OpenMind Journal of Multidisciplinary Innovation & Development
Vol. 2, Issue – 6, (Nov-Dec) 2026
ISSN: 3108-2920 (Online)

Research Article

Gamified Formative Assessment and Student Engagement: Measuring Cognitive and Affective Outcomes in STEM Classrooms. An Experimental Study in Imo State, South-East Nigeria

Joy Onyeka Nkeiruka*[1], Nathaniel TimAhanna Ukwuoma, PhD[2] & Celestine Kelvins Ihekwoaba, PhD[3]

[1, 2 & 3] Department of Educational Psychology/Guidance and Counselling, Faculty of Education, Alvan Ikoku Federal University of Education, Owerri, Imo State, Nigeria

***Related declarations are provided in the final section of this article*

ARTICLE INFORMATION

Received: 16 Oct 2026

Accepted: 11 Nov 2026

Published: 19 Nov 2026

Correspondence Author:

Joy Onyeka Nkeiruka*

Copyright © 2026 The Author(s). The Authors retain copyright. Licensed under the **Creative Commons Attribution 4.0 International License** (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract

Gamified formative assessment, which adds game elements such as points, badges and leaderboards to low-stakes quizzes, is widely promoted as a way of increasing engagement, yet controlled evidence from sub-Saharan African STEM classrooms is scarce. This study tested the effect of gamified formative assessment on cognitive and affective outcomes among Senior Secondary 2 students in Imo State, South-East Nigeria. A pretest–posttest, delayed-posttest quasi-experimental design with a control group was used. Twelve intact Mathematics and Physics classes from 12 schools were randomly assigned to gamified assessment on digital quiz platforms (n = 158) or to non-gamified paper quizzes with the same items and feedback (n = 154) for eight weeks. After controlling for pretest scores, the gamified group outperformed the control group on the posttest, $F(1, 309) = 124.13$, $p < .001$, $\eta^2p = .29$, $g = 1.26$, and on a delayed retention test four weeks later, $F(1, 309) = 59.80$, $p < .001$, $g = 0.88$. The gamified group also reported higher behavioural, emotional and cognitive engagement (g = 0.84 to 1.15) and intrinsic motivation (g = 0.84), and slightly lower test anxiety ($g = -0.23$). Gender did not moderate the effect. The findings suggest that gamified formative assessment can improve both achievement and engagement in resource-constrained STEM classrooms, although novelty effects and the short duration warrant caution.

Keywords: Gamification; Formative Assessment; Student Engagement; Motivation; STEM Education; Nigeria

INTRODUCTION

Student engagement is widely regarded as a precondition for learning in science, technology, engineering and mathematics (STEM), yet many learners find STEM subjects abstract and anxiety-provoking. Gamification, defined as the use of game design elements in non-game contexts, has become a popular strategy for addressing this problem (Manzano-León et al., 2021; Nadi-Ravandi & Batooli, 2022). Meta-analyses report small to moderate positive effects on cognitive, motivational and behavioural outcomes (Bai et al., 2020; Huang et al., 2020; Li et al., 2023; Sailer & Homner, 2020), and reviews of digital quiz platforms such as Kahoot! are generally favourable (Wang & Tahir, 2020; Zhang & Yu, 2021).

Gamified quizzing also fits naturally with formative assessment, in which evidence of learning is gathered frequently and used to guide teaching and learning (Brown, 2022; Schildkamp et al., 2020). Frequent low-stakes quizzes with immediate feedback can support learning, while game mechanics may sustain attention and effort (Sanchez et al., 2020; Yu et al., 2021). Evidence in science and mathematics education is encouraging but uneven (Hui & Mahmud, 2023; Kalogiannakis et al., 2021).

However, most evidence comes from higher education and high-income settings, and effects vary with design, duration and context (Bai et al., 2021; Zainuddin et al., 2020). In Nigeria, technology integration in schools depends on teacher readiness and device access (Ayanwale et al., 2022), and research on educational games in African contexts is still emerging (Oyelere et al., 2020). In Imo State, in the South-East geopolitical zone, STEM teaching is largely examination-driven, so evidence on whether gamified formative assessment improves both learning and engagement is needed. Recent Nigerian studies have examined gamification and feedback in English tutoring apps for pre-service teachers (Nwankwo et al., 2026), the design of technology-enhanced learning environments for learner engagement and collaboration in North-central Nigeria (Asemota, Edinoh, & Ejike, 2026) and the role of technological pedagogical content knowledge in preparing teachers for digital classrooms (Asemota, Edinoh, & Kyaune, 2026), but little of this work tests gamified formative assessment in STEM classrooms.

