NIGERIAN ONLINE JOURNAL OF EDUCATIONAL SCIENCES AND TECHNOLOGY
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SCOOLJ, OLUWAJUWONLO JOSEPH

Department of Social Sciences Education, University of Lagos

To cite this article:
Scoolj, O. J. (2024). The impact of gamification strategies on primary school pupils' motivation to learn mathematics in Southwest, Nigeria. *Nigerian Online Journal of Educational Sciences and Technology (NOJEST)*, 6 (2), 1-14

Nigerian Online Journal of Educational Sciences and Technology (NOJEST)

Volume 6, Number 2,2024

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Article Infor

Article History

Received:
05 March 2024

Accepted:
September 07, 2024

Keywords
Gamification, Motivation, Mathematics, Primary School Pupils

Abstract

Nigeria grapples with challenges within its educational framework, with a prevailing focus on quantitative metrics often neglecting qualitative aspects. Mathematics education, in particular, stands out as a significant hurdle in achieving educational objectives. This study seeks to examine the influence of gamification strategies on primary school pupils' motivation to learn mathematics in Southwest Nigeria. It employed a quasi-experimental pre-test/post-test control group factorial design: the research encompasses eight primary schools across Lagos and Osun states. The Motivation to Learn Mathematics Scale (MLMS) was adapted from the Science Motivation Questionnaire (SMQ) to gauge motivation levels. Data collected were subjected to analysis employing descriptive statistics, ANCOVA. The findings reveal a positive impact of gamification treatment on pupils' motivation to learn mathematics. Moreover, the study shows that gender does not exert a significant influence on primary school pupils' motivation to learn mathematics. similarly, the area of classification does not significantly affect pupils' motivation. Consequently, it is recommended, among other measures, that the incorporation of gamification strategies into mathematics teaching for primary school pupils be prioritized.

Introduction

Quality education is indispensable for nations to harness and optimize their material and human resources. Blessing and Dorothy (2016) contend that Nigeria's educational challenges stem from a policy focus that prioritizes quantitative metrics over qualitative aspects of institutional development. This approach has resulted in the establishment of primary, secondary, and tertiary

educational institutions by both state and federal governments without adequate attention to the quality of the learning experiences offered. This phenomenon underscores the politicization of education in Nigeria, where educational institutions are often utilized as tools for political gain. Moreover, Ozturk (2001) asserts that sustainable economic development hinges upon substantial investments in human capital. This investment is pivotal in fostering productivity, creativity, entrepreneurship, and technological advancement among the populace. Goczek, Witkowska, and Witkowski's (2021) research underscores the correlation between educational quality and heightened economic prospects. Notably, Nigeria's low ranking in global education indices, such as the World Economic Forum report, underscores the magnitude of the challenge. This educational deficit translates into significant learning gaps, with a substantial proportion of primary school children failing to attain minimum proficiency levels in learning (World Bank, 2019).

Additionally, the World Bank (2019) contends that access to quality education is pivotal in bridging early gaps in cognitive and socio-behavioural skills. Despite this, Grant (2017) argues that investment in primary education alone is insufficient to drive economic growth, underscoring the importance of comprehensive educational interventions that extend to at least junior secondary education. Quality education, therefore, must be cultivated from the foundational levels to foster sustainable development. Primary education plays a foundational role in shaping subsequent learning outcomes. Primary education, as defined by the National Policy on Education (2004), aims to instil permanent literacy, numeracy, and effective communication skills in children aged 6 to 11. However, despite concerted efforts such as the Universal Primary Education initiative, Mathematics remains a significant obstacle to educational attainment (Aburime, 2007; Universal Basic Education Commission, 2018).

