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Effect of Gamification Learning Instructional Strategy on Mathematics Students' Achievement in FCT Abuja

Daniel Zanutakhi Jonah
Department of Science and Environmental Education, Faculty of Education, University of Abuja, Abuja, Nigeria
Jonahd341@gmail.com

U. S. Anaduaka
Department of Science and Environmental Education, Faculty of Education, University of Abuja, Abuja, Nigeria
anaduakauc@gmail.com

N. O. Orji
Department of Science and Environmental Education, Faculty of Education, University of Abuja, Abuja, Nigeria

Abstract. *The study examined the effect of gamification instructional strategy on junior secondary school students' achievement in mathematics in the Federal Capital Territory (FCT), Abuja. Two research questions were raised and two hypotheses were formulated to guide the study. The design for the study was quasi-experimental, using a pretest-posttest control group design. The population of the study consisted of 46,326 Junior Secondary One (JS1) students in Kuje Area Council of FCT Abuja for the 2023/2024 academic session. The sample for the study was 107 JS1 students drawn from two public junior secondary schools in Kuje Area Council, selected through simple random sampling of schools, with one school balloted to the experimental group (n = 52) and the other to the control group (n = 55). The instrument used for data collection was the Mathematics Achievement Test (MAT), a 25-item multiple-choice instrument constructed from a table of specification aligned with the National Curriculum for Junior Secondary School Mathematics. Content validity was established through expert review, and the reliability of the instrument, determined through test-retest administration and Pearson Product Moment Correlation, yielded a coefficient of 0.86. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at the 0.05 level of significance. The findings revealed a statistically significant difference in the achievement scores of students taught mathematics using the gamification strategy and those taught using the conventional method, in favour of the gamification group. The findings further revealed no significant difference in the achievement scores of male and female students taught using the gamification strategy. Based on these findings, it was concluded that gamification instructional strategy significantly enhances students' mathematics achievement, and does so equitably across gender. It was recommended that mathematics teachers adopt gamification in classroom instruction, and that school administrators and educational stakeholders provide the training and instructional materials required to support its implementation.*

Keywords: *Gamification, Instructional Strategy, Mathematics Achievement, Junior Secondary Schools, Gender.*

Introduction

Mathematics, often described as the language of the universe, is a cornerstone of human knowledge that equips individuals with the analytical tools and problem-solving skills necessary to address complex challenges across academic and professional domains [1]. It underpins scientific inquiry and technological innovation, providing the quantitative framework essential for understanding the natural world and driving technological progress [2]. Despite this importance, the performance of students in mathematics remains unsatisfactory in Nigeria generally, and in the Federal Capital Territory (FCT) in particular, as evidenced in West African Examinations Council (WAEC) external examiners' reports. This persistent underperformance is reflected not only in examination outcomes but in a declining number of students choosing to pursue mathematics-related courses at higher levels of education.

A primary factor contributing to this academic struggle is students' negative attitude toward mathematics: many students perceive the subject as abstract, difficult, and irrelevant to daily life, a perception that intensifies disengagement as they progress through school [3]. Traditional teaching methods often fail to capture students' interest, creating a disconnect between classroom instruction and real-world application, and there is a pressing need for innovative pedagogical approaches capable of transforming the learning experience and improving academic outcomes. Gamification, the use of game design elements such as points, badges, challenges, and leaderboards outside the context of a game, has been proposed as one such approach, aimed at raising students' motivation, performance, and lesson involvement by internalising the external motivation these elements provide [4]. By applying game design principles to mathematics instruction, gamification seeks to create a dynamic and immersive learning experience that encourages active participation, problem-solving, and skill development in an engaging way [5].

Academic achievement, understood as the successful acquisition of knowledge, skills, and competencies as measured through assessments and formal evaluation, is closely tied to instructional approach and the degree of active engagement a lesson affords. Gender has also remained a subject of continuing research interest in mathematics education: while some studies report gender-based differences in achievement, the extent and direction of such differences vary considerably across contexts, and evidence increasingly points to instructional environment, rather than inherent ability, as the more consequential factor [6]. This study was designed to investigate the effect of gamification instructional strategy on junior secondary school students' achievement in mathematics in FCT Abuja, with explicit attention to whether its benefits, if any, are shared equitably by male and female students.

Statement of the Problem

Mathematics underpins advancements in science, technology, engineering, and business, and is an indispensable life skill that fosters critical thinking, problem-solving, and logical reasoning. Despite its importance, evidence from national examinations such as WAEC and the National Examinations Council (NECO), as well as internal school assessments, consistently reveals a concerning pattern of poor academic achievement in the subject in Nigeria. A primary factor contributing to this struggle is students' negative attitude and disposition toward mathematics: many students perceive the subject as abstract and difficult, a perception that leads to disengagement and diminished motivation to learn [7]. While various studies have explored factors influencing achievement in mathematics, a critical gap remains regarding effective instructional strategies capable of addressing both the attitudinal and academic dimensions of this challenge specifically among junior secondary students, who are at the foundational stage of secondary mathematics education [8]. Traditional teaching methods often fail to captivate students' interest, and there is a pressing need to explore innovative pedagogical approaches, such as gamification, that can transform the learning experience and improve academic outcomes at this critical stage. It was against this background that the present study investigated the effect of gamification instructional strategy on mathematics students' achievement in FCT Abuja.