This study addresses that gap through an experiment with four objectives: (a) to test the effect of gamified formative assessment on achievement; (b) to test its effect on retention; (c) to test its effect on behavioural, emotional and cognitive engagement, intrinsic motivation and test anxiety; and (d) to examine whether gender moderates the effect.

LITERATURE REVIEW AND HYPOTHESES

Gamified Formative Assessment

Gamified formative assessment combines frequent low-stakes testing with feedback and game elements such as points, badges, levels, avatars and leaderboards. Its theoretical rationale rests on self-determination theory, which holds that learning environments satisfying needs for competence, autonomy and relatedness foster intrinsic motivation and engagement (Ryan & Deci, 2020). Immediate feedback and visible progress can support competence, while choice and play can support autonomy. Feedback itself is one of the strongest influences on learning when

learners use it (Wisniewski et al., 2020), and peer and self-assessment elements further support learning (Double et al., 2020; Yan, 2020).

Engagement, Emotion and Cognitive Load

Engagement is multidimensional, comprising behavioural, emotional and cognitive components, and recent work adds agentic engagement, in which students actively shape their learning (Reeve et al., 2020; Wong & Liem, 2022). Positive activity-related emotions are associated with higher achievement (Camacho-Morles et al., 2021), which suggests that enjoyable assessment may support learning. Conversely, game elements can add extraneous load if poorly designed, so effectiveness depends on design (Sweller, 2020). Gamification has also been reported to increase motivation and engagement in STEM subjects such as chemistry and in flipped learning environments (Chans & Portuguez Castro, 2021; Ekici, 2021). Competitive elements, such as leaderboards, may affect learners differently depending on their position (Bai et al., 2021).

Nigerian studies provide local context for feedback-rich, technology-supported assessment. Work on formative assessment in junior secondary schools has examined teacher feedback methods in relation to students' self-efficacy (Ferguson et al., 2026), and research on assessment and feedback has been examined under digital conditions (Edinoh et al., 2026). Studies of gamification and feedback in English tutoring apps (Nwankwo et al., 2026) and of technology-enhanced learning environments designed for engagement, collaboration and critical thinking (Asemota, Edinoh, & Ejike, 2026) extend this interest to digital tools, while research on teachers' technological pedagogical content knowledge addresses readiness to use them (Asemota, Edinoh, & Kyaune, 2026). These studies point to growing local interest in digitally supported learning, but they do not test gamified formative assessment against cognitive and affective outcomes in STEM classrooms, which this study does.

Hypotheses

H1: Students taught with gamified formative assessment achieve higher posttest scores than control students, controlling for pretest scores.

H2: The gamified group achieves higher scores on a delayed retention test, controlling for pretest scores.

H3: The gamified group reports higher behavioural, emotional and cognitive engagement.

H4: The gamified group reports higher intrinsic motivation.

H5: The gamified group reports lower test anxiety.

RQ: Does gender moderate the effect of gamified formative assessment on achievement?

METHODOLOGY

Research Design

A pretest–posttest, delayed-posttest quasi-experimental design with a control group was used. Intact classes were the unit of assignment because students could not be reassigned between classes; classes were randomly allocated to conditions.

Participants and Sampling

Participants were Senior Secondary 2 students in Imo State, South-East Nigeria. Twelve intact classes (six Mathematics and six Physics) from 12 public and private schools, four from each senatorial zone (Owerri, Okigwe and Orlu), were randomly assigned to the gamified condition (six classes, $n = 158$) or the control condition (six classes, $n = 154$), with the zones and subjects balanced across conditions. Table 1 gives the sample profile, and Table 2 confirms baseline equivalence.