Mathematics, broadly defined as the ability to understand and utilize numbers for basic arithmetic operations, holds immense importance across various domains of life (Awofala & Blessing, 2014). Adeyemi and Adaramola (2014) expand this definition to encompass the application of numerical reasoning in everyday contexts, while Dieckmann (2008) underscores the practical utility of mathematics in diverse settings, including home, work, and community life. Given the pervasive nature of mathematical skills, their mastery is indispensable for effective functioning in a digitized world (Awofala & Blessing, 2014). Despite the intrinsic value of mathematics, challenges persist in its effective instruction and acquisition. Teachers in Nigerian schools have cited issues such as

student disinterest, instructional deficiencies, and inadequate resources as impediments to mathematics education. Moreover, scholars have also identified factors such as a fixed mindset, inadequate teacher training, and insufficient instructional materials as contributors to poor mathematics competency (Boaler, 2013; Suleiman & Hammed, 2019; Kiryakova, Angelova & Yordanova, 2014).

Furthermore, researcher's observations reveal a noteworthy phenomenon wherein children exhibit a heightened engagement level in challenging activities, particularly evident in their immersion in video games for extended periods. These games, whether played on consoles, smartphones, tablets, or computers, are meticulously designed to evoke curiosity and perseverance among players. Interestingly, while these same children may struggle to maintain focus during a conventional lesson lasting thirty minutes, the experience of failure in video games appears to instill a sense of resilience and determination. This observation has sparked interest among academics, educators, and researchers, prompting them to explore the underlying properties and frameworks of video games. Consequently, this exploration has led to the emergence of gamification as a pedagogical approach. Gamification capitalizes on the motivational elements inherent in video games to foster engagement, persistence, and learning in educational contexts.

Gamification, while not a novel concept, has found extensive application in sectors such as health, business, and marketing, albeit being relatively nascent in educational contexts. It involves the adaptation of game properties and features into non-game settings, such as classrooms, to harness game-based mechanics, aesthetics, and thinking. Kapp (2012) describes gamification as a process aimed at engaging individuals, motivating action, promoting learning, and facilitating problem-solving by incorporating game elements. Similarly, Deterding, Dixon, Khaled, and Nacke (2011) define gamification as the integration of game design elements into non-game environments, including educational settings. These elements encompass various aspects such as stages, rewards, targets, and pacing strategies. By leveraging these elements, gamification enhances concentration levels, strengthens focus, and fosters a resilient "do to finish" attitude among participants, encouraging persistence despite initial failures. Moreover, gamification fosters increased participation and motivation among learners by creating an environment that incentivizes progress and achievement. This approach encourages learners to navigate the learning process with agility, aiming to attain rewards and overcome challenges effectively. The gamified learning experience

is characterized by its effectiveness, efficiency, attractiveness, and entertainment value, as highlighted by Bozkurt (2014) and Sahin & Naml (2016).

However, despite the potential benefits of gamification in mathematics education, empirical research on its application remains scarce in the Nigerian context. In light of this gap, this study aims to investigate the impact of gamification strategies on primary school pupils' motivation to learn mathematics in Southwest Nigeria.

Research Questions

The following questions were raised and answered in the study:

1. What is the effect of gamification strategies on primary school pupils' motivation to learn mathematics in Southwest Nigeria?
2. To what extent does to moderate the impact of gamification strategies on primary school pupils' motivation to learn mathematics in Southwest Nigeria?
3. To what extent do areas of classification (Rural & Urban), moderate the impact of gamification strategies on primary school pupils' motivation to learn mathematics in Southwest Nigeria?
4. what is the interaction impact of gamification (treatment) and gender on primary school pupils' motivation to learn Mathematics?
5. What is the interaction impact of gamification (treatment) and Area classification (Rural & Urban) on primary school pupils' motivation to learn Mathematics?
6. What is the interaction impact of gender and area classification (Rural & Urban) on primary school pupils' motivation to learn Mathematics?

Research Hypotheses

Ho_1 There is no significant impact of gamification (treatment) on primary school pupils' motivation to learn Mathematics.

Ho_2 There is no significant main impact of gender on primary school pupils' motivation to learn Mathematics.

Ho_3 There is no significant main impact of Area classification (Rural & Urban) on primary school pupils' motivation to learn Mathematics.

Ho_4 There is no significant interaction impact of gamification (treatment) and gender on primary school pupils' motivation to learn Mathematics.

Ho_5 There is no significant interaction impact of gamification (treatment) and Area classification (Rural & Urban) on primary school pupils' motivation to learn Mathematics.

