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Effect of Gamification Element on Students Academic Performance in Mathematics in Basic Schools in Kwara State

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ABSTRACT
Gamification elements are excellent tools for promoting specific behaviors and enhancing academic performance. *Method:* The study used a non-equivalent group design using a 2x2x2 factorial, quasi-experimental pre-test-post-test format. The population for this study were all junior secondary students in Kwara State. The target population for this study was all junior secondary students in basic 2 (J.i.S 2) in Kwara-North. Two junior secondary schools in Kwara-North L.G.A. were chosen using a purposive sample technique because they have functional and well-equipped computer labs. School B was the control group, whereas School A was the experimental group. The two groups were intact classes. The instruments used for data collection were: The Mathematics Concepts Performance Test (MCPT) and the Quizalize gamification application. To ensure the reliability of the instrument, a pilot study was carried out the acquired results were tested using split-half Reliability coefficients, and a value of .89 was obtained. The findings of the study revealed that the adoption of gamification element has an impact on junior secondary school students' mathematics performance, female students performed better than male students after the treatment was administered. It was recommended among others that the gamification element is successful in lowering the level of abstractness connected with the teaching and learning of some mathematical concepts at the junior secondary school level of education, mathematics teachers should incorporate it into the classroom.

Keywords: Gamification, Gamification Elements, Academic Performance, Mathematics Concepts.

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INTRODUCTION

Educators are faced with challenges to solve issues related to the adaptation of the learning process toward students' needs, motivation, and engagement. In bridging the gap between teacher-centered methods of instruction and learner-centered instructional delivery is the application of appropriate instructional processes, strategies, and resources. One of which is gamification. Gamification is the application of game design and principles to non-game situations to improve participation, engagement, loyalty, and competitiveness (Van-Gaalen et al, 2021). Gamification is the integration of game components and game thinking into non-game activities (Kiryakova et al, 2014). Gamification is described as the application of conventional game components (rules of play, point scoring, and competition with others) to other areas of activity, to engage people in problem-solving. Gamification is the addition of motivating features to a learning framework or system to improve user engagement using solid game theory and game mechanics (Ayre, 2021). Gamification is a technique for increasing motivating affordances by incorporating game-like experiences and enhancing behavioral outcomes (Ofosu-Ampong, 2020). Gamification can be referred to as the application of game mechanics, aesthetics, and game thinking to people's motivation, engagement, and problem-solving, but its actual meaning includes the use of game-like features to drive learners (Kapp, 2012). Gamification is the addition of motivational aspects to a learning framework or system to increase user engagement using sound game theory and game mechanics (Ayre, 2021).

Gamification is a cutting-edge method of teaching that makes use of game design in the classroom to attract students' attention, boost their confidence, and maintain their engagement (Vann & Tawfik, 2020). It is the practice of adding game elements to already existing things, like websites or online communities, to encourage learners' interest, loyalty, and engagement. To improve learning, gamification is used in educational software and practices (Bellotti et al, 2012). The use of game elements and concepts in a learning environment to influence student behavior, inspire them, and promote participation is known as gamification in education (EduTrends,

2016). Gamification elements are excellent tools for promoting specific behaviors and enhancing academic performance (Landers, 2014). Gamification elements aid in the development of fundamental abilities, and memory muscle (Güler & Güler, 2015). Well-designed rules, scoring, challenges, teamwork, puzzles, and role-playing are a few examples of game elements that are related to the mechanics of motivation, interaction, and reward (Marczewski, 2018). Game design elements are documentation of behavior, scoring systems, badges, trophies, rankings, ranks, levels, reputations, points, group tasks, time pressure, tasks, quests, avatars, virtual worlds, and virtual trade (Blohm & Leimeister, 2013).

