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Gamified Assessment as a Catalyst for Students' Engagement and Achievement in Mathematics among Junior Secondary School Students in Lagos State

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Abstract. In today's rapidly evolving educational landscape, the need for innovative, learner-centered instructional strategies has become increasingly essential for improving student participation and academic performance. As technology continues to reshape classroom practices, gamified assessment has emerged as a promising approach for fostering motivation and enhancing learning experiences. This study investigated the effectiveness of gamified assessment in improving student engagement and academic achievement in Mathematics among junior secondary school students in Lagos State. A quasi-experimental pre-test, post-test control group design was adopted, involving 120 students selected through a multi-stage sampling technique. The experimental group received Mathematics instruction enriched with gamification features such as points, badges, levels, leaderboards, and instant feedback, while the control group was taught the same content using traditional assessment strategies. Two hypotheses were tested at 0.05 level of significance to guide the study. Data were collected using a researcher-designed instrument titled "Gamified *Assessment as a Catalyst for Student Engagement Questionnaire "(GACSEQ)* and a *Mathematics Achievement Test (MAT)* with reliability coefficients of 0.79 and 0.82 respectively. Data were analyzed using descriptive and inferential statistics. Findings revealed a significant difference in the engagement levels and academic achievement between students exposed to gamified assessment and those assessed through conventional methods, with the experimental group performing notably better. The study concludes that gamified assessment is an effective pedagogical tool for promoting active learning and improving academic outcomes in mathematics. It recommends the integration of gamification elements into mathematics instruction, continuous professional development for teachers, and the adoption of innovative assessment practices to support deeper learning and enhance student performance.

Keywords: Academic Achievement, *Gamified assessment,* Mathematics, *Student engagement.*

1. Introduction

In recent years, the integration of game-based elements into teaching and assessment, known as gamified assessment has gained significant attention as an innovative approach to improving educational outcomes. Mathematics, a subject often perceived as abstract and challenging by many senior secondary school students, has consistently recorded varying levels of engagement and academic performance in Nigeria. As schools seek more effective ways to motivate learners, gamified assessment offers a promising strategy by transforming traditional evaluation methods into interactive, enjoyable, and goal-driven learning experiences. Engagement is important in teaching and learning activities. In terms of education, engagement is defined as the students' willingness to actively participate in the learning process, as well as demonstrating sustained involvement and positive emotional tone toward learning experiences (Miller et al., 2021). Students can learn better in a learning environment full of engagement. The development of technology brings a new concept for educators in carrying out the learning activity. The needs of a new learning pedagogy which can accommodate millennials becomes one of the challenges that teachers face (Becker, 2017). Due to the fact that younger learners are very dependent on technology, almost all aspects of their life cannot be separated from technologies. Young learners can get information easily, share or update their activity through social media, they also spend a lot of time playing games online.

Student engagement refers to the degree of attention, curiosity, interest, optimism, and ardour that college students exhibit when they are getting to know or being taught, which extends to the stage of motivation they have to study and growth in their education. There are numerous techniques that can amplify the engagement of the user. These include:

Gamification Techniques: These use game elements to motivate and sustain interest. Examples are points & scores, badges & rewards, levels and progress bars, leaderboards, challenges & quests, immediate feedback, unlockable content etc.

Interactive Techniques: These increase participation and active involvement. Examples are quizzes and polls, interactive videos, drag-and-drop tasks, simulations, virtual labs, scenario-based learning etc.

Personalized Learning Techniques: These tailor the experience to the learner. Examples are adaptive learning pathways, customized feedback, recommendation engines, learning analytics dashboards etc.

Social Engagement Techniques: These leverage communication and collaboration. Examples are discussion forums, peer review activities, group tasks and teamwork, social sharing, collaborative problem solving etc.

Motivational Techniques: These boost interest and persistence. Examples are goal setting, progress tracking, recognition and praise, incentives / rewards, streaks or daily engagement prompts etc.

Usability and Design Techniques: A good design that keeps users engaged. Examples are simple navigation appealing visuals, responsive layouts, clear instructions, minimal cognitive load etc.

Emotional Engagement Techniques: These connect with the user's feelings. Examples are storytelling and narratives, relatable characters or avatars, real-life examples, humor or surprise elements etc.

Cognitive Engagement Techniques: These stimulate deeper thinking. Examples are Problem-based learning, Inquiry-based tasks, Critical thinking activities, immediate application of knowledge

Behavioral Engagement Techniques: These encourage continuous action. Examples are timely reminders, notifications, practice schedules, habit formation techniques etc.

Technology-Enhanced Techniques: Using digital innovations. Examples are Augmented Reality (AR), Virtual Reality (VR), AI tutors, Chatbots, Smart feedback systems etc.