Table 1

Profile of Participants by Condition ($N = 312$)

Characteristic	Gamified ($n = 158$)	Control ($n = 154$)	Total ($N = 312$)
Female, *n* (%)	92 (58.2)	78 (50.6)	170 (54.5)
Male, *n* (%)	66 (41.8)	76 (49.4)	142 (45.5)
Classes	6	6	12
Subjects	3 Mathematics, 3 Physics	3 Mathematics, 3 Physics	6 Mathematics, 6 Physics

Table 2

Baseline Equivalence of the Groups

Measure	Gamified *M* (*SD*)	Control *M* (*SD*)	Test
Pretest achievement (0–40)	18.04 (5.50)	18.87 (5.60)	$t(309) = -1.31$, $p = .191$
Baseline engagement (1–5)	3.28 (0.28)	3.28 (0.32)	No difference

Intervention

For eight weeks, both groups completed three formative quizzes per week on the same curriculum topics with identical items and feedback. The gamified group answered on digital quiz platforms (Kahoot! and Quizizz) using a teacher's projector and students' shared phones in small teams, with points, badges, avatars and team leaderboards. The control group answered the same items on paper, with feedback given orally and on marked scripts. Teachers in both groups received the same item bank and a one-day orientation.

Instruments and Measures

Cognitive outcomes were measured with a 40-item multiple-choice achievement test covering the unit content, taken as a pretest, a posttest and a four-week delayed posttest (parallel forms). Affective outcomes were measured by five-point Likert scales: engagement (behavioural,

emotional and cognitive subscales, following the multidimensional view of engagement in Wong & Liem, 2022), intrinsic motivation (Ryan & Deci, 2020) and test anxiety. Experts reviewed content validity, and a pilot test preceded the study; all scales exceeded .70 reliability.

Data Analysis and Ethics

Achievement and motivation outcomes were analysed with analysis of covariance (ANCOVA) controlling for the pretest (achievement) or baseline engagement (affective outcomes), reporting partial eta-squared (η^2p) and Hedges's g (Cohen, 1988). Engagement subscales were compared with Welch's t tests, and p values for the five affective outcomes were adjusted with the Holm method. Gender moderation was tested through a condition × gender interaction. School authorities approved the study, guardians consented, students assented, participation was voluntary and results were reported anonymously.

RESULTS

Cognitive Outcomes

Table 3 and Figure 1 show that both groups improved, but the gamified group improved more and sustained more of its gain. On the posttest, the gamified group scored 26.24 (SD = 5.24) against 21.88 (SD = 5.45) for the control group. ANCOVA confirmed the difference after adjusting for pretest scores (Table 4): adjusted means were 26.51 and 21.60, $F(1, 309) = 124.13$, $p < .001$, $\eta^2p = .287$, $g = 1.26$, supporting H1. The advantage persisted on the delayed test, adjusted means 24.24 and 20.46, $F(1, 309) = 59.80$, $p < .001$, $\eta^2p = .162$, $g = 0.88$, supporting H2, though it was smaller than at the posttest.

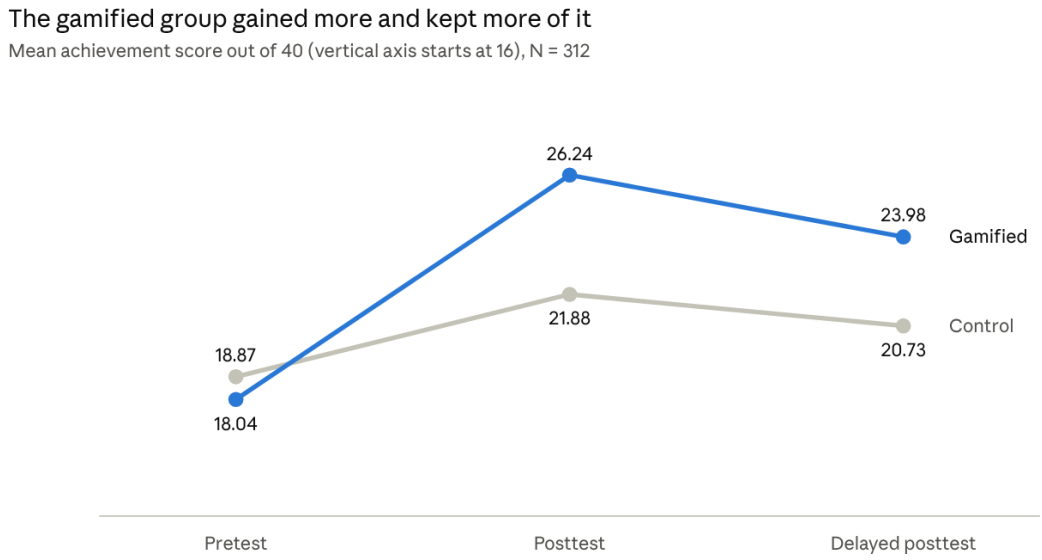
Table 3

Achievement Scores by Condition and Time (Out of 40)