Similarly, Gupta and Goyal (2022) listed several game elements that are used to satiate learners' desires in an educational context, including rewards, competition, criticism, gifting, leaderboards, teams, quests, social graphs, levels, virtual goods, achievement, challenges, chance, rivalry, cooperation, resource acquisition, turns, win, progression, emotions, consistent graphical experience, boss flight, collections, content unlocking, and altruism. In addition, gamification components like a narrative, scores, points, badges, objectives and goals, leader board, feedback, reward, experience, achievement, profile, difficulty challenge, level, virtual products, and progress bar all have a big impact on how well students learn (Koivisto & Hamari, 2014; Ozgur et al, 2018; Subhash & Cudney, 2018). One of the primary game-based drivers for enticing learners is the intrinsic dynamic nature of gamification narratives (Jacobs, 2018). Storytelling teaching strategy that aids in student comprehension of challenging mathematical concepts. The abstract nature of mathematics may be changed into a more familiar image in learners' thoughts by using storytelling as an instructional approach to teaching mathematics (Emel & Zeynep, 2019). Point is yet another game element that can be applied to gamified learning. According to Nah et al. (2014), points are abstract integers that serve as a feedback system for students. Students are motivated and interested in games that use points (Pratama, 2020). Because they provide learners with rapid feedback and a reward for achieving a task or objective, points are motivators (Kladchuen & Srisomphan, 2021).

Students are rewarded with badges, which are gamification components (Ayre, 2021). Furthermore, feedback is also one of the elements of gamification, which gives students confidence in their skills. Feedback is a crucial part of learning because it helps students understand the material they're studying and offers clear instructions on how to get better (Quizalize, 2017). Gamified activities give learners feedback on their progress while encouraging the development of social skills including cooperation, judgment, and problem-solving (Brunder, 2015). Gamification offers a new technique for feedback-based learning while also acting as a channel for linking students with online educational materials (Lebuna et al., 2022). Leaderboards are necessary to design efficient gamified learning sessions. Students are encouraged to participate in learning activities when leaderboards are used (Huang & Hew, 2015). Prior research, by Gonzalaz, et al., 2016; Hew et al, 2016; Pasare, et al., 2017; Ding et al, 2017; Dochie et al, 2017) has demonstrated that leaderboards influence learning outcomes, inspire learners and improve student learning accomplishment in the setting in which they are used. Additionally, elementary school students are frequently bored and have short attention spans. The cognitive and social development of a youngster includes playing video games. When students are permitted to play and participate in hands-on activities rather than being made to memorize information (formula) from books, they learn more (Clark et al., 2018). Therefore, it is necessary to include fun elements in their lessons to keep their interest and improve their performance (Reeves, 2015). Even in important classes like mathematics, which is frequently viewed as an abstract subject and is feared by many students. Given the many advantages that gamification provides, game elements must be incorporated into mathematics.

Mathematics is essential to the growth of the social, economic, and technological systems of the country. In Nigeria's secondary schools, mathematics is taught as one of the core topics. In Nigerian secondary schools, mathematics is a required subject (Ogunode, 2020). The Comparative Education Study and Adaptation Centre (CESAC), stated that the objectives of secondary school mathematics are to foster the following: the development of computational skills, the desire and capacity to be precise to a degree relevant to the problem at hand, the development of precise, logical, and abstract thinking, the capacity to recognize problems and solve them using relevant mathematics knowledge, and the stimulation and encouragement of creativity, originality, and curiosity. In Nigeria's educational system, mathematics is one of the prerequisites for entry into postsecondary institutions and influences students' decisions about their future careers in science and technology (Oginni et al, 2021). All facets of human life are impacted by mathematics. Numbers play a central role in all facets of human existence, including social, economic, political, geographic, scientific, and technological dimensions. Mathematics continues to be a crucial tool that equips people for effective employment, regardless of the profession they are in or their career path (Dele-Ajayi et al., 2019). Understanding mathematics is essential for daily life and long-term planning, not simply for one's career or the advancement of the country. The mind's creative and cognitive capacities can be enhanced by mathematics study, and its influence on national development is equally substantial (Etuk & Bello, 2016).

However, the scientific character of mathematics has contributed to gender stereotypes in the field. One such element that has been shown to have a significant impact on students' academic performances, particularly in science disciplines, is gender (Adigun et al, 2015). Gender stereotyping, which promotes male and female students to display interest in courses pertinent to and connected to the roles expected

of them in society, might be blamed for these performance gaps (Lewis et al, 2019). Ajayi and Imoko (2015) examined gender inequalities in mathematics achievement and retention. The study showed that achievement and retention scores between male and female students who were taught algebra via PBL did not significantly differ, demonstrating that both sexes are capable of competing and cooperating in mathematics.

