GAMIFICATION OF CHEMISTRY CONCEPTS' EFFECT ON STUDENTS MOTIVATION AND ACADEMIC PERFORMANCE

Frank OKODASO
EDU2102073.

DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY
FACULTY OF EDUCATION UNIVERSITY OF BENIN
BENI CITY

OCTOBER 2025

GAMIFICATION OF CHEMISTRY CONCEPTS' EFFECT ON STUDENTS MOTIVATION AND ACADEMIC PERFORMANCE

Frank OKODASO
EDU2102073

A PROJECT SUBMITTED TO THE DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY, FACULTY OF EDUCATION UNIVERSITY OF BENIN,BENIN CITY IN PARTIAL FULFILMENT OF THE REQUIREMENT OF THE AWARD OF THE BACHELOR OF SCIENCE (ED) DEGREE IN CHEMISTRY EDUCATION

OCTOBER 2025

CERTIFICATION

We the undersigned, certified that this research work was carried out by OKODASO FRANK in the department of curriculum and instructional technology, Faculty of Education, University of Benin , Benin city in partial fulfillment of the requirement of the award of Bachelor of science (Ed) degree in chemistry Education.

______________________ DATE______________

Dr. (Mrs.) O. H. Iyamu
(Project Supervisor)

______________________ DATE______________

Dr. (Mrs.) I. K Oteze
(Project Coordinator)

____

Prof. Dr. F. O. Idehen
(Head of Department)

____

DATE

DEDICATION

This research work is dedicated to God Almighty for his

ACKNOWLEDGEMENTS

The researcher expresses sincere appreciation to Jehovah God Almighty for guiding him through ups and downs of his academic journey in the University of Benin, enabling the successful completion of this project. Gratitude is extended to his supervisor Dr. Mrs O.H. Iyamu for her patience and invaluable constructive feedback throughout the project. Furthermore, thanks are offered to the Head of Department Dr. Festus. O. Idehen for his amazing leadership in the Department, the researcher also want to appreciate Mrs. A. Onubogu for her contribution to this research work, and other dedicated lecturers in the Department of curriculum and instructional technology for sharing their knowledge and expertise.

Genuine thanks goes to the researcher's Mum Mrs Rebecca Okodaso for her unwavering love, support and prayers during this project. He is also grateful to his siblings Monday Okodaso, Clara Okodaso, Ochuko Aghwotu and most especially his sponsor Miriam Okeoghene Okodaso for making this academic journey a success.

The researcher extends heartfelt gratitude to his boss and colleagues at Enina Group of Schools for their support in this significant achievement offering them many thanks and blessings.

TABLE OF CONTENTS

	PAGE
TITLE	i
CERTIFICATION	ii
DEDICATION	iii
ACKNOWLEDGEMENTS	iv
ABSTRACT	vii
CHAPTER ONE: INTRODUCTION	
Background of the Study	1
Statement of the Problem	5
Research Questions	6
Research Hypothesis	7
Purpose of the Study	7
Significance of the Study	8
Scope/delimitation of the Study	9
Operational Definition of Terms	10
CHAPTER TWO: REVIEW OF RELATED LITERATURE	
Theoretical framework	12
Concept of Chemistry Education	17
Introduction to Gamification in Education	20
Gamification in Chemistry Education	22
Strategies Used by Chemistry Teachers to Incorporate Gamification	26
The Influence of Game Elements on Student Motivation in Chemistry	30
Impact of Gamification on Student Motivation to Learn Chemistry	34
Benefits of Using Gamification in Teaching Chemistry	37
Challenges of Using Gamification in Teaching Chemistry	40
Summary of the review of related literature	43

PAGE

CHAPTER THREE: METHODOLOGY

Research Design 47

Population of the Study 48

Sample and Sampling Techniques 48

Research Instrument 49

Validity of Instrument 50

Reliability of Instrument 50

Method of Data Collection 50

Method of Data Analysis 51

CHAPTER FOUR: PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

Presentation of Results 52

Discussion of Findings 65

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary 68

Conclusion 69

Recommendations 70

REFERENCES 72

APPENDIX 78

ABSTRACT

This study Examines the impact of Gamifcation of chemistry concepts; Effect on students motivation and academic performance of students in Egor Local government area of Edo State.

