



GAME-BASED LEARNING AND ITS INFLUENCE ON STUDENT ACADEMIC ACHIEVEMENT IN SECONDARY SCHOOL BIOLOGY IN NIGERIA. A REVIEW

BY

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Abstract

This review explores the impact of Game-Based Learning (GBL) on student academic achievement in secondary school biology within the Nigerian educational context. With increasing concerns about student engagement and performance in science subjects, particularly biology, educators are seeking innovative methods to improve learning outcomes. Game-Based Learning has emerged as a promising approach, integrating educational content with interactive and engaging gameplay elements. Drawing on both international and local studies, this review highlights the effectiveness of GBL in enhancing student motivation, conceptual understanding, and retention of biological concepts. It also examines how the use of digital and non-digital games in Nigerian classrooms can address challenges such as low student interest and limited teaching resources. While evidence suggests that GBL has the potential to significantly boost academic performance, the review also notes contextual barriers such as infrastructure limitations, teacher preparedness, and curriculum alignment. The paper concludes by emphasizing the need for strategic implementation, teacher training, and further research to fully harness the benefits of GBL in improving biology education in Nigeria's secondary schools.

Keywords: Game-based, learning, academics, achievement, Biology

Introduction

Biology, a core science subject, is essential for understanding life processes and tackling global challenges in areas such as health, agriculture, and environmental conservation. Biology, as one of the foundational sciences, is pivotal for technological advancements. It provides insights into the natural world and underpins careers in medicine, pharmacy, agriculture, and engineering (Chew, 2014). The biology curriculum in Nigerian secondary schools is designed to impart laboratory skills, scientific knowledge, and practical applications in everyday life, addressing issues in health, agriculture, and environmental management (Ado &



Udoh, 2018). The subject's importance has been further emphasized by researchers who link it to better health understanding, career development, and problem-solving skills in society (Cakir, 2017; Institute of Biology, 2013).

Despite its significance, the teaching and learning of Biology face challenges, particularly regarding abstract and complex topics like population ecology. Reports, including the West African Examination Council (WAEC) Chief Examiner's report (2019), indicate poor student performance in Biology due to factors such as inadequate teaching strategies, lack of laboratory resources, and deficiencies in curriculum delivery (Ogundare et al., 2022; Okorie, 2018; Omatade, 2016). Traditional lecture-based teaching methods, which emphasize rote memorization and teacher-centered learning, fail to engage students effectively or foster critical thinking (Etiubon & Udoh, 2017). To address these challenges, innovative and student-centered approaches such as game-based learning was proposed in this study.

Concept of Game-based Learning

Game-based learning involves the use of structured play or competitive activities designed to reinforce educational content while promoting student engagement and enjoyment. Grounded in constructivist and experiential learning theories, this approach encourages active participation, collaboration, and immediate feedback. By integrating gaming elements into biology instruction, educators can create a more interactive and stimulating learning environment. Game-based strategies increase student interest and drive by tapping into their natural curiosity and competitive spirit. When students perceive learning as enjoyable and rewarding, they are more likely to engage actively. Research by Akpan and Okon (2021) demonstrated that biology students exposed to educational games showed increased enthusiasm and willingness to participate in class activities compared to those taught through conventional methods. Similarly, Chukwu and Adeyemi (2022) reported that students exposed to game-based instruction exhibit higher levels of motivation and content retention. Despite these promising findings, limited empirical research has been conducted in the Nigerian context, particularly concerning the teaching of virology concepts in secondary education.

Game-based involves engaging pupils with the use of educational materials in a playful and dynamic way. Game-based learning is not just creating games for pupils to play, it is designing learning activities that can incrementally introduce pupils to certain concepts, and guide users towards an end goal. Also, Sadeghi and Dousti (2013) posited that game-based learning strategy entails increased learning efficacy, immediate feedback during game play; repetition, drill, and practice of essential language skills, pupils-centered learning, increased motivation, and an element of fun. Game-based learning strategy helps to remove the elements of difficulty in the course of teaching and learning primary school Mathematics



because pupils are subjected to mathematical exercises through active participation with their hands, head and heart in a safe environment. Game-based learning strategy is essential in teaching and learning processes as it increases overall motivation of pupils, helps pupils in problem-solving, increases class cooperation and makes pupils have fun and be happy among others.