Ho_6 There is no significant interaction impact of gender and area classification (Rural & Urban) on primary school pupils' motivation to learn Mathematics.

Methodology

This research employs a quantitative approach, utilizing a quasi-experimental pre-test/post-test control group factorial design. The study encompasses eight primary schools across two states in Southwest Nigeria: Lagos and Osun, selected purposively to represent differing developmental contexts within the region. The target population comprises all public Primary Five (Basic 5) pupils, chosen for their maturity and ability to understand instructions. A multi-stage sampling technique was employed, involving stratification of pupils into senatorial zones, followed by classification into urban and rural areas. Local government areas were then selected, with one urban and one rural area chosen through simple balloting. Primary schools were subsequently sampled from these areas using simple random sampling. The sample size, calculated based on a target population of 683,949, resulted in 384 pupils with a 95% confidence level and a confidence interval of 5%. Additionally, intact classes of pupils were chosen for inclusion in treatment groups (one treatment and one control) to prevent experimental contamination. The Motivation to Learn Mathematics Scale (MLMS), adapted from the Science Motivation Questionnaire (SMQ) developed by Glynn and Koballa (2005), was used as the sole instrument. This scale measures six components of motivation: intrinsically motivated numeracy learning, extrinsically motivated numeracy learning, relevance of numeracy learning to personal goals, responsibility for numeracy learning, confidence in numeracy learning, and anxiety about numeracy assessment. Pupils responded to each of the 30 items on a 5-point Likert-type scale. To ensure the instrument's validity, it was reviewed by experts in the departments of measurement and evaluation at the University of Lagos. The instrument was administered twice within a two-week interval, and Cronbach's alpha was used to assess its internal consistency, resulting in a reliability coefficient of 0.77. Data analysis involved descriptive statistics, including frequency count, percentage, mean, and standard deviation. Six hypotheses were tested using Analysis of Covariance (ANCOVA) facilitated by the Statistical Package for Social Scientists (SPSS 21.0) at a significance level of 0.05.

Result

Table 1: **sample distribution table for intact class by Area of Classification, State**

States	Area classification				Total
	Urban		Rural		
	Control	Experiment	Control	Experiment	
Lagos	31	26	49	53	159
Osun	48	42	45	51	186
Total	79	68	94	104	345

State

		Frequency	Per cent
Valid	Lagos state	158	45.8
	Osun state	187	54.2
	Total	345	100.0

Area Classification

		Frequency	Per cent
Valid	Urban Area	147	42.6
	Rural Area	198	57.4
	Total	345	100.0

Group

		Frequency	Percent
Valid	Control	173	50.1
	Experimental	172	49.9
	Total	345	100.0

Table 1 shows that 158 pupils in Lagos state participated in the study and 187 pupils in Osun state participated in the study thereby making the total participants be 345 pupils in both states. Also 147 pupils who participated in the study lived and schooled in areas considered to be Urban based on the level of infrastructural facilities development in each LGA, such as roads, electricity, drinking water, housing, communication services, sewage treatment and the nature of occupational opportunities in each LGA. Conversely, 198 pupils are considered to live and schooled in rural areas of both Lagos and Osun states. Furthermore, 173 pupils were grouped into the control group while 172 pupils also were grouped into the experimental group in both Lagos and Osun states.

Table 2: **Distribution of pupils by state and Gender**

		Gender		Total
		Male	Female	
State	Lagos	74	84	158
		46.8%	53.2%	45.8%
	Osun	92	95	187
		49.2%	50.8%	54.2%
Total		166	179	345
		48.1%	51.9%	100%

Table 2 shows that 74 pupils who participated in the study are male from Lagos state representing 46.8% while 84 pupils who are female from Lagos state constitute 53.2%. Similarly, 92 pupils who are male from Osun state represent 49.2% and 95 pupils who are female constitute 50.8% of Osun state. In total, there are 166 males which is 48.1% and 179 Females representing 51.9% from both Lagos and Osun states.