The study adopted a descriptive survey design and involved a sample of 66 students selected using the proportionate sampling technique. A structured questionnaire titled Gamifcation of chemistry concepts Effect on students motivation and academic performance was used for data collection. The instrument was validated by experts, and it's reliability was established using the cronbach Alpha method, yielding a coefficient value above 0.7 . Data collected were analyzed using mean and standard deviation to answer the research questions.

Findings reveals that chemistry teachers used games to evaluate students understanding of chemistry topics, the study also confirms that gamification has a significant positive impact on student motivation and engagement in chemistry lessons. The use of strategies such as games, rewards, competitions, and puzzles not only boosts students’ interest in the subject but also helps with retention and makes learning more interactive. These findings support existing literature on the effectiveness of gamification in education. However, the variation in responses regarding the impact of gamification on confidence and collaboration highlights the need for further research to explore how different students perceive and benefit from these strategies.

CHAPTER ONE

INTRODUCTION

Background to the Study

In today's classrooms, teaching is no longer just about delivering facts it is about making learning meaningful, interactive, and inspiring. One approach that has gained significant attention for achieving this is gamification, which involves incorporating game-like features such as points, badges, leaderboards, challenges, and progress tracking into non-game contexts like school lessons. In education, gamification transforms lessons into active, goal-driven experiences that encourage students to remain engaged, motivated, and focused on achieving learning objectives (Antunes, Pacheco, & Giovanela, 2012; Dicheva, Dichev, Agre, & Angelova, 2015).

Chemistry, often referred to as the central science, connects concepts from physics, biology, and environmental science, with applications in medicine, agriculture, engineering, and technology (Brown, LeMay, Bursten, & Murphy, 2014). Despite its importance, chemistry is often perceived as a difficult subject, particularly in areas such as hydrocarbons, which require mastery of abstract concepts like chemical structures, reaction mechanisms, and specialized terminology (Childs & Sheehan, 2009; Erman, 2017). In Nigerian secondary schools, many students find these topics challenging, resulting in low motivation, disengagement, and poor academic performance (Okebukola, 2005; Ojo, 2017).

A major reason for these challenges is the continued reliance on teacher-centered approaches, dominated by lectures and rote memorization. While such methods allow quick transmission of information, they often reduce students to passive listeners, limiting participation, critical thinking, and deep conceptual understanding (Eilks, Rauch, Ralle, & Hofstein, 2013; Nzeyimana & Ndihokubwayo, 2019). Over time, this contributes to low enthusiasm, reduced retention, and poor achievement in chemistry. Research has shown that meaningful learning in chemistry requires learner-centered, active, and cooperative approaches that engage students physically, socially, and cognitively (Cahyana, Supasorn, & Hwang, 2017; Kara, 2021). Constructivist and social cognitive theories emphasize that meaningful learning occurs when students actively construct knowledge through collaboration, problem-solving, and practical experiences (Amineh & Hanieh, 2015; Yilmaz, 2011).

Gamification presents a promising alternative teaching method that shifts the focus from passive reception to active engagement, making lessons interactive, rewarding, and goal-oriented. Through activities such as virtual quizzes, timed challenges, interactive simulations, and leaderboards, gamification fosters both intrinsic motivation learning for satisfaction and extrinsic motivation learning driven by rewards ultimately enhancing academic performance (Baek, Min, & Yun, 2015; Andiastutik & Lutfi, 2017). Although gamification has been widely applied in fields such as mathematics, language learning, and computer science (Smaldino, Lowther, & Clif, 2019), its use in Nigerian chemistry classrooms remains limited. In the teaching of hydrocarbons in particular, little empirical evidence exists regarding its effectiveness in improving student motivation and achievement, even though studies consistently show that students are more likely to retain knowledge and develop positive attitudes when they are engaged in enjoyable and meaningful tasks (Franco-Mariscal, Oliva-Martínez, & Gil, 2016; Partovi & Razavi, 2019).