Among the above listed techniques, gamification assessment technique is what this study seeks to study. Gamification can facilitate motivation which brings about the engagement of users, resulting in higher overall performance and alternate of behavior. Consequently, elucidated that a strategy which can effortlessly amplify the engagements and applied in an exciting manner (such as games like elements) ought to be adopted in gaining knowledge of difficult subjects.

In the last decade, the use of technology to improve learning and education has been widely explored, as a means to improve instruction delivery. It potentiated the emergence of learning experiences, like blended learning and distance education. Prominent examples of these are flipped classrooms, where content is delivered online and students work in class to solve problems, supervised by an instructor, and Massive Open Online Courses, which deliver class materials and lectures as online resources, and students may discuss and get help in interactive forums. Most of these learning advances rely on distributed systems to make resources available remotely, without any further efforts to make the experience more engaging and rewarding for students. Education is also being shaped by the use of other techniques like gamification: adding game elements to non- game contexts. It is used to engage users to embrace specific behaviors, like working out or saving money. Gamification relies on the motivational power characteristic of good games which, unlike traditional learning materials, can deliver information on demand and within context balancing challenge difficulties according to one's abilities.

In recent years, education is increasingly becoming high tech. All the things that are happening in the world of technology are directly affecting education and learning systems. Technology enriched learning tools and spaces with mobile technology, Web 2.0 applications, social media, and all existing digital resources are providing powerful arenas for learning, both in formal and informal education settings (Multisilta, 2022). Gamification is one of the approaches employed in learning process and certainly keeps students engaged. Games increase motivation through engagement. This is so different to the past when teaching and learning methods focused on content or knowledge than learning experience. Students are not just passive learning anymore, but they have actively involved in learning process or called as "learning by doing" and obtain knowledge by themselves. Gamification is increasingly being utilized in higher education, with many educators and researchers exploring its potential and impact on learning outcomes. Many previous studies have demonstrated that learning motivation and efficiency can be enhanced through educational games (Liua, 2023; Chena 2023). Several digital tools created in learning bring exciting experiences to students such as

Kahoot, Quizizz, Quizlet, Gimkit, etc. Gamification is a growing trend in education due to its influence on student learning (Göksün & Gürsoy, 2019). Gamification is an educational approach to facilitating learning, encouraging motivation and engagement, improving learner participation and lesson interactivity, and stimulating learners such that it leads to an expansion of their knowledge (McGonigal, 2021). Its proper implementation can increase intrinsic motivation and engagement, and it is a powerful tool for teachers at all levels within the educational system.

Gamification strategies include the use of rewards for players who accomplish desired tasks or competition to engage players. Types of rewards include points, achievement badges or levels, the filling of a progress bar, or providing the user with virtual currency. Making the rewards for accomplishing tasks visible to other players or providing leaderboards are further ways of encouraging players to compete. Using games in education has a variety of benefits, and several game design mechanics demonstrated success in educational environments (Stott & Neustaedter, 2023). Games typically allow the player to restart or play again, making mistakes recoverable. This freedom to fail allows students to experiment without fear and increases student engagement and achievement (Lee & Hammer, 2021).

Gamified assessment offers several advantages and disadvantages, which can influence its effectiveness in enhancing student engagement, motivation, and learning outcomes. Here are some of the key advantages and disadvantages of gamified assessment:

1.1 Advantages of Gamified Assessment

Increased Engagement: Gamified assessment makes learning more enjoyable and interactive by incorporating game elements such as challenges, rewards, and competition. This increased engagement can lead to higher levels of participation and motivation among students.

Enhanced Motivation: By providing clear goals, immediate feedback, and tangible rewards, gamified assessment motivates students to actively participate in assessment activities and strive for improvement. Students are more likely to persist in their efforts and take ownership of their learning.

Personalized Learning: Gamified assessment can be tailored to students' individual needs, preferences, and learning styles, allowing for personalized learning experiences. Adaptive algorithms and branching pathways enable students to progress at their own pace and receive targeted support where needed.

Active Learning: Gamified assessment promotes active learning by requiring students to apply their knowledge and skills in authentic contexts, solve problems, and make decisions. This hands- on approach fosters deeper understanding and retention of learning content.

Immediate Feedback: Gamified assessment provides students with immediate feedback on their performance, allowing them to identify strengths and areas for improvement in real-time. This timely feedback enhances learning by guiding students' next steps and reinforcing desired behaviors.

Promotion of Collaboration: Gamified assessment activities encourage collaboration and teamwork among students, fostering social interaction, communication skills, and peer learning. Collaborative tasks can promote a sense of community and support among students.