Purpose of the Study

The purpose of this study was to investigate the effect of gamification instructional strategy on junior secondary school students' achievement in mathematics in FCT Abuja. Specifically, the study sought to:

i. examine the mean achievement scores of students taught mathematics using gamification instructional strategy and their counterparts taught using conventional method in junior secondary schools in FCT Abuja; and
ii. determine the mean achievement scores of male and female students taught mathematics using gamification instructional strategy in junior secondary schools in FCT Abuja.

Research Questions

The following questions were raised to guide the study.

i. What is the difference in the mean achievement scores of students taught mathematics using gamification instructional strategy and their counterparts taught using conventional method in junior secondary schools in FCT Abuja?
ii. What is the difference in the mean achievement scores of male and female students taught mathematics using gamification instructional strategy in junior secondary schools in FCT Abuja?

Hypotheses

The following null hypotheses were formulated and tested at the 0.05 level of significance.

H01: There is no significant difference in the mean achievement scores of students taught using gamification instructional strategy and their counterparts taught using the conventional method.

H02: There is no significant difference in the mean achievement scores of male and female students taught mathematics using gamification instructional strategy [9].

Methodology

The study adopted a quasi-experimental design, involving an experimental group taught mathematics using gamification and a control group taught using conventional teaching method. A pretest was administered to both groups to determine the equivalence of student performance prior to treatment, followed by a posttest administered after treatment to determine the effectiveness of the gamification intervention. The design is represented symbolically as EG → O_1 → X_1 → O_2 and CG → O_1 → X_2 → O_2, where EG and CG denote the experimental and control groups, X_1 denotes teaching using gamification, X_2 denotes teaching using the conventional method, and O_1 and O_2 denote the pretest and posttest respectively.

The population of the study consisted of 46,326 Junior Secondary One (JS1) students in Kuje Area Council, FCT Abuja, for the 2023/2024 academic session. The sample comprised 107 JS1 mathematics students from two public junior secondary schools in Kuje Area Council, selected using simple random sampling from among the thirty junior secondary schools in the Area Council, with simple balloting used to assign one school to the experimental group (n = 52: 28 male, 24 female) and the other to the control group (n = 55: 30 male, 25 female). Students were taught by their regular mathematics teachers, who served as research assistants using researcher-prepared lesson plans, over the course of the second term of the academic session.

The instrument used for data collection was the Mathematics Achievement Test (MAT), comprising 25 multiple-choice items with four options each, constructed from a table of specification aligned with the National Curriculum for Junior Secondary School Mathematics, with each item carrying one mark for a maximum obtainable score of 25. Content validity was established through review by a lecturer in the Department of Science and Environmental Education, University of Abuja, and two experienced mathematics teachers. The reliability of the instrument was determined through a pilot test administered outside the sampled schools, using the test-retest method and Pearson Product Moment Correlation, yielding a reliability coefficient of 0.86. The pretest and posttest instruments

shared the same features, with items reshuffled to reduce test-wiseness. Mean and standard deviation were used to answer the research questions, and Analysis of Covariance (ANCOVA), with pretest scores entered as covariate, was used to test the hypotheses at the 0.05 level of significance.

Result Presentation

Research Question One

What is the difference in the mean achievement scores of students taught mathematics using gamification instructional strategy and their counterparts taught using conventional method in junior secondary schools in FCT Abuja?

Table 1. Mean and Standard Deviation of Achievement Scores of Students Taught Mathematics with Gamification and Those Taught with Conventional Method

Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Gamification	52	23.24	4.83	47.34	7.88
Conventional Method	55	26.32	—	32.81	7.85

Table 1 shows that students taught mathematics using gamification recorded a posttest mean achievement score of 47.34 (SD = 7.88), while students taught using the conventional method recorded a posttest mean of 32.81 (SD = 7.85), a mean difference of 14.53 in favour of the gamification group. This indicates that students taught mathematics using gamification showed considerably greater improvement in achievement than those taught using the conventional method [10].

Research Question Two

What is the difference in the mean achievement scores of male and female students taught mathematics using gamification instructional strategy in junior secondary schools in FCT Abuja?

Table 2. Mean and Standard Deviation of Achievement Scores of Male and Female Students Taught Mathematics with Gamification

Gender	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Male	28	25.32	4.21	46.22	8.05
Female	24	23.43	3.24	42.44	7.86

Table 2 shows that male and female students in the gamification group began with broadly comparable pretest achievement (male M = 25.32, SD = 4.21; female M = 23.43, SD = 3.24). At posttest, male students recorded a mean of 46.22 (SD = 8.05) and female students a mean of 42.44 (SD = 7.86), a posttest mean difference of 3.78 in favour of male students. This suggests a modest gender gap in raw posttest means within the gamification group, which was tested formally below.