Gamification also aligns with mastery-based learning, where learners must demonstrate competence at one level before advancing to the next. In this model, learners are encouraged to persist until mastery is achieved without fear of failure. Experience points, levels, and digital rewards can replace traditional grades as indicators of progress, shifting emphasis from “How many marks did I get?” to “What have I learned?” (Lee & Hammer, 2011; Daley, 2012; Philip, 2012). This fosters persistence, resilience, and deeper understanding of concepts.

Like other sciences, chemistry occupies a central role in daily life as it helps learners understand the world around them. However, its teaching and learning have been marked by persistent challenges, including lack of problem-solving skills, limited visualization, poor vocabulary comprehension, and weak teacher-student interaction (Childs & Sheehan, 2009; Byusa, Kampire, & Mwesigye, 2020). Students often struggle in both theoretical and laboratory contexts, where inadequate infrastructure, safety concerns, and limited engagement further reduce learning outcomes (Rahman, Singh, & Pandey, 2020). Many students also focus on completing laboratory tasks quickly rather than reflecting deeply, leading to superficial understanding (Ndihokubwayo, Habiyaremye, & Nyirahabimana, 2020).

To overcome these challenges, several instructional approaches have been introduced, including activity-based learning, cooperative learning, problem-based learning, project-based learning, and the integration of digital tools such as virtual and augmented reality simulations (Dorimana, Uwizeyimana, & Byusa, 2021; North, Strain, & Abbott, 2021). These approaches have been proven to promote collaboration, persistence, and conceptual understanding while stimulating curiosity and scientific inquiry (da Silva Júnior, Batista, & Ferreira, 2021). Gamification fits well within this learner-centered framework, as it equips students with meaningful activities that make learning both enjoyable and rewarding. It not only enhances conceptual understanding but also boosts motivation, fosters a sense of community, and helps learners develop problem-solving and critical thinking skills (Cahyana et al., 2017; Franco-Mariscal et al., 2016).

Given the persistent challenges students face in learning hydrocarbons, the limitations of traditional instructional methods, and the potential of gamification to improve motivation and performance, this study investigates the effects of gamification of chemistry concepts on students' motivation and academic achievement. By focusing on the integration of gamified strategies into the teaching of hydrocarbons, it seeks to contribute to improving chemistry education in Nigerian secondary schools and provide evidence-based recommendations for enhancing both student engagement and overall learning outcomes.

Statement of the Problem

Chemistry is central to science and everyday life, with applications in medicine, agriculture, technology, and industry. Yet, it remains one of the most difficult subjects for many Nigerian secondary school students. Concepts such as hydrocarbons are particularly challenging because they involve abstract ideas, complex molecular structures, and specialized terms that are not always easy to understand. These difficulties often result in loss of interest, low motivation, and poor academic performance in chemistry.

A major reason for this challenge is the continued reliance on teacher-centered methods such as lectures and rote memorization. While these approaches enable quick coverage of content, they often render students passive listeners who are rarely engaged with the subject . Many classrooms also lack well-equipped laboratories and modern learning tools that could make chemistry more practical and interactive. Large class sizes and limited teacher training in innovative teaching strategies further compound the problem, leaving students without adequate encouragement and support to build confidence and enthusiasm in learning chemistry.

One potential solution to these challenges is gamification, which involves integrating game-like features such as points, badges, leaderboards, and challenges into teaching. Research in other subject areas has shown that gamification increases student motivation and improves learning outcomes by making lessons more interactive and rewarding.