Time	Gamified *M* (*SD*)	Control *M* (*SD*)
Pretest	18.04 (5.50)	18.87 (5.60)
Posttest	26.24 (5.24)	21.88 (5.45)
Delayed posttest	23.98 (5.48)	20.73 (5.80)

Figure 1

Mean Achievement Scores by Condition Across the Study (Out of 40)



N = 312

Table 4

ANCOVA of Achievement Outcomes, Controlling for Pretest

Outcome	Adjusted *M* gamified	Adjusted *M* control	*F*(1, 309)	*p*	η^2p	*g*
Posttest	26.51	21.60	124.13	< .001	.287	1.26
Delayed posttest	24.24	20.46	59.80	< .001	.162	0.88

Affective Outcomes

The gamified group reported significantly higher engagement on all three subscales (Table 5): behavioural (g = 1.15), cognitive (g = 0.93) and emotional (g = 0.84), supporting H3. Intrinsic motivation was also higher, adjusted means 3.66 and 3.19, $F(1, 309) = 55.55$, $p < .001$, η^2p = .152, supporting H4. Test anxiety was slightly lower in the gamified group, adjusted means 2.82 and 2.97, F (1, 309) = 4.25, p = .040, a small effect (η^2p = .014, g = −0.23) that remained significant after Holm adjustment, supporting H5. Figure 2 compares all effect sizes.

Table 5

Affective Outcomes by Condition (1–5 Scale)

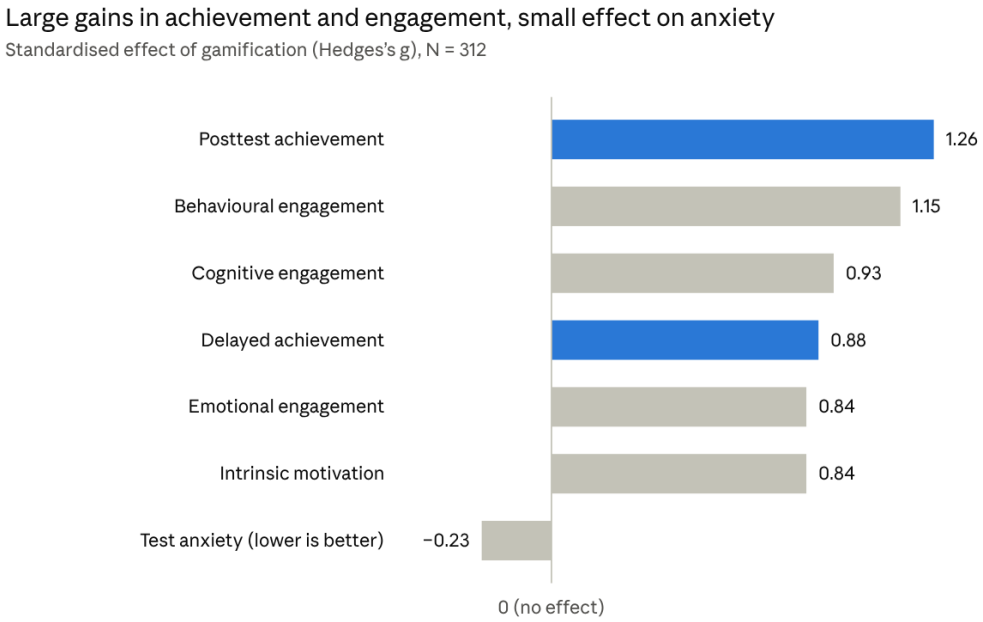
Outcome	Gamified *M* (*SD*)	Control *M* (*SD*)	Test	*p*	Effect size (*g*)
Behavioural engagement	3.91 (0.57)	3.26 (0.56)	t = 10.18	< .001	1.15

