and Female Students taught using Gamification Method

Gender	N	Mean	Std. Deviation	Std. Error Mean	Mean difference	95% Confidence Interval of the Difference	
						Lower	Upper
Male	74	21.59	4.013	.467	.439	-.900	1.779
Female	58	21.16	3.655	.480			
Total	132						

Table 3 shows the mean academic performance of male and female students taught Set Theory using the gamification method. The results indicated that male students had a mean score of 21.59, while



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female students had a mean score of 21.16. The small mean difference of 0.439 suggesting that both groups performed almost the same. The confidence interval also shows that this difference is not statistically significant. Therefore, the findings indicated that the gamification method benefited both male and female students equally.

Null Hypothesis One

There is no significant difference in the academic performance score of senior secondary school students taught set theory using the gamification method and those taught using Demonstration method in Kebbi State, Nigeria. The null hypothesis was tested using independent sample T-test from the post-test scores of the two independent groups. The result of the analysis is presented in table 4.

Table 4: Independent Samples T-test Results of Students taught Set Theory using Gamification and Demonstration Methods

Group	N	Mean	Std. Deviation	T-value	Df	P-value
Gamification	132	21.40	3.852	15.685	355	.000
Demonstration	225	14.75	3.880			
Total	357					

Table 4 shows the Independent Samples t-test comparing the mean scores of students taught Set Theory using the Gamification method and those taught with the Demonstration method. The Gamification group had a much higher mean score (Mean = 21.40, SD = 3.85) compared to the Demonstration group (Mean = 14.75, SD = 3.88). The t-value is 15.685 with a significance value of $p = .001$, which is less than the 0.05 level. Since $p < 0.05$, this means the difference in performance between the two groups is statistically significant. Therefore, we reject the null hypothesis. This indicates that the Gamification method had a significantly greater effect on students' performance in Set Theory than the Demonstration method.

Null Hypothesis Two

There is no significance difference in the mean academic performance scores of SS2 male and female students taught set theory using gamification method in Kebbi State, Nigeria. The null hypothesis was tested using independent sample T-test from the post-test scores of the two independent groups. The result of the analysis is presented in table 5.

Table 5: Independent Samples T-test Results for Male and Female Students taught Set Theory using Gamification Method

Gender	N	Mean	Std. Deviation	T-value	df	P-value
Male	74	21.59	4.013	.649	130	.517
Female	58	21.16	3.655			
Total	132					

Table 5 shows the independent samples t-test comparing the academic performance of male and female students taught Set Theory using the Gamification method. The results indicated that male students had a mean score of 21.59, while female students had a similar mean score of 21.16. The small difference between the two means suggests that both groups performed almost the same under the gamified instruction. The t-test produced a t-value of 0.649 with a p-value of 0.517, which is greater than the 0.05 level of significance. This means there is no statistically significant difference between the performance of male and female students. Since $p > 0.05$, we fail to reject the null hypothesis. Therefore, gender does not significantly influence students' academic performance when the Gamification method is used.



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Summary of the Major Findings

The key findings derived from the research questions and hypotheses that guided the study were that:

1. Students taught Set Theory using the gamification method significantly achieved higher academic performance compared to those taught with the demonstration method.
2. There was no significant difference in academic performance between male and female students taught Set Theory using gamification.

Discussion of Findings

The findings for Research Question/Hypothesis One revealed that students taught Set Theory using the gamification method performed significantly better than those taught through the demonstration method. This indicates that game-based learning enhanced students' understanding, participation, and overall academic performance more effectively than traditional teacher-centered approaches. The result supports previous studies (e.g., Pawa et al., 2020; Arufe Giráldez et al., 2022; Bainbridge et al., 2022), which reported that gamification improves engagement and comprehension in abstract mathematical concepts. However, it contrasts with Hanus and Fox (2015), who found that poorly implemented gamification may not improve performance. This suggests that the effectiveness of gamification depends largely on proper design and implementation. The findings for Research Question/Hypothesis Two showed no significant difference in the academic performance of male and female students taught using gamification. This implies that gamified instruction benefits both genders equally. The result aligns with studies such as Akanmu (2019), Pawa et al. (2020), and Makinde and Yusuf (2017), which found no gender gap when student-centered strategies were used. Although Parajuli and Thapa (2017) reported male students performing better than females, the present study demonstrates that well-structured gamification can reduce gender differences and promote equal learning opportunities in mathematics.

Conclusion

This study examined the effectiveness of the gamification method compared with the demonstration method on senior secondary school students' performance in Set Theory in Kebbi State, Nigeria. Based on the findings, it was concluded that gamification significantly improves students' academic performance more than the traditional demonstration approach. Students exposed to gamified instruction showed better understanding and higher achievement, indicating that active and interactive learning enhances mastery of abstract concepts. The study also concluded that gender does not significantly influence the effectiveness of gamification, as both male and female students performed at comparable levels. This suggests that gamification provides equal learning opportunities and supports inclusive classroom practice. Overall, the findings confirm that gamification is an effective and innovative instructional strategy for improving the teaching and learning of Set Theory in senior secondary schools.

Recommendations

Based on the findings and conclusions of this study, the following recommendations are made to improve teaching and learning of Set Theory among senior secondary school students in Kebbi State and beyond:

1. Teachers should adopt the gamification method as a core instructional strategy for teaching Set Theory and other mathematics topics. Since the method significantly improved students' performance.



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2. Gender-friendly instructional practices should be maintained, not because gamification shows gender differences, but because its benefits learners equally. Teachers should ensure that both male and female students participate fully in game-based activities and collaborative tasks.

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