Test of Hypotheses

H01: There is no significant difference in the mean achievement scores of students taught mathematics with gamification and those taught with the conventional method.

Table 3. ANCOVA Results of Achievement Scores of Students Taught Mathematics with Gamification and Those Taught with Conventional Method

Source	Type III SS	df	Mean Square	F	Sig.
Corrected Model	7843.183	4	1960.796	31.707	.000
Intercept	18671.323	1	18671.323	301.922	.000
Pretest	176.770	1	176.770	2.858	.095
Group	7471.413	1	7471.413	120.815	.000
Gender	9.905	1	9.905	.160	.690
Gender × Group	2.221	1	2.221	.036	.850
Error	4390.751	105	61.842		
Total	344479.000	105			
Corrected Total	12233.934	105			

Table 3 reveals a statistically significant main effect for instructional group, $F(1, 105) = 120.815$, $p = .000$. Since this p-value is less than the 0.05 alpha level, $H0_1$ was rejected. This indicates a significant difference in the mean achievement scores of students taught mathematics using gamification and those taught using the conventional method, in favour of the gamification group, even after controlling for pretest scores.

H02: There is no significant difference in the mean achievement scores of male and female students taught mathematics using gamification instructional strategy [11].

Table 4. ANCOVA Results of Achievement Scores of Male and Female Students Taught Mathematics with Gamification

Source	Type III SS	df	Mean Square	F	Sig.
Corrected Model	35.510	2	17.755	.275	.761
Intercept	10656.743	1	10656.743	165.215	.000
Pretest	29.771	1	29.771	.462	.501
Gender	8.583	1	8.583	.133	.717
Error	2322.080	50	64.502		
Total	227014.000	50			
Corrected Total	2357.590	50			

Table 4 shows that the effect of gender on achievement was not statistically significant, $F(1, 50) = .133$, $p = .717$. Since this p-value is greater than the 0.05 alpha level, $H0_2$ was not rejected. This indicates that although male students recorded a numerically higher raw posttest mean than female students within the gamification group (Table 2), this difference was not statistically significant once pretest performance was controlled for. There was, therefore, no statistically significant difference in the mathematics achievement scores of male and female students taught using gamification [12].

Discussion of Findings

The finding that students taught mathematics using gamification achieved significantly higher scores than those taught using the conventional method is consistent with the results of Noah, who found that senior secondary school students exposed to a computer game-based instructional package significantly outperformed those taught through conventional classroom instruction in mathematics. Both studies underscore the potential of game-based learning to enhance academic achievement, suggesting that the interactive, engaging, and motivating nature of gamification contributes to deeper

understanding and better retention of mathematical concepts [13]. Noah attributed the success of the game-based approach to its capacity to create an immersive learning environment that captures and sustains students' attention; similarly, in the present study, gamification likely provided students with a sense of autonomy, competence, and relatedness, key components of self-determination theory, often lacking in conventional instruction, and its incorporation of challenges, rewards, and immediate feedback likely fostered persistence in solving mathematical problems.

The finding, however, contrasts with Türkmen and Soybaş, who examined the effect of gamification on 5th-grade students' achievement and attitude in mathematics in Turkey and found no statistically significant difference between the gamified and conventional groups, although students in their experimental group did show a numerically greater improvement in academic performance. This discrepancy suggests that the effectiveness of gamification may be sensitive to contextual factors, implementation design, and the specific game elements employed, rather than being a uniformly guaranteed effect of gamification as a label; it underscores the need for careful attention to design and implementation fidelity when applying gamification in a new instructional context such as junior secondary mathematics in FCT Abuja [14].

The absence of a statistically significant gender difference in achievement within the gamification group indicates that the strategy benefited male and female students comparably. While the raw posttest means favoured male students numerically (Table 2), this difference did not survive ANCOVA once pretest achievement was controlled for [15]. This is broadly consistent with the wider pattern in the gamification literature, in which game-based instructional elements, points, badges, challenges, and leaderboards, are not inherently gender-specific in their appeal, and supports the conclusion that gamification can be adopted as an instructional strategy without disadvantaging either gender in mathematics achievement outcomes.

Conclusion

Based on the findings of the study, it was concluded that gamification instructional strategy significantly enhances junior secondary school students' achievement in mathematics compared with the conventional method, and that this benefit is shared equitably by male and female students, with no statistically significant achievement gap observed between them once pretest performance was accounted for. Based on the findings of the study, the following recommendations were made: Mathematics teachers should adopt gamification instructional strategy in classroom instruction to improve students' achievement in mathematics. School administrators should provide enabling environments and instructional materials that support gamified learning. Government and educational stakeholders should organise workshops and seminars to train teachers on the effective use of gamification in teaching mathematics. Curriculum planners should incorporate gamification and similar innovative teaching strategies into the school curriculum and teacher training programmes.

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