Through game-based learning, participants learn more actively and with greater interest, enabling the learned content to leave a deeper impression than would be possible using conventional methods (Papastergiou, 2009). Furthermore, games can enhance the social skills of students as well as improve their skills in understanding and solving problems (Kirikkaya, Iseri, & Vurkaya, 2010). In a nutshell, game-based instruction is an educational game program designed by integrating teaching content and game characteristics. Trybus (2015) posited that Game-based learning strategy is the process of using certain gaming principles and applying these principles to real-life settings/situation in order to engage users and motivate them to learn for effective teaching learning processes. A game program could induce a learning cycle, including allowing learners making judgment and practice and having the system give feedback (Yoon, 2014). Such a cycle allows learners feeling happy and being willing to continuously spending time on such a learning cycle; besides, continuously participating in such games could achieve certain training goals or specific learning outcome (Yen-chun, 2017)

Games provide repeated exposure to content in a dynamic format, facilitating better comprehension and application of knowledge. A study by Alade and Amusan (2022) found that students taught virus-related biology concepts using board and digital games scored significantly higher on assessments than their peers in traditional classrooms. These findings indicate that game-based learning can bridge gaps in understanding complex scientific ideas. Many educational games require teamwork, strategy formulation, and real-time decision-making, which cultivate higher-order thinking skills. Tunde and Nwosu (2021) emphasized that such activities not only enhance individual learning but also build interpersonal and cognitive skills that are essential for scientific inquiry. Hartt et al. (2020) discovered that game elements that inspire delight, facilitate peer engagement, and allow the opportunity to share ideas have become increasingly beneficial in game design.

Game-Base Learning has become an increasingly prominent strategy in education, offering a means to enhance learning experiences by incorporating game elements into teaching methodologies. It has been shown to improve student engagement, motivation and knowledge retention, particularly in subjects like science, where traditional teaching approaches often fail to capture students' interest. Biology, with its complex and abstract concepts, requires innovative instructional strategies to promote active learning and simplify understanding, making gamification a highly effective approach. Additionally, it encourages active learning and can be personalized to fit the needs of individual students (Orji et al., 2017). Yildirim and



Sen (2021) found that incorporating gamified elements into science classrooms significantly enhanced students' emotional and cognitive involvement. Similarly, Adesoji and Olusola (2019) demonstrated that gamified activities such as quizzes and role-playing significantly improved the enthusiasm and participation of biology students in Nigerian secondary schools. These findings illustrate how gamification can shift the classroom dynamic, transforming students from passive listeners to active participants

Another important aspect of gamification is its impact on knowledge retention, the ability to recall and apply learned information over time. Most a time, in traditional teaching approaches students struggle to retain concepts for examinations. Retaining information over time is a common challenge for students, particularly in subjects like biology that involve extensive terminologies and abstract ideas. Gamification addresses this challenge by encouraging deep learning through interactive and repetitive tasks. Huang and Soman, (2013) showed that biology students who participated in gamified lessons exhibited better long-term retention compared to those taught through traditional methods. Collaborative games, such as team-based challenges and problem-solving tasks, were particularly effective, as they fostered peer learning and feedback. Similarly, Oladipo and Adebayo (2020) found that students who engaged in gamified biology lessons performed better on delayed post-tests, indicating that gamification strengthens the durability of knowledge.

Other key benefits of gamification is its ability to enhance student engagement, which is a critical determinant of academic success. Fasuyi et al. (2022) defined engagement as the behavioral, emotional, and cognitive involvement of students in learning activities. Unfortunately, traditional teaching methods often fail to engage students effectively, leading to passive learning and low achievement. In contrast, gamification captures students' attention, evokes positive emotions, and encourages active participation in learning. Adesoji and Olusola (2019) found that activities such as biology scavenger hunts and role-playing significantly improved student engagement in Nigerian secondary schools, demonstrating the potential of gamification to transform classroom dynamics