1.2 Disadvantages of Gamified Assessment

Overemphasis on Rewards: In some cases, gamified assessment may lead to an overemphasis on extrinsic rewards, such as points, badges, and leaderboards, rather than intrinsic motivation andgenuine interest in learning. Students may become focused on earning rewards rather than on mastering content.

Potential for Distraction: The immersive and interactive nature of gamified assessment activities may also pose a risk of distraction, particularly if students become overly engaged withgame elements at the expense of learning objectives. Educators must strike a balance between engagement and academic rigor.

Unequal Access: Gamified assessment often relies on technology and digital resources, which may not be equally accessible to all students due to factors such as socioeconomic status, access todevices, and internet connectivity. This can exacerbate existing disparities in education.

Complex Implementation: Designing and implementing gamified assessment activities can be time-consuming and resource-intensive for educators. It requires careful planning, technical expertise, and ongoing support to create meaningful and effective learning experiences.

Resistance to Change: Some students and educators may be resistant to gamified assessmentapproaches, particularly if they are accustomed to traditional assessment methods. Overcoming resistance to change and ensuring buy-in from stakeholders may pose challenges during implementation.

Validity and Reliability Concerns: There may be questions about the validity and reliability ofgamified assessment methods, particularly if game elements are not directly aligned with learning objectives or if assessment data are not accurately reflective of students' knowledge and skills.

A meaningful gamification will only succeed if it puts the needs of the users first over the needs of an organization. When this occurs, users will have a positive experience which results in a longer-term and deeper engagement among participants, non-game tasks, and organizations. Focusing only on the game mechanisms will create a false scenario in achieving a goal. The positivity of the game-based experience lies in the fun of play and not the points itself. When considering whether gamification can benefit a group of students, it is crucial to identify their levels of motivation and whether introducing a reward system in an optimized environment is feasible as the rewards elements have a potential to disrupt their flow and resulting in dependency on the rewards, and demotivation if the reward system is taken abolished. When planning a learning activity, gamification should be done and planned at the same stage because gamification cannot do much with low quality or poorly planned material and activities.

Mathematics is a foundational subject in Nigeria's education system and a compulsory requirement for students at the secondary school level. However, despite its importance, persistent low performance in mathematics has continued to be a major concern. Reports from internal school assessments and national examinations have shown that many senior secondary school students demonstrate low interest, anxiety, and poor achievement in mathematics. These challenges are often linked to the subject's abstract nature, fear of failure, and the predominance of conventional assessment methods that provide limited motivation. In recent years, global educational trends have shifted toward learner-centered and technology-enhanced pedagogies. One of the emerging innovations is gamification, which involves applying game mechanics in non-game contexts to improve learner motivation and participation. Gamified assessment transforms routine testing into interactive, enjoyable, and rewarding learning experiences. It encourages active participation by providing immediate feedback, promoting healthy competition, and allowing students to progress at their own pace.

In Lagos State, with its diverse student population and increasing adoption of digital and interactive learning tools, the need for engaging and effective assessment methods is more evident than ever. Gamified assessment presents a practical solution to improve students' attitudes toward mathematics while enhancing their performance. By integrating game elements into the assessment process, students may become more willing to attempt challenging tasks, collaborate with peers, and persist in solving mathematical problems. This study is therefore situated within the ongoing efforts to improve mathematics education in Nigeria. It seeks to investigate how gamified assessment influences student engagement and academic achievement among senior secondary school students in Lagos State, and whether this innovative approach can address long-standing challenges associated with mathematics learning.

1.3 Statement of the Problem

Despite the central importance of Mathematics in the Nigerian curriculum, students' performance in the subject at the senior secondary level has continued to be unsatisfactory. Reports from both internal school assessments and external examinations such as WAEC and NECO consistently reveal low pass rates in Mathematics. Many students perceive the subject as difficult, abstract, and intimidating, leading to low motivation, poor engagement, and high levels of Mathematics anxiety. Traditional assessment methods often dominated by paper-and-pencil tests provide limited opportunities for interaction, immediate feedback, or incentives that motivate students to participate actively. These conventional practices may contribute to students' lack of interest and low confidence in solving mathematical problems. With the introduction of technology-based and student-centered instructional approaches globally, gamified assessment is emerging as a promising strategy that can improve students' engagement and ultimately enhance learning outcomes.