Outcome	Gamified *M* (*SD*)	Control *M* (*SD*)	Test	*p*	Effect size (*g*)
Emotional engagement	3.91 (0.68)	3.33 (0.69)	$t = 7.44$	< .001	0.84
Cognitive engagement	3.85 (0.60)	3.27 (0.63)	$t = 8.18$	< .001	0.93
Intrinsic motivation	3.66 (0.59)	3.19 (0.54)	$F = 55.55$	< .001	0.84
Test anxiety	2.82 (0.71)	2.97 (0.58)	$F = 4.25$	.040	−0.23

Note. Engagement subscales: Welch's *t* tests. Intrinsic motivation and test anxiety: ANCOVA with baseline engagement as covariate ($df = 1, 309$). Holm-adjusted *p* values for the five affective outcomes remained below .05.

Figure 2

Standardised Effect of Gamified Formative Assessment by Outcome (Hedges's g)



N = 312

Gender Moderation

The condition × gender interaction on posttest achievement was not significant, $B = -0.19$, $t = -0.22$, $p = .830$, so female and male students benefited similarly. Gender itself was also not a significant predictor ($p = .914$).

Hypothesis Summary

Table 6

Summary of Hypothesis Tests

Hypothesis	Key evidence	Decision
H1	Posttest, $F(1, 309) = 124.13$, $g = 1.26$	Supported
H2	Delayed test, $F(1, 309) = 59.80$, $g = 0.88$	Supported
H3	Engagement subscales, $g = 0.84$ to 1.15	Supported
H4	Intrinsic motivation, $g = 0.84$	Supported
H5	Test anxiety, $g = -0.23$, $p = .040$	Supported (small effect)
RQ	Condition × gender, $p = .830$	No moderation

DISCUSSION

Gamified formative assessment produced large gains in achievement and engagement relative to non-gamified formative assessment with identical items and feedback. This is important because the control group also received frequent formative quizzes, so the difference is attributable to the game elements and digital delivery rather than to testing alone. The results are consistent with meta-analytic evidence of positive effects of gamification (Bai et al., 2020; Huang et al., 2020; Li et al., 2023; Sailer & Homner, 2020), although the effects observed here are larger than those typically reported, which may reflect the novelty of the platforms in this setting and warrants caution.

The pattern across engagement dimensions is informative. Behavioural engagement showed the largest gain, which fits the idea that points, teams and immediate feedback prompt effort and participation, while emotional and cognitive engagement also rose, in line with accounts of enjoyment and agentic involvement (Camacho-Morles et al., 2021; Reeve et al., 2020; Ryan & Deci, 2020). The higher intrinsic motivation supports a self-determination interpretation in which visible progress supports competence (Ryan & Deci, 2020), and parallels findings for STEM and game-based learning (Chans & Portuguez Castro, 2021; Hui & Mahmud, 2023; Yu et al., 2021).

The smaller delayed effect shows that some of the advantage faded after four weeks, a familiar pattern in the literature (Zainuddin et al., 2020). The small effect on test anxiety suggests that gamification did not substantially reduce anxiety, perhaps because competition can raise pressure for some students (Bai et al., 2021). The absence of gender moderation is encouraging for equity. Finally, the success of the intervention with shared devices suggests that gamified assessment is feasible in resource-constrained schools when teachers are supported (Ayanwale et al., 2022).

CONCLUSION

Gamified formative assessment improved achievement, retention, engagement, and intrinsic motivation among SS2 STEM students in Imo State, with a small additional benefit in reducing test anxiety. These findings suggest that gamified formative assessment can be an effective instructional approach for enhancing students' learning experiences and outcomes in STEM

education. Its application may be particularly valuable in Imo State and similar educational settings in South-East Nigeria, where interactive, learner-centred approaches can support teaching and learning.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations are made:

i. **Integrate Gamified Quizzes into STEM Teaching:** Teachers should incorporate gamified quizzes into STEM instruction as frequent, low-stakes formative assessment activities rather than relying exclusively on summative tests.

ii. **Design for Shared Devices:** Schools should adopt team-based gamified activities supported by teacher-projected displays to ensure participation, particularly in settings with limited access to digital devices.

iii. **Manage Competition Carefully:** Teachers should prioritise team leaderboards, collaborative challenges, and progress badges over individual rankings to minimise discouragement among lower-performing students (Bai et al., 2021).

iv. **Prioritise Pedagogy Over Technology:** Gamified activities should be accompanied by timely feedback, meaningful instructional support, and follow-up teaching to ensure that game elements contribute directly to learning (Wisniewski et al., 2020).

v. **Provide Teacher Training:** Educational authorities and school administrators should organise professional development programmes to strengthen teachers' competencies in digital formative assessment, gamification strategies, and educational platform use (Ayanwale et al., 2022; Schildkamp et al., 2020).

