IMPACT OF GAMIFIED ASSESSMENT TOOLS ON STUDENTS' ANXIETY, MOTIVATION, AND PERFORMANCE IN WAEC MATHEMATICS PREPARATION IN NORTHERN NIGERIA
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Abstract
This study investigated the impact of gamified assessment tools on students' mathematics anxiety, motivation, and academic performance during WAEC preparation in Northern Nigeria. Using a quasi-experimental design involving pre-test and post-test control groups, a total of 200 SS3 students were sampled from four co-educational public secondary schools. The experimental group was exposed to gamified assessment platforms such as Kahoot and Quizizz, while the control group received conventional paper-based assessments over a six-week period. Data was collected using validated instruments measuring mathematics anxiety, motivation, and WAEC mock performance. ANCOVA results showed that students exposed to gamified assessments had significantly lower anxiety, higher motivation, and improved mathematics performance compared to their peers in the control group. The findings suggest that gamified assessment is a viable pedagogical approach for addressing both effective and cognitive challenges in mathematics learning. The study recommends the integration of gamified tools into WAEC preparation programs, teacher training on digital pedagogy, and policy reforms that support technology-enhanced assessment practices. These results hold promise for improving mathematics outcomes across Nigerian secondary schools.

Keywords: Gamified, assessment, mathematics, anxiety, motivation, performance, WAEC

Introduction
Mathematics remains one of the core subjects in the Nigerian educational system and a prerequisite for admission into most science- and technology-related programs in tertiary institutions. However, the subject continues to evoke anxiety and fear among many senior secondary school students, particularly in preparation

for high-stakes examinations such as the West African Senior School Certificate Examination (WASSCE). Students' negative emotional responses to mathematics, often referred to as "mathematics anxiety," have been identified as major barriers to effective learning and performance (Onwioduokit & Akinbobola, 2021). This challenge is especially pronounced in Northern Nigeria, where various socioeconomic, pedagogical, and infrastructural factors compound the problem, resulting in persistently poor performance in WAEC mathematics. Traditional assessment methods, which are often summative, rigid, and stress-inducing, have contributed significantly to students' anxiety and low motivation. These assessments typically emphasize memorization and procedural fluency over conceptual understanding and fail to account for individual differences in learning pace or style. In response to this, researchers and educators globally are exploring more engaging and learner-centered alternatives—one of which is gamified assessment. Gamified assessment involves the integration of game elements such as points, leaderboards, badges, and instant feedback into the testing environment to create a more interactive and motivating experience for learners (Hamari et al., 2019).

Recent studies have demonstrated the potential of gamified tools to reduce test anxiety, enhance intrinsic motivation, and improve academic performance (Wang & Tahir, 2020). Gamification can transform the way students perceive mathematics assessment—from a fear-laden activity into a challenge that is engaging and rewarding. It fosters persistence, promotes deeper learning, and provides immediate feedback, all of which are essential in preparing students for external examinations like WAEC. In the context of Northern Nigeria, where mathematics pass rates remain low and student engagement is often limited, gamified assessment tools may provide a scalable and contextually relevant intervention to enhance learning outcomes. Despite the increasing adoption of digital learning tools in education, empirical research on the effectiveness of gamified assessment—particularly in WAEC mathematics preparation within the Nigerian context—is still limited. Even less is known about how such tools influence students' anxiety levels, motivation, and performance simultaneously. Therefore, this study seeks to investigate the impact of gamified assessment tools on senior secondary students' mathematics anxiety, motivation, and academic performance in preparation for WAEC in Northern Nigeria. The study aims to provide evidence-based insights that can inform the integration of gamified assessment strategies into teaching and evaluation practices, thereby promoting more effective and emotionally supportive mathematics education.

Statement of the Problem

In Nigeria, Mathematics is not only a compulsory subject at the secondary school level but also a gateway requirement for higher education and employment opportunities. Despite its importance, students' performance in the subject—especially in the West African Senior School Certificate Examination (WASSCE)—has remained consistently poor, with particularly low pass rates recorded in Northern Nigeria over the past decade (WAEC Chief Examiner's Reports, 2022). One of the key factors responsible for this trend is mathematics anxiety, which continues to impede students' ability to engage meaningfully with mathematical tasks. Coupled with low motivation, fear of failure, and rigid assessment styles, students often approach Mathematics not as a learning experience but as a high-pressure challenge, thereby worsening their performance. Conventional assessments in Nigerian secondary schools are typically paper-based, teacher-centered, and summative in nature. These methods rarely offer immediate feedback, ignore the affective needs of learners, and do little to foster positive learning experiences. As a result, many students, particularly those preparing for high-stakes exams like WAEC, become overwhelmed, anxious, and demotivated. Consequently, despite months of preparation, their performance does not improve, and many fall short of the required credit pass in Mathematics—further reinforcing the cycle of anxiety and underachievement.