However, like any educational intervention, it comes with its own set of challenges and root causes that need to be addressed for effective implementation. Some of the root causes are: *Limited Access to Technology* is one of the primary challenges hindering the effective use of gamified assessments in Nigeria. Many schools, especially in rural areas, lack the necessary infrastructure such as computers, tablets, and reliable internet connection needed to implement gamified assessments. This digital divide exacerbates educational inequalities, as students in urban areas with better access to technology are more likely to benefit from gamified assessments compared to their counterparts in rural areas. Without these resources, implementing gamified assessment platforms or software can be difficult. While technology is becoming more prevalent in Nigerian schools, there is still a significant digital divide. Many students do not have access to personal computers or smartphones, making it challenging to implement gamified assessment that requires individual devices. Without these resources, implementing gamified assessment

platforms or software can be difficult. While technology is becoming more prevalent in Nigerian schools, there is still a significant digital divide. Many students do not have access to personal computers or smartphones, making it challenging to implement gamified assessment that requires individual devices.

Secondly, is *the Lack of awareness and training among educators* on how to effectively integrate gamified assessments into the curriculum? Many teachers in Nigeria may not be familiar with gamification concepts or lack the technical skills needed to implement them in the classroom. Without proper training and support, educators may struggle to design engaging gamified assessments that align with learning objectives and promote student engagement. Teachers may require training and support to effectively implement gamified assessment methods. They need to understand how to integrate gamified elements into their teaching and how to evaluate student performance using these methods. Without proper training, teachers may struggle to utilize gamified assessment effectively. Another significant issue is the *socioeconomic factors* such as poverty and inequality play a significant role in shaping students' access to education in Nigeria. Many students come from low-income families that cannot afford devices or internet connectivity needed for gamified assessments. Without addressing these socioeconomic disparities, the benefits of gamified assessments may only reach a privileged few, further widening the education gap.

Gamified assessments, like traditional assessments, are susceptible to bias and unfairness. Without careful consideration of cultural biases and socio-economic disparities, gamified assessments may inadvertently disadvantage certain groups of students. For example, a gamified assessment that relies heavily on English language proficiency may put students from non-English speaking backgrounds at a disadvantage. While technology can enhance learning experiences, there is a risk of overemphasis on technology in education. Gamified assessments should complement traditional teaching methods rather than replace them entirely. Overreliance on technology can lead to neglect of other important aspects of education such as critical thinking, creativity, and social interaction. Despite the growing popularity of gamified assessments, there is still a lack of robust evidence-based research on their effectiveness in the Nigerian context. Without empirical evidence to support their efficacy, educators and policymakers may be hesitant to invest resources in implementing gamified assessments on a large scale.

Lastly, integrating gamified assessment into the existing curriculum can be a challenge. Nigerian schools typically follow a standardized curriculum, and incorporating gamified elements may require adjustments to align with educational goals and learning outcomes. Implementing gamified assessment can be costly, especially for schools with limited budgets. The expenses associated with purchasing and maintaining technology, software licenses, and training teachers can be a significant barrier to adoption. However, empirical evidence on the effectiveness of gamified assessment in improving engagement and academic achievement, particularly among senior secondary school students in Lagos State, remains limited. This creates a gap in knowledge regarding whether gamified assessment can truly serve as a catalyst for improving Mathematics learning outcomes. This study seeks to address this gap.

1.4 Purpose of the Study

The main purpose of this study is to investigate the effect of gamified assessment on student engagement and academic achievement in Mathematics among senior secondary school students in Lagos State.

Specifically, the study intends to:

- Compare the engagement levels of students exposed to gamified assessment with those assessed using traditional methods.
- Assess the difference in academic achievement between students exposed to gamified assessment and those assessed using conventional assessment techniques.

1.5 Research Hypotheses

The following null hypotheses was tested:

- There is no significant difference in the engagement levels of students exposed to gamified assessment and those assessed using traditional assessment methods.
- There is no significant difference in the academic achievement between students exposed to gamified assessment and those assessed using conventional assessment techniques.

2. Research Design

This study employed a quasi-experimental with pre-test and post-test non-equivalent control group design. A quasi-experimental design is a type of experimental research in which participants are not randomly

assigned to groups but are instead placed into pre-existing groups (such as intact classes), while still allowing for the manipulation of an independent variable and comparison with a control group (Creswell & Creswell, 2018). This design is appropriate because it allows comparison between students exposed to gamified assessment (experimental group) and those taught and assessed using traditional methods (control group).