Hypothesis Testing:

Table 3: Summary of ANCOVA of Post Motivation to Learn Mathematics by Group, Gender, and Area Classification

Source	SS	df	MS	F	Sig.	Partial Eta Squared
Corrected Model	358307.425[a]	8	44788.428	283.449	.000	.871[a]
Intercept	23019.985	1	23019.985	145.685	.000	.302
Motivation to learn	270.902	1	270.902	1.714	.191	.005
Group	336732.412	1	336732.412	2131.052	.000	.864
Area of classification	33.250	1	33.250	.210	.647	.001
Gender	55.037	1	55.037	.348	.555	.001
group * area of classification	235.483	1	235.483	1.490	.223	.004
group * gender	113.671	1	113.671	.719	.397	.002
Area of classification * gender	.961	1	.961	.006	.938	.000
group * area of classification * gender	12.064	1	12.064	.076	.782	.000
Error	53092.128	336	158.012			
Total	2762114.000	345				
Corrected Total	411399.554	344				

Ho1: There is no significant impact of gamification (treatment) on primary school pupils' motivation to learn Mathematics.

Table 3 shows that an analysis of covariance (ANCOVA) was conducted to examine the impact of gamification (treatment) on primary school pupils' motivation to learn mathematics while controlling for pre-motivation to learn scores. The dependent variable was the post-score of the Motivation to Learn Mathematics Scale (MLMS). The results revealed a significant main effect of gamification treatment on pupils' motivation to learn mathematics, $F(1, 336) = 2131.052$, $p < .001$,

η^2 = .864. The partial eta-squared value of .864 indicates a large effect size based on Cohen's guidelines. However, there was no significant main effect of pre-motivation to learn on post-motivation to learn scores, F (1, 336) = 1.714, p = .191, η^2 = .005. Thus, rejecting the null hypothesis, there is evidence to suggest that gamification treatment significantly impacts primary school pupils' motivation to learn mathematics.

Ho2: There is no significant main impact of gender on primary school pupils' motivation to learn Mathematics.

Table 3 illustrates the results of an analysis of covariance (ANCOVA) performed to investigate the main impact of gender on primary school pupils' motivation to learn mathematics while controlling for pre-test scores. The dependent variable in this analysis was the post-test score measuring motivation to learn. The findings indicated no significant main effect of gender on pupils' motivation to learn mathematics, F(1, 336) = .348, p = .555, η^2 = .001. Consequently, there is no evidence to suggest that gender has a significant impact on primary school pupils' motivation to learn mathematics.

Ho3: There is no significant main impact of Area classification on primary school pupils' motivation to learn Mathematics.

Table 3 presents the results of an analysis of covariance (ANCOVA) conducted to investigate the main impact of area classification on primary school pupils' motivation to learn Mathematics while controlling for pre-test scores. The dependent variable was the post-test score measuring motivation to learn. The findings indicated no significant main impact of area classification on pupils' motivation to learn Mathematics, F(1, 336) = .210, p = .647, η^2 = .001.

Ho4: There is no significant interaction impact of gamification (treatment) and gender on primary school pupils' motivation to learn Mathematics.

The outcomes of the Two-Way Analysis of Covariance (ANCOVA) are presented in Table 3, revealing that there was no statistically significant interaction impact between gamification

(treatment) and gender on primary school pupils' motivation to learn Mathematics, F(1, 336) = .719, p =.397, with a partial eta-squared (η^2) of .002. These results suggest that, after accounting for the pre-test scores, the joint impact of gamification (treatment) and gender did not significantly impact the post-test scores on primary school pupils' motivation to learn Mathematics. The partial eta-squared value of .002 indicates a no effect size, highlighting that the observed non-significant interaction effect is not practically meaningful in explaining variations in post-test scores.

Ho5: There is no significant interaction impact of gamification (treatment) and Area classification on primary school pupils' motivation to learn Mathematics.

A review of Table 3 reveals no statistically significant interaction impact between gamification treatment and area classification on the post-test scores of primary school pupils' motivation to learn Mathematics, after controlling for pre-test scores, F(1, 336) = 1.490, p = .223, partial η^2 = .004. This result suggests that the impact of gamification on primary school pupils' motivation to learn Mathematics does not significantly vary based on the geographical classification of areas.