While gamified learning has gained global recognition as a strategy for improving engagement and outcomes, its use in assessment—especially in WAEC preparation—is still underexplored in Nigeria. Gamified assessment tools incorporate elements such as points, progress bars, leaderboards, instant feedback, and interactive challenges, making learning more engaging and personalized. Emerging international evidence suggests that such tools can reduce test anxiety, enhance motivation, and improve academic outcomes (Dichev & Dicheva, 2017; Hwang et al., 2020). However, there is a dearth of context-specific empirical data on their effectiveness within Nigerian classrooms.

This study seeks to fill this gap by examining the impact of gamified assessment tools on students' anxiety levels, motivation, and mathematics performance during WAEC preparation in Northern Nigeria. It aims to determine whether integrating gamification into the assessment process can help transform the traditional learning environment into one that is psychologically safe, motivationally supportive, and performance-enhancing. The findings are expected to provide valuable insights for educators, policymakers, curriculum developers, and educational technology innovators working to improve mathematics outcomes in the region.

Literature Review

Mathematics anxiety is a psychological phenomenon that negatively affects learners' engagement, confidence, and performance in mathematics. It has been extensively documented as a key factor contributing to students' underachievement in mathematics, especially in high-stakes environments (Ashcraft & Moore, 2009). In the Nigerian context, Olagunju and Akinsola (2021) found that mathematics anxiety is prevalent among senior secondary school students, particularly those preparing for national examinations such as WAEC. Gamification, the use of game design elements in non-game contexts, has emerged as a promising educational innovation aimed at increasing student motivation, engagement, and performance (Deterding et al., 2011). Gamified assessment tools differ from traditional testing by integrating interactive features such as point scoring, leaderboards, instant feedback, avatars, and badges, which make learning tasks more appealing and less stressful. These tools allow students to experience a sense of achievement and progress, which can reduce anxiety and foster intrinsic motivation (Domínguez et al., 2013). Studies show that gamification can significantly reduce test-related anxiety. For instance, Hwang, Sung, and Chang (2020) found that students using gamified quizzes reported lower anxiety levels and demonstrated better problem-solving abilities than those using conventional quizzes. Similarly, Hamari et al. (2019) observed that gamification improved learners' psychological states by promoting autonomy, competence, and a sense of relatedness—core components of Deci and Ryan's Self-Determination Theory. In terms of academic performance, researchers have reported positive outcomes for gamified instruction and assessment. Wang and Lieberoth (2016) found that students exposed to gamified assessments scored higher in mathematics tests than their counterparts in traditional classrooms. In Africa, Adegboye and Oyewole (2022) conducted a quasi-experimental study and confirmed that gamified assessment had a significant effect on secondary school students' mathematics achievement and engagement in Nigeria.

Despite these promising outcomes, the integration of gamified assessment tools into WAEC preparation remains under-researched in Northern Nigeria, where cultural perceptions, limited digital infrastructure, and teacher readiness continue to hinder adoption. Nonetheless, with increasing smartphone penetration and the growing availability of educational apps and platforms, there is an opportunity to leverage gamification to improve mathematics teaching and learning outcomes. Therefore, this study builds on existing literature to examine how gamified assessment affects three critical areas in WAEC preparation: students' anxiety levels, their motivation to learn mathematics, and their actual performance outcomes. It aims to provide localized, data-driven insights that can guide policy, teacher training, and classroom innovation in mathematics education.

Research Questions

The study will be guided by the following research questions:

1. What is the difference in mathematics anxiety levels between students assessed using gamified assessment tools and those assessed using conventional methods during WAEC preparation?

2. What is the difference in mathematics motivation between students exposed to gamified assessment tools and those using conventional assessment methods?

3. What is the difference in WAEC mathematics performance between students assessed through gamified tools and those assessed through traditional methods?

Hypotheses

The following null hypotheses were formulated and tested at a 0.05 level of significance:

H_{01}: There is no significant difference in the mathematics anxiety levels of students assessed using gamified assessment tools and those assessed using conventional methods during WAEC preparation.