LIMITATIONS AND FUTURE RESEARCH

The use of intact classes may have limited equivalence between groups despite random assignment. Furthermore, the findings reflect data from only one state and two subjects, which may limit their generalisability. Future research should employ multilevel modelling, longer follow-up periods, classroom observations, and investigations into the specific game elements responsible for observed learning effects.

Article Publication Details
This article is published in the **OpenMind Journal of Multidisciplinary Innovation & Development**, ISSN: 3108-2920 (Online). In Volume 2 (2026), Issue 6 (Nov - Dec) - 2026
The journal is published and managed by **OMR PUBLICATION** .

Acknowledgements

We sincerely thank the editors and the reviewers for their valuable suggestions on this paper.

Authors' contributions

All author(s) read and approved the final manuscript.

Funding

The author(s) declare that no funding was received for this work.

Data availability

No datasets were generated or analyzed during the current study.

Declarations

Ethics approval and consent to participate

The author(s) declare that not applicable.

Consent for publication

The author(s) declare that not applicable.

Competing interests

The author(s) declare no competing interests.

REFERENCES

1. Asemota, R., Edinoh, K., & Ejike, G. A. (2026). Designing technology-enhanced learning environments for 21st-century classroom: An empirical study. *ResearchGate*. https://www.researchgate.net/publication/405696098
2. Asemota, R., Edinoh, K., & Kyaune, W. H. (2026). The role of TPACK (technological pedagogical content knowledge) in preparing teachers for the digital age. *ResearchGate*. https://www.researchgate.net/publication/404040527

3. Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022). Teachers' readiness and intention to teach artificial intelligence in schools. *Computers and Education: Artificial Intelligence, 3*, Article 100099.
4. Bai, S., Hew, K. F., & Huang, B. (2020). Does gamification improve student learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts. *Educational Research Review, 30*, Article 100322.
5. Bai, S., Hew, K. F., Sailer, M., & Jia, C. (2021). From top to bottom: How positions on different types of leaderboard may affect fully online student learning performance, intrinsic motivation, and course engagement. *Computers & Education, 173*, Article 104297.
6. Brown, G. T. L. (2022). The past, present and future of educational assessment: A transdisciplinary perspective. *Frontiers in Education, 7*, Article 1060633.
7. Camacho-Morles, J., Slemp, G. R., Pekrun, R., Loderer, K., Hou, H., & Oades, L. G. (2021). Activity achievement emotions and academic performance: A meta-analysis. *Educational Psychology Review, 33*(3), 1051–1095.
8. Chans, G. M., & Portuguez Castro, M. (2021). Gamification as a strategy to increase motivation and engagement in higher education chemistry students. *Computers, 10*(10), Article 132.
9. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum.
10. Double, K. S., McGrane, J. A., & Hopfenbeck, T. N. (2020). The impact of peer assessment on academic performance: A meta-analysis of control group studies. *Educational Psychology Review, 32*(2), 481–509.