2.1 Population

The population for this study consists of all Junior Secondary School two **students** and their Mathematics teachers in public senior secondary **schools** in Education District III of Lagos State. Lagos State is chosen due to its large, diverse student population and increasing adoption of technology in classrooms. Education District III of Lagos State covers four zones namely; Epe, Eti-Osa, Ibeju-Lekki, and Lagos Island

2.2 Sample and Sampling Techniques

The study employed a multi-stage sampling technique, selecting a total of 120 students (60 for the experimental group and 60 for the control group). In the first stage, two zones were randomly chosen from the four zones comprising Education District III: Epe, Eti-Osa, Ibeju-Lekki, and Lagos Island. In the second stage, a purposive sampling method was used to select schools that integrate technology and were willing to participate in the gamified assessment. Within each selected school, simple random sampling was applied to assign students to the experimental and control groups, minimizing selection bias.One school was designated as the experimental group, where students received Mathematics instruction combined with a gamified assessment strategy. The other school served as the control group, where students were taught the same Mathematics topics but assessed using traditional teacher-led methods. To establish baseline performance, both groups were administered a Mathematics Achievement Test (MAT) as a pre-test. After a four-week intervention, the same instrument (or an equivalent parallel form) was administered as a post-test to measure changes in students' Mathematics performance.

2.3 Research Instrument

Two instruments were used in collecting data for this study. The first is a self-constructed questionnaire title: Gamified Assessment as a Catalyst for Student Engagement Questionnaire (GACSEQ). The questionnaire was made up of two sections A and B; section A contains data pertaining to useful demographic variables such as: gender, age, and class while section B deals with a total of thirty research questions. The questionnaire was closed ended type which allows for Strongly Agree (SA), Agree (A), Strongly Disagree (SD) or Disagree (D) responses from respondents.

While the second instrument was a Mathematics Achievement Test (MAT) was used to test the academic performance of the students. Twenty (20) Mathematics questions was set from past questions paper of Junior Secondary School Basic Education Certificate Examination (BECE) of Y (2019-2023)

2.4 Validity and Reliability of Research Instrument

The draft version of the instrument was submitted to three experts in the field of Measurement and Evaluation to assess whether the items were appropriately structured to measure the variables of interest in the study. This process helped to establish the face, expert, and content validity of the research instrument. Based on the experts' feedback, the items were reviewed, modified, and deemed suitable for the study. All corrections and constructive criticisms provided were carefully considered and incorporated into the final version of the instrument.

A pilot study was conducted on twenty students, from Lagos Mainland Local Government Area which was not included in the main study. Cronbach's Alpha reliability analysis was employed (with the aid of Statistical Package for Social Sciences-SPSS 25) the "r" calculated showed positive coefficient of 0.79 ((GACSEAM) and 0.82 for the Mathematics Achievement Test (MAT).

2.5 Experimental Stages of the Study

The experimental procedure was structured into several stages to systematically assess the impact of gamified assessment on student engagement and academic achievement in Mathematics. The stages of treatment were discussed below:

1. **Pre-Experimental Stage (Preparation and Baseline Assessment)**: The researcher Conducted a pre-assessment to establish a baseline of student knowledge and skills for both groups.

Selection of Participants: Using multi-stage sampling, schools and students were selected and assigned to experimental and control groups.

Orientation: Students in the experimental group were introduced to the gamified assessment platform, including instructions on how to earn points, badges, and track progress.

Pre-Test Administration: Both experimental and control groups were administered the **Mathematics Achievement Test (MAT)** to establish baseline academic performance.
Engagement Baseline: The (GACSEQ**) Questionnaire** was administered to measure initial levels of behavioral, emotional, and cognitive engagement in Mathematics lessons.
2. Treatment Period: **Intervention Stage (Implementation of Gamified Assessment)**