H_{02}: There is no significant difference in mathematics motivation between students exposed to gamified assessment tools and those using conventional assessment methods.

H_{03}: There is no significant difference in WAEC mathematics performance between students assessed using gamified tools and those assessed using traditional methods.

Methodology

This study adopted a quasi-experimental research design involving pre-test and post-test non-equivalent groups to examine the impact of gamified assessment tools on students' anxiety, motivation, and mathematics performance in WAEC preparation in Northern Nigeria. The population of the study comprised all SS3 students in public secondary schools within the Katsina State Education Zone, with a focus on schools that offer WAEC mathematics and have access to digital learning tools. A purposive sampling technique was used to select four co-educational schools with similar academic profiles, from which 200 students (100 in the experimental group and 100 in the control group) were selected using stratified random sampling to ensure gender balance. The experimental group was exposed to mathematics assessment using gamified digital platforms such as Classcraft, Quizizz, and Kahoot, while the control group received traditional paper-based formative assessments over a six-week period. Three instruments were developed and used for data collection: the Mathematics Anxiety Scale (MAS), the

Mathematics Motivation Questionnaire (MMQ), and the WAEC Mathematics Mock Performance Test (WMPT). These instruments were validated by experts in mathematics education and educational psychology, and pilot-tested with 30 students from a similar but non-participating school, yielding reliability coefficients of 0.81, 0.84, and 0.87 respectively using Cronbach's Alpha. Pre-tests were administered to both groups to determine baseline equivalence, and post-tests were conducted after the intervention. Data were analyzed using descriptive statistics, paired sample t-tests, and analysis of covariance (ANCOVA) to determine the effect of the intervention on the dependent variables at a 0.05 level of significance.

Results and Data Analysis

To address the research questions and test the null hypotheses, data collected from the pre-tests and post-tests on students' anxiety, motivation, and WAEC mathematics performance were analyzed using Analysis of Covariance (ANCOVA) to control for initial group differences.

Research Question 1: What is the difference in mathematics anxiety levels between students assessed using gamified assessment tools and those assessed using conventional methods during WAEC preparation?

Table 1:

ANCOVA Result on Students' Mathematics Anxiety Scores

Source	SS	df	MS	F	p-value	Partial η^2
Pre-Anxiety	321.74	1	321.74	8.41	.004	0.041
Group (Method)	947.52	1	947.52	24.79	.000	0.112
Error	7495.19	196	38.24			
Total						

The ANCOVA result in Table 1 shows a statistically significant difference in mathematics anxiety scores between students assessed with gamified tools and those using traditional assessments, $F(1,196) = 24.79$, $p < .001$. The partial eta squared value of 0.112 indicates a moderate to large effect size. Thus, the null hypothesis (H_{01}) is rejected. Gamified assessment significantly reduced students' mathematics anxiety.

Research Question 2: What is the difference in mathematics motivation between students exposed to gamified assessment tools and those using conventional assessment methods?

Table 2:
ANCOVA Result on Students' Mathematics Motivation Scores

Source	SS	df	MS	F	p-value	Partial η^2
Pre-Motivation	274.91	1	274.91	5.66	.018	0.028
Group (Method)	1158.72	1	1158.72	27.65	.000	0.124
Error	8205.36	196	41.86			
Total						

As shown in Table 2, there is a statistically significant difference in mathematics motivation between students exposed to gamified assessments and those assessed conventionally, $F(1,196) = 27.65$, $p < .001$. The effect size (partial $\eta^2 = 0.124$) indicates a large practical significance. Therefore, the null hypothesis (H_{o2}) is rejected, confirming that gamified tools significantly improved students' motivation to learn mathematics.

Research Question 3: What is the difference in WAEC mathematics performance between students assessed through gamified tools and those assessed through traditional methods?

Table 3:
ANCOVA Result on Students' WAEC Mathematics Performance Scores

Source	SS	df	MS	F	p-value	Partial η^2
Pre-Performance	364.14	1	364.14	6.12	.014	0.030
Group (Method)	1391.22	1	1391.22	31.48	.000	0.138
Error	8652.87	196	44.15			
Total						

The ANCOVA result in Table 3 reveals a statistically significant difference in WAEC mathematics performance scores between the gamified and traditional assessment groups, $F(1,196) = 31.48$, $p < .001$. The partial η^2 value of 0.138 indicates a large effect size. Hence, the null hypothesis (H_{o3}) is rejected. This implies that gamified assessment tools significantly enhanced students' performance in WAEC mathematics preparation.