Kasahara et al (2019) studied the effects of leaderboards, a game element, on intrinsic motivation. The study found that students improved code metrics under gamification conditions without additional rewards, despite competition-related game elements, such as leaderboards, are not recommended in learning-focused environments. Langendahl et al (2016) findings revealed that; the four-game elements particularly useful to enhance student engagement and motivation are: narrative, challenges, progression, and feedback. They also framed the experiences into cognitive, performative, and normative aspects of teaching and learning. From this framework, they concluded that gamification can be used to surprise and disrupt students, encourage them to be active in class, and make learning fun. Elshemy (2017) investigated the effect of pictures, voice, interactive elements, feedback, and virtual currency rewards in science subjects on a sample size of 68. The study shows a positive effect on students' academic performance. Smiderle et al (2020) investigated the effect of ranking, points, and badges on 1st-year courses in programming. The study revealed a positive effect of these elements on students' learning outcomes. Research Purpose determined the significant difference in the pre and post-test performance mean scores of the experimental and control groups; examined the difference in the mean scores of male and female students' performance in the experimental and control groups

METHOD

The study used a non-equivalent group design using a 2x2x2 factorial, quasi-experimental pre-test-post-test format. The population for this study was all junior secondary students in Kwara State. The target population for this study was all junior secondary students in basic 2 (J.S.S 2) in Kwara-North. Two junior secondary schools in Kwara-North L.G.A. were chosen using a purposive sample technique because they feature functional and well-equipped computer labs. School B was the control group, whereas School A was the experimental group. The two groups were an intact class. The instruments used for data collection were: The Mathematics Concepts Performance Test (MCPT), and the Quizalize gamification application. To ensure the reliability of the instrument, a pilot study was carried out with Ten junior secondary school students from a non-participating school. The acquired results were tested using split-half Reliability coefficients and a value of .89 was obtained. The instruments were accepted for use in the study based on the high-reliability index. Before the start of the treatment, an MCPT pre-test was given to the experimental and control groups. This enables the researcher to know in advance how well the students performed academically in the subject and whether there would be any appreciable differences in the performance of the students before exposing them to treatment. The experimental group was taught mathematics using a gamification-based teaching strategy. While the control group was taught using a conventional learning strategy. The treatments lasted for 6 weeks. The post-test of MCPT was administered after the treatment. Both descriptive and inferential statistics were used to examine the data that had been gathered. Descriptive statistics using Frequency counts, mean scores, and percentages were used to answer the research questions, while inferential statistics using paired sample t-test was used to test the hypothesis.

RESULTS AND DISCUSSION

Result

Demographic Information of Respondents

Table 1. Distribution of participants based on treatment groups

Group	Frequency	Percentage
Experimental	64	52.5
Control	58	47.5
Total	122	100.0

Table 2, shows that 64(52.5%) of the participants were in the experimental group, and 58(47.5%) were in the control group. this result is an indication that more students were in the experimental group.

Table 2. Gender Distribution of Participants

Control Group		
Gender	Frequency	Percentage
Male	34	58.6
Female	24	41.4
Total	58	100.0
Experimental Group		
Gender	Frequency	Percentage
Male	28	43.8
Female	36	56.3
Total	64	100.0

According to Table 2, of the 58 students who took part in the control group, 34 (58.6%) were male and the remaining 24 (41.1%) were female. This table's outcome reveals that male students participated in the study at a higher rate. However, in the experimental group, 36 of the individuals (56.3%) were female while 28 (43.8%) of the sample size were men. This suggests that the experimental group had more females than males.

Research Question One: What are the significant differences in the pre and post-test performance mean scores of the experimental and control groups?

Table 3. Mean Analysis of the experimental and Control groups

Groups		N	Mean	Std. Dev
Experimental	Pretest	64	33.75	9.30
	Post-test		69.31	14.15

Control	Pretest	58	27.41	10.85
	Posttest		23.79	8.90

Table 3 shows the difference between the pre and post-treatment mean scores of the treatment groups. The table shows that there was a difference in the pre and post-performance mean scores of the two treatment groups, at the post-test the experimental group had a higher mean score of 69.31. Based on these analyses, it can be deduced that there was a difference in the pre and post-treatment mean scores of the treatment groups.