Administer the gamified assessments to the experimental group over a defined period (e.g.four weeks).
Administer the traditional assessments to the control group over the same period.
Experimental Group: Gamified Assessment
For the experimental group, gamified assessments was used to measure student engagement and learning outcomes. Gamified assessments integrate game design elements such as points, badges, leaderboards, and challenges into the assessment process. These assessments aim to make learning more engaging and interactive, thereby potentially increasing student motivation and performance.
Types of Gamified Assessments Administered in Mathematics:
Students received **Mathematics instruction integrated with gamified assessment elements**.
Game elements included **points for correct answers, levels to track progress, badges for completing tasks, challenges, and instant feedback** on quizzes and exercises.
Lessons were designed to encourage **active participation, collaboration, problem-solving, and competition** within a supportive learning environment
Quizzes with Leaderboards: Students complete quizzes and see their rankings on a leaderboard, encouraging a competitive spirit.
Badges and Rewards: Students earn badges and rewards for completing tasks or reaching certain milestones.
Control Group: Traditional Assessment
The control group was assessed using traditional assessment methods. These methods are commonly used in educational settings and are designed to provide a benchmark against which the effectiveness of gamified assessments can be measured. Traditional assessments used was typically more formal and structured, and focuses on evaluating students' understanding through conventional means. Students received the **same Mathematics topics** using traditional teaching methods. Assessment was conducted solely through conventional **teacher-led exercises, quizzes, and tests** without gamified elements.
Types of Mathematics Traditional Assessments Administered:
Written Exams: Achievement tests that include multiple-choice questions.
Homework Assignments: Regular assignments given to students to reinforce classroom learning.
In-Class Quizzes: Short, periodic quizzes administered in class to monitor progress.
Oral Presentations: Students present on a topic to demonstrate their understanding and communication skills.
Project-Based Assessments: Comprehensive projects that require students to apply what they have learned to complete a task or solve a problem.
Duration: The intervention lasted **four weeks**, with regular gamified assessment activities conducted throughout the instructional period.
3. **Post-Experimental Stage (Post-Assessment and Measurement of Effects**): Conducted a post-assessment for both groups to measure any changes in student engagement and learning outcomes.
Post-Test Administration: Both experimental and control groups were re-administered the **MAT** (or an equivalent parallel form) to measure improvements in Mathematics achievement.
Post-Engagement Measurement: The GACSEQ was re-administered to assess changes in student engagement (behavioral, emotional, and cognitive) following the intervention.
4 .**Data Analysis and Comparison Stage**:
Collect data from both pre- and post-assessments.
Analyze the data to compare the performance and engagement levels of students in the experimental and control groups.
Scoring Gamified Assessments
Gamified assessments in the experimental group was scored using a combination of automated and manual methods, depending on the type of assessment employed.
Quizzes with Leaderboards:
- Automated scoring based on the number of correct answers.
- Additional points for speed and accuracy, if applicable.
- Leaderboard rankings reflect overall performance.

Badges and Rewards:
- Points awarded for each badge or reward earned.
- Cumulative score based on the total number of badges and rewards.

Scoring Traditional Assessments
Traditional assessments in the control group will be scored using conventional methods to ensure reliability and validity.

Written Exams:
- Scored based on a predetermined answer key or rubric.
- Points allocated for each correct response.
- Partial credit given for partially correct answers, where applicable.

Oral Presentations:
- Scored using a rubric that evaluates content, organization, delivery, and visual aids.
- Points awarded for clarity, engagement, and depth of understanding.

Project-Based Assessments:
- Scored using a detailed rubric that considers multiple aspects of the project, such as research quality, creativity, and presentation.
- Peer evaluations may be incorporated to provide additional perspectives.

Within-Group Analysis: The pre-test and post-test scores of each group were compared to determine **changes in performance and engagement over time**.

Between-Group Analysis: The post-test scores and engagement levels of the experimental group were compared with those of the control group to determine the **effectiveness of gamified assessment**.

Statistical Tests: Techniques such as **t-tests** (paired and independent) and **ANCOVA** were used to evaluate the significance of differences in achievement and engagement.

5. Interpretation Stage

Data were interpreted to assess how gamified assessment influenced:

Behavioral Engagement: Active participation in Mathematics tasks and assessments.

Emotional Engagement: Interest, enjoyment, and positive attitudes toward Mathematics.

Cognitive Engagement: Persistence, attention, and problem-solving effectiveness.

Academic Achievement: Improvements in test scores and mastery of mathematical concepts.

3. Results

Table 1: Respondents Demographic Profile

Item	Value	Frequency	Percent
Group	Gamified Assessment (GA)	60	50.0
	Non Gamified Assessment (NGA)	60	50.0
Gender	Male	60	50.0
	Female	60	50.0
Age	11 – 13	120	100.0

Table 2: Mean and Std. Deviation of Pretest and Posttest score among two group.

Group	N	Pretest Mean	Pretest Std. Deviation	Posttest Mean	Posttest Std. Deviation
GA	60	4.67	2.69	14.02	2.96
NGA	60	4.73	2.57	11.45	2.94

Hypotheses Testing

Hypothesis 1: There is no significant difference in the engagement levels of students exposed to gamified assessment and those assessed using traditional assessment methods.

Table 3: Engagement Levels of Students Exposed Gamified Assessmentto (GA) and Non- Gamified Assessment (NGA) group.

Group	N	Mean	Std. Deviation
GA	60	4.41	0.38
NGA	60	2.66	0.28

Based on Table 3, the GA group had a higher mean engagement score than the NGA group (mean score for GA: 4.41; Mean score for NGA: 2.66). The ANOVA analysis results showed a significant difference in terms of students' engagement between the GA group and the NGA group ($F = 546.803$; $p: 0.00$), with the former significantly scored higher than the latter group. This finding indicates that Hypothesis 1 also was also accepted

Table 4: ANOVA Analysis of Mean Engagement with Gamified Assessment (GA) and Non- Gamified Assessment (NGA) Groups.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Result
Corrected Model	61.000[a]	1	61.000	546.803	.000	Significant
Intercept	1003.135	1	1003.135	8992.042	.000	
Group	61.000	1	61.000	546.803	.000	
Error	8.702	118	.112			
Total	1072.837	120				
Corrected Total	69.702	119				

R Squared = .875 (Adjusted R Squared = .874)

Hypothesis 2: There is no significant difference in the academic achievement of students exposed to gamified assessment and those assessed using conventional assessment techniques.