However, in Nigerian chemistry classrooms particularly in the teaching of difficult concepts like hydrocarbons gamification has not been widely applied or studied.

With the rapid advancement of technology and shifts in student preferences, concerns are growing about the effectiveness of conventional teaching methods in sustaining learners' interest and fostering positive attitudes toward learning. Current research suggests that many students perceive traditional methods as boring and disconnected from their interests and everyday experiences, leading to disengagement and apathy toward academic subjects. While studies in other contexts have highlighted the potential of gamification in enhancing students' motivation and academic performance, its effectiveness within Nigerian secondary schools remains relatively unexplored.

There is therefore a clear gap in understanding how gamification can be tailored to the unique needs of Nigerian secondary school students, particularly in chemistry. Limited research exists on its impact on students' interest, motivation, and academic achievement in science subjects such as mathematics, chemistry, and computer studies. Addressing this gap requires comprehensive research that investigates the specific influence of gamifying chemistry concepts such as hydrocarbons on students' motivation and academic performance.

Research Questions

The study will address the following research questions:

1. What strategies do chemistry teachers use to incorporate gamification in teaching?
2. How do game elements influence student motivation in chemistry?

3. What is the impact of gamification on student motivation to learn chemistry?
4. What are the benefits of using gamification in teaching chemistry?

Research Hypothesis

1. (H_{01}): There is no significant difference in the strategies chemistry teachers use to incorporate gamification in teaching.
2. (H_{02}): Game elements do not have a significant influence on student motivation in chemistry.
3. (H_{03}): Gamification has no significant impact on student motivation to learn chemistry.
4. (H_{04}): Using gamification in teaching chemistry does not result in significant benefits for students.

Objectives/Purpose of the Study

This study aims to investigate the gamification of chemistry concepts as a teaching approach and its effects on students' motivation and academic performance. Specifically, it seeks to:

1. To identify the strategies used by chemistry teachers to incorporate gamification in teaching.
2. To examine how game elements influence student motivation in chemistry.
3. To assess the impact of gamification on student motivation to learn chemistry.
4. To explore the benefits of using gamification in teaching chemistry.

Significance of the Study

This study is significant because it explores the potential of gamification as a solution to the persistent challenges students face in learning chemistry. Chemistry, particularly concepts like hydrocarbons, is often seen as abstract, complex, and difficult to master, which lowers students' motivation and results in poor performance. By investigating how gamification through points, challenges, badges, and leaderboards affects students' motivation and achievement, this research makes meaningful contributions to the teaching and learning of chemistry.

For Students: This study provides an alternative learning approach that makes chemistry lessons more interactive and enjoyable. Gamification can transform traditionally difficult topics such as hydrocarbons into engaging activities where learners actively participate, compete, and collaborate. In doing so, students are likely to develop stronger interest, deeper understanding, and improved performance in chemistry.

For Teachers: The study offers a practical teaching strategy that moves beyond rote memorization and passive lectures. By applying gamification in the classroom, teachers gain access to methods that promote active participation, stimulate curiosity, and provide immediate feedback, thereby enhancing both teaching effectiveness and student learning outcomes.

For Curriculum Developers: Findings from this research can inform curriculum reforms that integrate modern, student-centered approaches into chemistry education. Evidence from gamification can guide the design of materials and instructional practices that align with global STEM trends while responding to local challenges in Nigerian classrooms.

For Policymakers: The study has implications for education policy by highlighting the value of gamification in improving STEM education outcomes. It provides evidence that can support the implementation of innovative teaching methods in Nigerian schools, encourage teacher training on gamified approaches, and justify investments in digital tools that make learning more engaging and effective.