Games also provide immediate feedback, which can help students learn more quickly and understand their mistakes (Plass et al., 2015). Collaboration is another benefit of GBL, as it promotes social skills and teamwork (Chen and Law, 2016). Studying GBL must, therefore, represent the integrated viewpoints of cognitive, motivational, affective, and sociocultural perspectives, including both game design and game research as complementary aspects of the learning process (Plass et al., 2015). Despite its benefits, the implementation of gamification in education is not without challenges. One significant obstacle is the lack of teacher readiness and training. Ali and Mohammed (2023) pointed out that many teachers are not equipped with the skills or confidence to effectively integrate gamified activities



into their lessons. Addressing this issue requires targeted professional development programs to help educators understand and apply gamification strategies effectively. Game-based learning has a huge potential to positively impact pupils learning but it is difficult to effectively integrate game in teaching mathematics to pupils if teachers are not knowledgeable enough on how to use the game which will negatively affect pupil's performance in mathematics (Oluwatayo et al., 2020).

Barriers related to the cost of equipment is another challenge of implementing game-based learning, Fatin et al. (2019) also recommended that commercially available games be integrated into classroom settings for learning due to quality and cost-effectiveness. The available time required to implement games in a one-day lesson, Shaaruddin and Mohamad (2017) also claimed that gamification could be challenging in terms of time restrictions and delivery of the lesson itself. Molin (2017) which also highlighted Teachers faced challenges such as a lack of time to prepare gameplay sessions, inadequate technical skills, and difficulties in selecting and integrating appropriate games for teaching along with the findings of facilitating student dialogue during game-based learning (GBL) practices, uncertainties about how to integrate GBL into the curriculum, tight class schedules, and the novelty of GBL teaching methods may hinder teachers from adopting this approach. difficulties in obtaining game analytics and analyzing student progress, and limited access to technological resources. Additionally, there is often resistance to change from both educators and institutions entrenched in traditional methods. However, when implemented correctly, gamification has the potential to revolutionize education, making learning more engaging and meaningful for students.

Statement of the problem

This study is justified by the critical need to address persistent challenges in biology education. Biology, a core science subject, often suffers from low student engagement and poor knowledge retention due to traditional teaching methods that is teacher centered which emphasize rote memorization over active learning. These challenges hinder students' academic achievement and limit their interest in pursuing careers in science-related fields. Game-based learning strategy is an innovative teaching strategy, has been shown to improve engagement and retention by transforming learning into an interactive and enjoyable experience. However, most studies on game-based in education focus on digital platforms and are conducted in developed countries, leaving a gap in localized research on low-cost, classroom-based gamification in Nigeria. Addressing this gap is crucial, as classroom-based games are more accessible and practical for schools, where digital resources are limited. By investigating the impact of classroom game-based learning platforms on student engagement and knowledge retention in biology, this study provides evidence-based insights that can inform curriculum development, teacher training and educational policies. Ultimately, it aims to enhance the quality



of biology education, improve learning outcomes and contribute to the global discourse on effective teaching strategies in science education.

Theoretical Framework for the Study

This study is grounded in constructivist learning theory and self-determination theory, which collectively explain the effectiveness of gamification in education. Constructivist learning theory, as proposed by Vygotsky (1978), emphasizes that learners construct knowledge actively through social interaction and engagement. This approach represents a departure from traditional, teacher-centered models of education that rely on the passive transmission of information from the instructor to the student. Instead, game-based learning encourages learners to explore, experiment, and collaborate, fostering a deeper and more meaningful understanding of the subject matter (Gee, 2003). These game-based learning elements can enhance students' motivation and cognitive skills, as they are more likely to be engaged and attentive when their psychological needs are met (Deci & Ryan, 2000). However, it is essential to recognize that not all games are equally effective at promoting learning and motivation. Some games may not provide sufficient opportunities for autonomy, competence, or relatedness, resulting in lower levels of intrinsic motivation (Ryan et al., 2006). Additionally, some games may be too complex or difficult for students, leading to frustration and disengagement (Kiili, 2005). To maximize the benefits of game-based learning, instructors must carefully consider the design and implementation of these activities in the classroom. Gamification satisfies students' psychological needs for competence, autonomy and relatedness through challenges, rewards, and teamwork, thereby increasing engagement and knowledge retention in biology education.