11. Edinoh, K., Obalum, A. N., & Asemota, R. (2026). Rethinking assessment and feedback in the digital age: An empirical study. *ResearchGate*. https://www.researchgate.net/publication/405696097
12. Ekici, M. (2021). A systematic review of the use of gamification in flipped learning. *Education and Information Technologies, 26*(3), 3327–3346.
13. Ferguson, T. P., Asemota, R., & Edinoh, K. (2026). Formative assessment practices and student self-efficacy: Evaluating teacher feedback methods in improving learning in junior secondary schools. *ResearchGate*. https://www.researchgate.net/publication/414594587
14. Huang, R., Ritzhaupt, A. D., Sommer, M., Zhu, J., Stephen, A., Valle, N., Hampton, J., & Li, J. (2020). The impact of gamification in educational settings on student learning outcomes: A meta-analysis. *Educational Technology Research and Development, 68*(4), 1875–1901.
15. Hui, H. B., & Mahmud, M. S. (2023). Influence of game-based learning in mathematics education on the students' cognitive and affective domain: A systematic review. *Frontiers in Psychology, 14*, Article 1105806.
16. Kalogiannakis, M., Papadakis, S., & Zourmpakis, A.-I. (2021). Gamification in science education: A systematic review of the literature. *Education Sciences, 11*(1), Article 22.
17. Li, M., Ma, S., & Shi, Y. (2023). Examining the effectiveness of gamification as a tool promoting teaching and learning in educational settings: A meta-analysis. *Frontiers in Psychology, 14*, Article 1253549.
18. Manzano-León, A., Camacho-Lazarraga, P., Guerrero, M. A., Guerrero-Puerta, L., Aguilar-Parra, J. M., Trigueros, R., & Alias, A. (2021). Between level up and game over: A systematic literature review of gamification in education. *Sustainability, 13*(4), Article 2247.

19. Nadi-Ravandi, S., & Batooli, Z. (2022). Gamification in education: A scientometric, content and co-occurrence analysis of systematic review and meta-analysis articles. *Education and Information Technologies, 27*(7), 10207–10238.
20. Nwankwo, P. I., Igwe, E. J., & Edinoh, K. (2026). The role of gamification and feedback in English tutoring apps for enhancing grammar and speaking skills of pre-service teachers in Nasarawa State, Nigeria. *ResearchGate*. https://www.researchgate.net/publication/414593230
21. Oyelere, S. S., Bouali, N., Kaliisa, R., Obaido, G., Yunusa, A. A., & Jimoh, E. R. (2020). Exploring the trends of educational virtual reality games: A systematic review of empirical studies. *Smart Learning Environments, 7*, Article 31.
22. Reeve, J., Cheon, S. H., & Jang, H. (2020). How and why students make academic progress: Reconceptualizing the student engagement construct to include agentic engagement. *Contemporary Educational Psychology, 62*, Article 101899.
23. Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology, 61*, Article 101860.
24. Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review, 32*(1), 77–112.
25. Sanchez, D. R., Langer, M., & Kaur, R. (2020). Gamification in the classroom: Examining the impact of gamified quizzes on student learning. *Computers & Education, 144*, Article 103666.
26. Schildkamp, K., van der Kleij, F. M., Heitink, M. C., Kippers, W. B., & Veldkamp, B. P. (2020). Formative assessment: A systematic review of critical teacher prerequisites for classroom practice. *International Journal of Educational Research, 103*, Article 101602.

27. Sweller, J. (2020). Cognitive load theory and educational technology. *Educational Technology Research and Development, 68*(1), 1–16.
28. Wang, A. I., & Tahir, R. (2020). The effect of using Kahoot! for learning: A literature review. *Computers & Education, 149*, Article 103818.
29. Wisniewski, B., Zierer, K., & Hattie, J. (2020). The power of feedback revisited: A meta-analysis of educational feedback research. *Frontiers in Psychology, 10*, Article 3087.
30. Wong, Z. Y., & Liem, G. A. D. (2022). Student engagement: Current state of the construct, conceptual refinement, and future research directions. *Educational Psychology Review, 34*(1), 107–138.
31. Yan, Z. (2020). Self-assessment in the process of self-regulated learning and its relationship with academic achievement. *Assessment & Evaluation in Higher Education, 45*(2), 224–238.
32. Yu, Z., Gao, M., & Wang, L. (2021). The effect of educational games on learning outcomes, student motivation, engagement and satisfaction. *Journal of Educational Computing Research, 59*(3), 522–546.
33. Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational Research Review, 30*, Article 100326.
34. Zhang, Q., & Yu, Z. (2021). A literature review on the influence of Kahoot on learning outcomes, interaction, and collaboration. *Education and Information Technologies, 26*(4), 4507–4535.

PUBLISHER'S NOTE

OMR PUBLICATION remains neutral with regard to jurisdictional claims in published maps and institutional affiliations. The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of OMR PUBLICATION

and/or the editor(s). OMR PUBLICATION disclaims responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.