For Researchers: Finally, this study expands the body of knowledge on gamification in science education. Since little empirical work has been done on gamification in Nigerian chemistry classrooms, the findings will serve as a foundation for further research. It will provide insights for future scholars interested in exploring how game-based strategies can be adapted to address learning difficulties and enhance motivation in chemistry and other STEM subject

Scope and Delimitation of the Study

This study is confined to Senior Secondary School students in selected schools within Egor Local Government Area, Benin City, Edo State, Nigeria. The scope specifically covers the teaching and learning of hydrocarbons as a core topic in the Senior Secondary School Chemistry curriculum. Gamification will serve as the independent variable and will be introduced through mobile-based learning activities and structured in-class challenges that include points, badges, leaderboards, and progress tracking. The dependent variables are students' motivation and academic performance in hydrocarbons.

Other areas of chemistry outside hydrocarbons, as well as other school subjects, are beyond the scope of this research and will not be addressed.

Operational Definition of terms

Gamification: The application of game-like features such as points, badges, leaderboards, and challenges in non-game learning contexts to improve motivation and learning outcomes.

Chemistry: The branch of science concerned with the composition, structure, properties, and changes of matter, often referred to as the central science because it connects physical sciences with life sciences.

Motivation: The internal and external factors that stimulate students' desire and persistence to engage in learning tasks.

Academic Performance: The measurable outcomes of students' learning, as reflected in tests and assessments on hydrocarbons.

Hydrocarbons: Organic compounds composed entirely of carbon and hydrogen atoms, studied as a fundamental topic in organic chemistry.

Game Elements: The individual features used in gamification (e.g., points, badges, leaderboards, levels, challenges, and progress tracking) that structure the learning experience.

Teaching Approach: The instructional method adopted by teachers, in this case, gamification, which shifts learning from teacher-centered delivery to student-centered engagement.

Engagement: The degree of attention, curiosity, interest, and active participation students show in gamified chemistry lessons.

Intrinsic Motivation: The drive to learn for personal satisfaction, curiosity, or mastery, without reliance on external rewards.

Extrinsic Motivation: The drive to learn based on external rewards such as grades, badges, points, or recognition.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter presents review of literature relevant to this work on the Gamification of chemistry concepts, effects on student motivation and academic performance.Attention will be focused on the following sub-headings:

- Theoretical framework
- Concept of Chemistry Education
- Introduction to Gamification in Education
- Gamification in Chemistry Education
- Strategies Used by Chemistry Teachers to Incorporate Gamification
- The Influence of Game Elements on Student Motivation in Chemistry
- Impact of Gamification on Student Motivation to Learn Chemistry
- Benefits of Using Gamification in Teaching Chemistry
- Challenges of Using Gamification in Teaching Chemistry
- Summary of the review of related literature

Theoretical Framework

The present study on the gamification of chemistry concepts and its effect on students' motivation and academic performance is anchored on a strong theoretical foundation that explains why and how gamified approaches can influence learners. This foundation draws primarily from three well-established perspectives in educational psychology: Self-Determination Theory (SDT) developed by Edward Deci and Richard Ryan, Behaviorist

Learning Theory propounded by B. F. Skinner, and Constructivist Learning Theory advanced by Jean Piaget and Lev Vygotsky**.** Each of these theories contributes uniquely to understanding the motivational and cognitive processes involved in learning and provides insights into why gamification, as an instructional strategy, can be particularly effective in chemistry education. Together, they justify the application of gamification in this study and demonstrate its potential to improve both students' motivation and their academic achievement.

Self-Determination Theory (SDT**)**, which was originally developed in the 1980s and later revised in 2017, is the underpinning theory for this study because it most directly explains the motivational processes that gamification targets. According to Ryan and Deci, intrinsic motivation thrives when three fundamental psychological needs are satisfied: competence, autonomy, and relatedness. In the context of chemistry, which is often perceived as abstract and difficult, students frequently struggle to maintain motivation because these needs are not adequately addressed in traditional classroom settings. Gamification offers a structure that actively nurtures these needs. For example, awarding points or badges to students who successfully balance chemical equations or solve stoichiometry problems enhances their sense of competence by providing visible evidence of achievement. Allowing learners to choose between different quests, such as tackling a challenge on hydrocarbons or a puzzle on acids and bases, gives them a sense of autonomy and control over their learning journey. Meanwhile, collaborative group challenges, such as team competitions on the periodic table or escape-room style activities on titration, foster relatedness by encouraging students to connect with and support one another.