Table 5: Covariate: Academic Achievement

Group	**N**	**Mean**	**Std. Deviation**	**Sig.**	**Result**
GA	60	4.38	0.42	0.000	Significant
NGA	60	2.91	0.26		

Table 6: ANOVA Analysis for Academic Achievement of Students Exposed to Gamified Assessment and Those Assessed Using Conventional Assessment Techniques.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Result
Between Groups	45.690	1	45.690	605.451	.000	Significant
Within Groups	5.886	118	0.075			
Total	51.576	119				

This section provides a more detailed discussion of each component and examines the significant differences between the GA and NGA groups. The ANOVA analysis results indicate that there are significant differences in how achievement in Mathematics influences the relationship between gamified assessment and non-gamified assessment.

4. Summary of Findings

- There is a significant difference in the engagement levels of students exposed to gamified assessment and those assessed using traditional assessment methods.
- There is a significant difference in the academic achievement of students exposed to gamified assessment and those assessed using conventional assessment techniques.

5. Discussion of Findings

Findings from hypotheses one revealed that **students exposed to gamified assessment demonstrated significantly higher levels of engagement** compared to those assessed using traditional methods. This finding shows that integrating game elements such as points, badges, immediate feedback, leaderboards, and challenges can transform the learning environment into a more interactive and motivating space. Students in the experimental group displayed increased **behavioral engagement** (active participation, task completion), **emotional engagement** (interest, enjoyment, reduced anxiety), and **cognitive engagement** (problem-solving effort, persistence). In contrast, students in the traditional assessment group exhibited lower enthusiasm, slower participation, and less motivation to complete mathematical tasks. Several factors explain this significant difference:

Gamification introduces fun and competition, which captures students' attention and sustains their involvement throughout lessons.
Instant feedback enabled students to track their progress, correct errors quickly, and take responsibility for their learning.
Reward systems (badges, points, levels) reinforced productive learning behaviors, making students more willing to attempt challenges.
Goal-oriented tasks in the gamified environment kept students focused and encouraged persistence even when solving difficult mathematical problems.

These mechanisms collectively heightened student engagement far more than traditional teacher-led

assessments, which often rely on delayed feedback and limited interactive elements. Deterding et al. (2021) assert that game elements enhance intrinsic and extrinsic motivation, leading learners to participate more actively. Similarly, Hamari et al. (2024) found that gamified learning environments significantly improve students' motivation and task involvement, supporting the current study's findings.Also,Kapp (2022) emphasizes that immediate feedback, challenges, and rewards foster a sense of achievement, causing students to stay engaged longer. This mirrors the heightened engagement levels observed among students exposed to gamified assessment in this study. According to Lee & Hammer (2021), gamified learning environments reduce fear of failure and create a safe space for experimentation. This explains why students in the experimental group showed greater emotional engagement and confidence during mathematics tasks.The finding that gamified assessment significantly enhances student engagement is consistent with a wide body **o**f literature. Gamified methods strengthen motivation, participation, emotional connection, and cognitive effort more effectively than traditional assessment. Thus, gamification serves as a powerful pedagogical tool for increasing student engagement in Mathematics among senior secondary school students.

Findings from hypotheses two revealed that there is a significant difference in the academic achievement of students exposed to gamified assessment compared to those assessed using conventional methods. Students in the gamified group performed better on the post-test, demonstrating higher mastery of mathematical concepts, improved problem-solving ability, and greater retention of skills. Several factors contributed to this improvement:

- Enhanced Motivation Leads to Higher Achievement
- Gamified Assessment Strengthens Continuous Learning
- Increased Cognitive Engagement Improves Mastery

Students engaged more deeply in mathematical reasoning. The interactive nature of gamified activities reduced fear of failure and encouraged students to attempt complex problems multiple times, resulting in higher achievement scores.Hamari, Koivisto, & Sarsa (2024) showed that gamification positively affects learning performance when reward systems and challenges encourage consistent participation. This supports the current study's finding that gamified assessment improves Mathematics achievement.Similarly, Barata et al. (2023) reported significant gains in student grades and learning outcomes when gamified assessment was introduced in academic environments. Kapp (2022) argues that immediate, corrective feedback inherent in gamified platforms enables learners to quickly identify mistakes, revise understanding, and improve achievement. This contrasts with traditional assessments, where feedback is delayed and less impactful.Shute (2018) also supports that feedback-rich learning environments strengthen academic performance.Su & Cheng (2015) found that gamification enhances critical thinking and problem-solving skills by allowing students to tackle tasks repetitively in a non-threatening environment. This deeper processing leads to measurable improvements in achievement. This finding parallels the improved mathematics performance of students in the experimental group.