Research Question Two: What is the difference in the mean score of male and female students' performance in experimental and control groups?

Table 4. Mean Analysis of Male and Female Students' Performance Experimental and Control Groups

Treatment Groups	**Gender**	**Frequency**	**Pre-Test Mean**	**Post-test Mean**
Control	Male	34	27.94	22.35
	Female	24	26.67	25.83
Total		**58**	27.41	**23.79**
Experimental	Male	28	33.39	65.89
	Female	36	34.03	71.97
Total		**64**	**33.75**	**69.31**

Table 4 shows the mean analysis of male and female students' performance in the experimental and control groups. On the pre-test, male participants had a mean score of 27.94 while the female students had a mean score of 26.67 whereas on the post-test the male students had a mean of 22.35 while the female students had a mean of 25.83. In the experimental group, the male student had a mean score of 33.39 while the female had a mean score of 34.03 after treatment was administered the male students had a mean score of 65.89 whereas the female students had a mean score of 71.97. Therefore, it can be inferred that the female students performed better than the male students after the treatment.

Hypotheses

Ho1: There is no significant main effect of treatments on junior secondary school students in mathematics.

Table 5. Paired Sample T-test showing the difference between Pre and Post Mean Scores of Treatment Groups

Test Variable (performance)	**Grouping Variable (Pre-and-Post performance**		**N**	**Mean**	**Std. Dev**	**df**	**t**	**Sig (P)**	**Remark**
Performance In Mathematics	Control	Pretest	58	27.41	10.85	57	1.99	.052	Not Significant
		Post-test		23.79	8.90				
	Experimental	Pretest	64	33.75	9.30	63	17.89	.000	Significant
		Post-test		69.31	14.15				
		Post-test		69.31	14.15				

Table 5 shows the difference between the pre and post-treatment mean scores of the treatment groups. The table shows that there was a difference in the pre and post-performance mean scores of the two treatment groups: control (df = 57; t = 1.99; p>.05), experimental (df = 63; t = 17.89; p<0.05), based on these analyses, it can be deduced that there was a difference in the pre and post-treatment mean scores of the treatment groups.

Ho2: There is no significant effect of gender on junior secondary school academic performance in mathematics after treatment.

Table 6. ANCOVA Analysis on the significant effect of gender on student performance in mathematics after treatment

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4032.918[a]	1	4032.918	6.356	.013
Intercept	11470.427	1	11470.427	18.077	.000
Gender	4032.918	1	4032.918	6.356	.013
Error	76143.967	120	634.533		
Total	357438.000	122			
Corrected Total	80176.885	121			

a. R Squared = .050 (Adjusted R Squared = .042)

Discussions

The pre- and post-treatment mean scores of the treatment groups differed, according to the results of the first research question. This suggests that the adoption of the gamification element has an impact on junior-senior high school students' mathematics performance. This result is consistent with that of Landers, (2014); Langendahl et al (2016), and Smiderle et al (2020) who revealed a positive effect of gamification elements on students' learning outcomes. The second question's research findings showed that following the treatment, female students did better than male students. This suggests that gender stereotypes, which encourage female students to display interest in mathematics relative to their male counterparts, may be to blame for the variations in performance. The results of this study don't support those of Ajayi and Imoko (2015) examined gender inequalities in mathematics achievement and retention. The study showed that achievement and retention scores between male and female students who were taught algebra via PBL did not significantly differ, demonstrating that both sexes are capable of competing and cooperating in mathematics.

CONCLUSION

It therefore can be concluded that junior secondary school students ' performance in mathematics has greatly improved because of the introduction of gamification elements in mathematics. The results of this study also showed that gender had no significant impact on junior secondary school student's performance in mathematics. According to the study's findings, the following suggestions are deemed appropriate:

1. Unarguably, the gamification element is successful in lowering the level of abstractness connected with the teaching and learning of some mathematical concepts at the junior secondary school level of education, mathematics teachers should incorporate it into the classroom
2. Mathematics teachers should work towards bridging the gender divide in education and technology by being keen on inclusiveness in the teaching and learning process.

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