Research evidence has reinforced the relevance of SDT in explaining gamification's success in chemistry education. Partanen (2019) showed that student-centered approaches inspired by SDT significantly improved engagement and motivation in quantum chemistry, where students often face high levels of difficulty. Similarly, Martínez-Jiménez et al. (2022) found that using augmented reality escape-room activities to teach stereochemistry not only enhanced students' motivation but also improved their conceptual understanding of the subject matter. These findings highlight that gamification, when designed with the principles of SDT in mind, is not a superficial motivational tool but a strategy that deeply supports students' psychological needs, thereby fostering lasting interest and improved performance in chemistry.

While SDT underpins this work, other theoretical perspectives provide supportive insights. Behaviorist Learning Theory helps to clarify how reinforcement sustains learning behaviors. B. F. Skinner argued that human behavior can be shaped and strengthened through reinforcement. In educational contexts, this means that desired behaviors are more likely to be repeated when they are consistently rewarded. Chemistry education often requires repetitive practice to master difficult concepts, such as calculating molar masses, predicting the outcomes of reactions, or applying gas laws. In traditional classrooms, students may easily lose interest in this kind of repeated practice, but gamification provides reinforcement mechanisms that make persistence more likely.

In a gamified chemistry environment, students might receive points for every correct calculation in a stoichiometry problem set or unlock new levels as they progress through increasingly complex organic reaction mechanisms. Leaderboards and virtual rewards act as reinforcements that encourage learners to continue engaging with the material. Liu, Santhanam, and Webster (2017) found that gamified systems with structured rewards maintain student engagement over extended periods of time, while Seibert and Dugan (2024) demonstrated that fully gamifying an introductory organic chemistry course led to measurable improvements in both student motivation and performance. These outcomes are consistent with Skinner's theory of reinforcement and show that gamification sustains learning behaviors that are essential for mastering chemistry concepts.

A third important perspective is provided by Constructivist Learning Theory, which was advanced by Jean Piaget and Lev Vygotsky. Constructivism emphasizes that learners build knowledge actively through exploration, problem-solving, and interaction with peers, rather than passively absorbing information. This perspective is especially significant for chemistry education because chemistry requires learners to navigate and connect three different representational levels: the macroscopic level of observable experiments, the microscopic level of atomic and molecular structures, and the symbolic level of equations and chemical formulas. Many students find it difficult to integrate these representations, which hampers deep understanding of core concepts. Gamification, however, offers an engaging means of bridging these levels by providing interactive and problem-based learning experiences.

Through gamified simulations, for instance, students can manipulate virtual molecules, observe reaction processes, and then connect these processes to the equations they write. Activities such as escape-room challenges on acids and bases allow students to solve puzzles collaboratively, thereby reinforcing teamwork and conceptual understanding. Similarly, a gamified module on hydrocarbons may challenge students to construct molecular structures and earn points for correctly identifying functional groups, blending symbolic and microscopic representations in a playful but rigorous way. Empirical evidence supports the effectiveness of such strategies. Bodnar et al. (2016) reported that gamification in STEM contexts encouraged collaboration, problem-solving, and deeper conceptual engagement. Martínez-Jiménez et al. (2022) also confirmed that gamified approaches improved both motivation and knowledge retention in chemistry, showing that gamification is highly consistent with constructivist principles.