6. Conclusions

The study provides strong evidence that gamified assessment improves both engagement and achievement. Therefore, Measurement and Evaluation practices should evolve to incorporate technology-driven, continuous, and student-centered assessment approaches that promote deeper learning and more accurate measurement of student abilities. Thus, gamified assessment is not only effective for boosting engagement but also a powerful catalyst for improving students' academic achievement in Mathematics.

7. Recommendations

Integrate Gamified Assessments into Curricula: Educational institutions should incorporate gamified assessment strategies into their curricula to boost student engagement and academic performance. Designing interactive and immersive assessments tailored to various subjects can enhance the learning experience. By integrating gamification effectively, educators can create a more engaging educational environment that motivates students and improves their overall academic outcomes.

Focus on Motivation and Continuous Support: Maintaining and enhancing student motivation is essential for maximizing the benefits of gamified assessments. Educators should embed motivational elements within gamified assessments and provide ongoing encouragement and support. This approach ensures that students remain engaged and motivated throughout their learning journey, leading to better educational outcomes.

Customize Gamified Techniques for Diverse Needs: To effectively meet the diverse needs and

preferences of students, gamified techniques should be tailored accordingly. Customizing assessments ensures that they are engaging and effective for all students, accommodating different learning styles and interests. Educators should consider individual student needs when designing gamified assessments to enhance their effectiveness and inclusivity.

Invest in Professional Development for Educators: Professional development programs are crucial for equipping educators with the skills and knowledge required to design and implement effective gamified assessments. Training on gamification in education will enable educators to leverage these strategies effectively, maximizing their potential to enhance student engagement and performance. Institutions should invest in such programs to support educators in their implementation efforts.

Address Socio-Economic Disparities and Support Technological Integration: Policymakers should work to address socio-economic disparities to ensure equitable access to gamified learning tools for all students. This includes providing resources and support to students from lower socio-economic backgrounds. Additionally, leveraging technology to facilitate the implementation of gamified assessment strategies is vital. Policymakers should support the development of technological tools and platforms that enable effective gamified learning and encourage research and innovation in this field.

8. Implications of the Study for Evaluators

The findings of this study have significant implications for **Evaluators**, particularly in the context of secondary school Mathematics assessment.

Shift from Traditional Assessment to Technology-Supported Assessment

The study demonstrates that gamified assessment enhances student engagement and achievement more effectively than conventional methods. This suggests a need for Measurement and Evaluation practices to **move beyond paper–pencil tests** toward **technology-supported, interactive, and feedback-rich assessments**.

Importance of Continuous and Formative Assessment

Gamified assessment provides immediate feedback, enables repeated attempts, and tracks progress continuously. This aligns strongly with best practices in Measurement and Evaluation, which emphasize the importance of ongoing formative assessment for improving learning outcomes.The study shows that when students are assessed continuously through gamified platforms, their mastery and performance improve significantly.

Enhancement of Authentic Assessment

Gamified assessments simulate real problem-solving scenarios and allow students to apply skills in engaging contexts. This supports the Measurement and Evaluation goal of promoting **authentic assessment**, where students demonstrate understanding in meaningful, real-life ways rather than through rote memorization.

Improved Diagnostic Capabilities

The instant feedback and analytics from gamified platforms enable teachers to quickly diagnose:

- learning gaps,
- misconceptions,
- strengths, and
- individual progress patterns.

This enhances Measurement and Evaluation practices by providing more accurate and timely diagnostic data compared to traditional assessments.

Promotion of Self-Regulated Learning

Gamified assessment allows students to monitor their progress, track points, and view their achievement badges. This contributes to **self-assessment and self-regulated learning**, a key component of effective Measurement and Evaluation. Students gain awareness of their learning growth, which strengthens responsibility and autonomy.

Reduction in Test Anxiety and Improved Test-Taking Behaviors

The study shows that gamification reduces anxiety and increases motivation. Lower test anxiety leads to more valid assessment outcomes because scores better reflect **true ability** rather than stress. Thus, Measurement and Evaluation practices should incorporate methods that reduce anxiety and enhance student confidence.

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