Academics Achievement Related with Game-Based Learning

One of the biggest problems in all formal learning is keeping students motivated enough to stick with the learning process to the end of e.g. a lesson, course, term/semester, Playing Is an important part of children's cognitive and social development A child learns through playing with others, creating, and improving his or her stage of development offers cognitive support needed to develop higher order mental processes, initiates the symbolic use of objects and first form of symbolization. Play and learning are related. When playing games, students actively see and do, rather than read and listen, as they complete increasingly difficult levels of learning. They are personally involved in what they are doing, and therefore, more motivated to retain what they have learned. The process of learning is often experienced as painful. The process of game-playing is generally engaging. If school activity would be treated in terms of learning, playing, and helping, then children could be more thoroughly engaged in the learning process. The objectives of Game-based learning include the following:

- To make learning meaningful to students



- To create a learning culture that is more in correspondence to student's interests and learning styles
- To create learning environments that actively involve students in the problem and enable them to understand the complex situation
- From "learning by listening" to more active "learning by doing"
- To provide a rewarding experience to many people with the application of computer games

Students have positive perceptions on gamified learning and appreciate the social interactions, engagement and immediate feedbacks associated with a game-based learning experience (Cheong et al., 2014). So many positive effects accrue from using games to learn. Some of the benefits of Game-Based

learning in science include:

- Games are useful in presenting repetitive learning in normal ways
- Games help in creating awareness, reinforcing facts and knowledge, teaching skills and

building values.

- They provide a participatory effect in learning especially in sciences
- Games increase motivation, attention and concentration
- Immerses them in the material so they learn more effectively
- Encourages them to learn from their mistakes
- Enhances tutoring, exploring/practicing skills, entertainment and attitude change.
- Computer gaming skills serve as precursor for computer skills.
- Improves problem-solving ability and creativity which are vital components in science

learning.

- Support cognitive processing, strategic skills and critical thinking
- Increases learning and memory capabilities
- Accommodates different learning styles (Ndirika, 2018)

Gamification uses game-based mechanics and game thinking to engage student, motivate actions and promote learning (Udeani & Akhigbe, 2020). Laine et al. (2016) also posited that game elements work harmoniously with other intervention built unto the game to impact on students learning. Game-based learning has been associated with improvements in problem-solving, critical thinking, collaboration, and self-regulation skills (Al-Khayat, et al., 2023). For instance, Udeani and Akhigbe (2020) examined gamification as an instructional approach under collaborative and competitive modes: An Analysis of students' learning outcomes in Biology. Findings from their study revealed that gamified learning experiences



have potential to improve student's grade, and engagement. This corroborates with findings from the study carried out by Olufunke et al., (2025) investigated the Effect of Game-based Learning Platforms on Senior Secondary Student's engagement and Knowledge Retention in Biology, findings indicated that gamification significantly enhances student engagement and knowledge retention, addressing the challenges of low engagement and poor academic outcomes prevalent. In a similar manner, Su and Cheng (2014) developed and implemented the use of a mobile gamification system in an elementary school science curriculum. Findings from the quasi-experimental research revealed that mobile gamification learning approach significantly improved the achievement and motivation of students. Ndirika (2018) worked on game-based learning: A panacea for better attitude and academic achievement in basic science and the study revealed the effectiveness of game-based learning in the academic achievement of students. Similarly, Obafemi and Adekunle (2021), who reported that gamification strategies create an interactive and enjoyable learning atmosphere, particularly in Nigerian classrooms with limited educational resources.

Conclusion

When games are used in teaching science, students become lively and actively involved in learning. The challenge of the science teacher is thus to meaningfully incorporate them as vital aspects of the lessons in order to make learning fun and to make the games more useful. The study confirmed the transformative potential of classroom game-based learning platform in biology education, particularly in areas facing educational challenges. By fostering a more engaging and interactive learning atmosphere, gamification not only enhances knowledge retention but also addresses the pressing need for innovative teaching strategies. The positive outcomes observed in this research advocate for the broader adoption of gamified approaches in educational settings, ultimately contributing to improved student performance and motivation in biology and beyond.

Recommendations

1. The study recommended that schools should incorporate classroom game-based learning strategies into the biology curriculum to enhance student engagement and improve academic achievement.
2. School management, ministry of education should provide a platform for training and retrained of teachers on the use of gamification techniques to effectively implement these strategies in the classroom.