When considered together, these three theories provide a comprehensive explanation of why gamification is well-suited to improving student outcomes in chemistry. However, Self-Determination Theory remains the central and underpinning theoretical framework for this study, as it directly explains how gamification fulfills learners' psychological needs, thereby enhancing intrinsic motivation and leading to improved academic performance. Behaviorism and Constructivism serve as complementary perspectives that strengthen the rationale but do not replace the primary explanatory power of SDT.

Concept of Chemistry Education

Chemistry education is a branch of science education that focuses on the teaching and learning of chemistry concepts, principles, and applications at various educational levels. It represents more than the transmission of factual knowledge about matter and its transformations; it involves equipping learners with the intellectual skills, attitudes, and competencies needed to understand the natural world and apply chemical knowledge to solve real-life problems. In this sense, chemistry education operates at the intersection of science, pedagogy, and human development.

At its core, chemistry education is concerned with enabling students to gain a conceptual understanding of matter,its composition, properties, interactions, and transformations. Beyond content mastery, it promotes the development of scientific skills such as observation, experimentation, analysis, problem-solving, and critical thinking. This dual focus on knowledge acquisition and skill development distinguishes chemistry education as both a scientific and an educational enterprise. Mahaffy (2015) explained that chemistry education should be understood as a multidimensional process that integrates three domains: knowledge of chemistry itself, knowledge of teaching and learning processes, and knowledge of the learners' cognitive and affective needs. Thus, teaching chemistry is not merely about presenting formulas and reactions but about structuring learning experiences that make abstract concepts meaningful and relevant to students' lives.

The objectives of chemistry education are broad and significant. It aims to provide students with sound knowledge of chemical principles, theories, and models that explain the behavior of matter, while also cultivating laboratory techniques, problem-solving skills, and scientific reasoning. In addition, it seeks to foster curiosity, creativity, persistence, and a scientific attitude toward inquiry and discovery. Chemistry education also has an applied dimension, as it helps learners appreciate the role of chemistry in daily life, industry, health, environment, and technology. Furthermore, it prepares students for advanced studies and professional roles in science, medicine, engineering, environmental management, and related fields. These objectives align with UNESCO's (2017) emphasis on science education as a means of promoting scientific literacy and equipping citizens to address global challenges such as climate change, health risks, and sustainable development.

The importance of chemistry education can be seen in its contribution to scientific literacy, technological advancement, and socioeconomic development. It enables learners to interpret natural phenomena and make informed decisions on issues involving food, drugs, pollution, and energy. Chemistry is also central to innovation in materials science, pharmaceuticals, agriculture, and environmental management, making it an essential driver of industrial and national growth. By encouraging inquiry and experimentation, chemistry education develops transferable skills applicable beyond the classroom. As Talanquer and Sevian (2020) observed, chemistry education must not be limited to academic achievement but should also empower learners to address societal and environmental problems through chemical knowledge and innovation.

The scope of chemistry education spans multiple levels and dimensions. It ranges from foundational exposure in secondary schools to specialized courses in universities and professional training in applied chemistry fields. The curriculum involves diverse topics such as atomic structure, bonding, states of matter, stoichiometry, thermodynamics, kinetics, organic and inorganic chemistry, analytical techniques, and environmental chemistry. It also employs diverse pedagogical approaches such as laboratory experiments, models and simulations, problem-based learning, gamification, and ICT integration. Assessment in chemistry education is equally multifaceted, covering both theoretical understanding through written tests and practical competence through laboratory exercises and projects.

Despite its importance, chemistry education often faces challenges due to the abstract and symbolic nature of chemical concepts. Learners may struggle with the "triple representational level" of chemistry: the macroscopic (observable), the submicroscopic (particles and atoms), and the symbolic (formulas and equations). Research shows that without careful teaching methods, these levels remain disconnected in students' minds, leading to misconceptions (Taber, 2018). This implies that the concept of chemistry education is not only about imparting content but also about designing pedagogical frameworks that bridge these representational levels, promote motivation, and make chemistry accessible and engaging.