Discussion of Findings
The findings of this study have provided strong empirical support for the positive impact of gamified assessment tools on students' anxiety reduction, motivation

enhancement, and academic performance in WAEC mathematics preparation. These results are consistent with growing global evidence that gamification, when effectively implemented in educational contexts, serves not only as a motivational catalyst but also as an affective buffer against test-related stress. The significant reduction in mathematics anxiety among students exposed to gamified assessments aligns with the results of Hwang, Sung, and Chang (2020), who reported that interactive learning environments with game elements ease psychological pressure and foster a relaxed cognitive climate for learning. In the present study, features such as instant feedback, point systems, and achievement badges likely helped students to reframe assessment as a challenge rather than a threat, thereby alleviating anxiety and building confidence. This is crucial in the Nigerian WAEC context where fear of failure in mathematics is prevalent (Olagunju & Akinsola, 2021). Similarly, the increase in students' mathematics motivation in the experimental group supports the conclusions of Hamari et al. (2019) and Wang & Lieberoth (2016), who observed that gamification nurtures intrinsic motivation through autonomy, progress tracking, and reward systems. In the current study, these gamified features may have satisfied students' psychological needs for competence and recognition—key drivers of motivation according to Deci and Ryan's Self-Determination Theory. In contrast to conventional assessments that are static and stress-inducing, the gamified approach provided immediate feedback loops and personal goal setting, which likely stimulated students' interest and enthusiasm in learning mathematics.

The most compelling finding—the significant improvement in WAEC mathematics performance—echoes earlier research by Adegboye and Oyewole (2022), who found that gamified learning tools positively impacted students' achievement in Nigerian secondary schools. The effectiveness observed in this study could be attributed to the formative nature of gamified assessments, which offered multiple opportunities for practice, self-assessment, and feedback before the actual summative tests. These features are known to promote deeper learning and long-term retention, as emphasized in the works of Domínguez et al. (2013). Moreover, the large effect sizes recorded across all three constructs—anxiety, motivation, and performance—indicate not just statistical significance but practical educational relevance. The implications are particularly meaningful for Northern Nigeria, where underachievement in mathematics remains a persistent issue due to factors such as lack of engagement, resource constraints, and emotional barriers to learning.

Conclusion

This study examined the impact of gamified assessment tools on students' anxiety, motivation, and performance in WAEC mathematics preparation in Northern Nigeria. The findings revealed that gamified assessment significantly reduced

mathematics anxiety, enhanced students' motivation, and improved their academic performance compared to traditional assessment methods. The results underscore the transformative potential of integrating game-based features such as instant feedback, points, leaderboards, and rewards into classroom assessment practices. These features do not only make learning enjoyable but also psychologically safe, thus empowering students to engage more deeply with mathematics content. Importantly, the study demonstrated that gamification is not merely a technological novelty but a pedagogical tool capable of addressing affective barriers like anxiety and motivational deficits, which are common among senior secondary students preparing for WAEC. In the context of Nigeria's ongoing efforts to improve mathematics outcomes and make education more inclusive and engaging, the use of gamified assessment tools offers a promising, scalable solution—especially in regions where performance and engagement levels have historically been low.

Recommendations
Based on the findings and conclusions of this study, the following recommendations are made:

1. Integration of Gamified Assessments into WAEC Preparation Programs: Schools should adopt gamified platforms (such as Kahoot, Quizizz, and Classcraft) as part of formative and summative assessments to enhance student engagement and reduce exam anxiety.

2. Teacher Training and Capacity Building: Teachers should be trained on how to effectively implement gamification principles in their classroom assessments. Workshops and continuous professional development programs should focus on the pedagogical use of educational technology.

3. Policy Inclusion: Educational policymakers, through bodies like the Nigerian Educational Research and Development Council (NERDC) and WAEC, should consider integrating gamification into national curriculum guidelines and official assessment frameworks.

4. Equitable Access to Digital Tools: Government and school administrators should ensure that rural and underserved schools are equipped with the necessary digital infrastructure to enable the successful implementation of gamified learning environments.

5. Further Research: More studies should be conducted across different subjects, regions, and school types to generalize the impact of gamification on learning outcomes, and to explore long-term retention, gender-based effects, and cost-effectiveness.

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