References

Adesoji, F. A., & Olusola, O. A. (2019). Enhancing student engagement in Nigerian biology classrooms through gamified activities. *Nigerian Journal of Educational Innovation*, 12(1), 68-75.



- Akpan, E. J., & Okon, I. M. (2021). Game-based learning and student achievement in secondary school science. *Nigerian Journal of Science Education*, 25(2), 115-128.
- Al-Khayat, M. R., Gargash, M. U., & Atiq, A. F. (2023). The effectiveness of game-based Learning in enhancing students' motivation and cognitive skills. *Journal of Education and Teaching Methods*, 2(3), 50-62.
- Chen, C.-H. and Law, V. (2016). Scaffolding individual and collaborative game-based learning in learning performance and intrinsic motivation. *Computers in Human Behavior*, 55, 1201–1212.
- Cheong, C., Filippou, J., & Cheong, F. (2014). Towards the gamification of learning: investigating student perceptions of game elements. *Journal of Information Systems Education*, 25(3), 233-244.
- Chukwu, L. A., & Adeyemi, R. T. (2022). Motivational effects of educational games on senior secondary school students in biology. *West African Journal of Educational Research*, 18(1), 54-70.
- Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. Springer Science & Business Media
- Etiubon, R. U. & Udoh, N. M. (2017). Effects of practical activities and manual on science students' academic performance on solubility in uruan local education authority of Akwa Ibom State. *Journal of Education and Practice*, 8(3), 202-209.
- Fatin, K. M. A., Natasha, Z. Z., Maslawati, M., & Melor M. Y. (2019). Benefits and challenges of using game-based formative assessment among undergraduate students. *Humanities & Social Sciences Reviews*, 7(4), 203-213
- Hartt, M., Hosseini, H. and Mostafapour, M. (2020). Game on: Exploring the effectiveness of game-based learning. *Planning Practice and Research*, 35(5), 589–604.
- Huang, W. H., & Soman, D. (2013). Gamification of education. Report Series: Behavioural Economics in Action, University of Toronto. Retrieved from <https://www.rotman.utoronto.ca>
- Ndirika, M. C. (2018). Game-based learning: A panacea for better attitude and academic achievement in basic science. *Journal of Educational and Social Research*, 3(8), 91-97.
- Obafemi, O. S., & Adekunle, R. A. (2021). Gamification and student engagement in Nigerian classrooms: Evidence from secondary education. *West African Journal of Education*, 19(4), 101-118.
- Ogundare, A. A., Ambode, A. B. & Babalola, F. E. (2022). Relationship Between Teachers' Work Load and Students' Academic Performance in Senior Secondary Schools in Irepodun Local Government, Kwara State, Nigeria. *Kashere Journal of Education*, 3(2), 17-25.



- Olufunke, O. K., Abdulraheem, D. G., and Rasdaq S. (2025). Effect of Game-Based Learning Platforms on Senior Secondary Student Engagement and Knowledge Retention in Biology in Kwara State, Nigeria. *Rima International Journal of Education (RIJE)*, 4 (1), 117-128
- Oluwatayo, J. C., Ngozi E. A. & Obidike, N.D. (2020). Challenges of game-based learning strategy in teaching mathematic in primary schools in Nkanu West Local Government Area of Enugu State. *Journal of Early Childhood and Primary Education*, 2(1), 15-26.
- Orji, R., Mandryk, R.L. and Vassileva, J. (2017). Improving the efficacy of games for change using personalization models. *ACM Transactions on Computer-Human Interaction*, 24(5), 1–22.
- Plass, J. L., Homer, B. D., and Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist*, 50(4), 258–283.
- Shaaruddin, J. and Mohamad, M. (2017) Identifying the effectiveness of active learning strategies and benefits in curriculum and pedagogy course for undergraduate TESL students. *Creative Education*, 8, 2312-2324. doi: 10.4236/ce.2017.814158.
- Udeani U. N. and Akhigbe J. N. (2020). Gamification as an instructional approach under collaborative and competitive modes: An analysis outcome students' learning outcomes in biology. *International Journal of Innovative Technology Integration in Education (IJITIE)* 4(1), 42-61.