Ho6: There is no significant interaction impact of gender and area classification on primary school pupils' motivation to learn Mathematics.

Table 3 presents the results of an analysis of covariance (ANCOVA) conducted to examine the interaction impact of gender and area classification on primary school pupils' motivation to learn mathematics while controlling for pre-test scores. The dependent variable in this analysis was the post-test score measuring pupils' motivation to learn mathematics. The results indicate no significant interaction impact of gender and area classification on post-test scores, F(1, 336) = 0.006, p = .938, η^2 = .000.

Discussion of Findings

The research has firmly established that gamification plays a crucial role in motivating students to engage more deeply in learning mathematics. This phenomenon not only creates a conducive environment but also prompts proactive involvement in the educational journey, facilitating a shift

from amotivation to intrinsic motivation. Galiç and Yıldız (2023) reported that the use of enriching game elements had a positive and substantial effect on students' motivation and attitude in mathematics lessons. Suárez Caballero (2023) similarly demonstrated a highly positive impact of gamification on motivation.

Floris, Fradiante, Marchisio Conte, and Rabellino (2024) found that the gamification strategy effectively stimulated students' motivation, and Hui and Mahmud (2023) reported an improvement in students' attitude and motivation through gamification. Sansyzbayev (2023) observed an enhancement and transformation of external motivation into internal motivation over time. Daineko, Goncharova, Zaitseva, Larionova, and Dyachkova (2023) discovered that gamification increased motivation but emphasized the need to consider individual characteristics of students' learning behaviour. Hassan, Emam, and Sayed (2023) concluded that gamification was effective in enhancing English as a Foreign Language (EFL) learners' motivation, attributing its efficiency to the challenging and motivating nature of adding inspiring gaming elements to traditional learning. Vélez Meza, Alexis, Mónica, and Jacinto (2020) found that students were more motivated when teachers incorporated playful elements in the classroom, and Santillán, Valderrama, Arce, and Barragán (2023) highlighted the role of gamification in helping learners stay motivated and enabling invisible learning, which occurs outside the classroom.

Dahalan, Alias, and Shaharom (2023) found that gamification and game-based learning improved motivation in vocational education learners. Shurygin, Anisimova, Orazbekova, and Pronkin (2023) confirmed increased learning motivation in mathematics through the use of gamification via mobile applications like MalMath. Anderson (2023) discovered that gamification positively influenced students' academic engagement, leading to higher mathematical achievement. Increased motivation during digital game-based activities resulted in higher achievement, influenced by both intrinsic and extrinsic factors. Fitria (2022) demonstrated that the application of gamification in learning positively influenced motivation scores. However, Donnermann, Lein, Messingschlager, Riedmann, Schaper, Steinhaeusser & Lugrin (2021) found no significant increase in motivation with the addition of gamification elements. Ratinho and Martins (2023) reported a positive influence of gamification strategies on students' motivation, although they noted a potential decline in motivation with prolonged exposure.

Conclusion

This study highlights the significant positive impact of gamification on primary school pupils' motivation to engage in mathematics learning activities in Southwest Nigeria. The findings emphasize the importance of integrating game elements into educational settings to foster intrinsic motivation and proactive participation among students. Aligning with existing literature, the research underscores the motivational benefits of gamification across various educational contexts. These insights offer valuable implications for educators and policymakers, emphasizing the potential of gamification to enhance learning outcomes and cultivate a lifelong passion for learning. However, future research should explore tailored approaches to optimize gamification interventions based on individual learner needs and preferences, ultimately driving educational excellence and societal development in Southwest Nigeria and beyond.

Recommendation

1. The Adaptive Gamification Intervention Package (AGIP), cultivated within the framework of this study, is advised to be implemented as a pivotal training manual within teacher training workshops.
2. Policymakers should consider integrating gamification elements into the mathematics curriculum to bolster student motivation and engagement.
3. Teachers should receive training on effectively implementing gamification strategies in their teaching practices. Thirdly, schools should invest in educational technology tools that support gamified learning experiences.
4. Collaboration among educators, researchers, and policymakers is essential for sharing best practices and advancing gamified mathematics education.

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