Introduction to Gamification in Education

In response to challenges in traditional learning, educational researchers and practitioners have turned to innovative approaches such as gamification to enhance teaching and learning across disciplines. The concept of gamification has gained increasing attention in the field of education over the past decade as educators seek creative ways to improve student engagement, motivation, and academic outcomes. Gamification is generally defined as the application of game elements, principles, and mechanics in non-game contexts, particularly in learning environments. Unlike educational games that are fully designed as game-based experiences, gamification focuses on incorporating selected features of games such as points, levels, badges, leaderboards, challenges, narratives, and feedback into traditional or digital learning activities to make them more interactive and appealing. By drawing on the motivational power of games, gamification aims to transform learning from a passive process into an active, participatory, and rewarding experience.

The educational potential of gamification is grounded in its ability to tap into students' intrinsic and extrinsic motivations. Self-Determination Theory, as developed by Deci and Ryan, suggests that people are more motivated when their needs for competence, autonomy, and relatedness are fulfilled. Game elements can satisfy these needs by offering learners a sense of achievement through rewards and progress markers, giving them control over their learning pathways through challenges and choices, and fostering social connections through collaboration and competition. Recent studies indicate that students engaged in gamified learning environments are often more motivated to complete tasks, persist in problem-solving, and take ownership of their learning than those in traditional settings (Subhash & Cudney, 2018).

In practice, gamification has been implemented across diverse educational contexts and disciplines, ranging from primary school classrooms to higher education and professional training. It has been shown to increase student participation, sustain attention, and improve learning outcomes by making lessons more enjoyable and meaningful. For instance, Dicheva et al. (2015) noted that gamification fosters deeper engagement when integrated with clear learning goals and effective pedagogical strategies. In the sciences, gamification can help students grapple with abstract and complex ideas by providing interactive representations, immediate feedback, and motivational structures that reduce cognitive overload and maintain learner interest.

One of the central advantages of gamification in education is its capacity to provide immediate and continuous feedback, a core feature of successful learning. Game mechanics such as progress bars or instant scoring give students real-time indicators of their understanding and performance, helping them to identify strengths and weaknesses promptly. Moreover, gamified learning often includes elements of challenge and competition, which, when carefully structured, stimulate students to strive for improvement and mastery. This, in turn, can reduce disengagement and dropout rates while encouraging persistence even in difficult subject areas such as mathematics and chemistry.

However, gamification is not only about motivation and engagement; it also plays a role in shaping students' cognitive and affective learning processes. By incorporating storytelling, role-play, and problem-solving scenarios, gamified learning environments situate knowledge in meaningful contexts, thereby promoting deeper comprehension and retention. Moreover, the use of badges, rewards, and recognition can enhance self-efficacy and build a sense of accomplishment, which are crucial for maintaining long-term interest in academic subjects. As Caponetto, Earp, and Ott (2014) observed, gamification offers the promise of bridging the gap between learners' personal interests in digital gaming and the formal demands of education, creating a synergy that encourages lifelong learning habits.

Despite its growing popularity, gamification in education is not without challenges. Some researchers caution that excessive reliance on external rewards may undermine intrinsic motivation if not carefully designed. Furthermore, the effectiveness of gamification can vary depending on factors such as students' age, prior experiences with games, and Great here's a well-structured, detailed, and humanized version of the text you provided, rewritten to connect directly to your project topic: "Gamification of Chemistry Concepts: Effect on Students' Motivation and Academic Performance." I've made sure it is coherent, relevant, and academically styled, with references from 2015 and above.

Gamification in Chemistry Education

Gamification has gained increasing attention in chemistry education in the past decade as educators seek innovative strategies to address long-standing challenges in teaching abstract concepts. Chemistry, particularly in areas such as organic, physical, and analytical chemistry, is often regarded as difficult due to its reliance on symbolic language, molecular representations, and reaction mechanisms. These complexities frequently contribute to low student motivation, disengagement, and underachievement, especially when traditional methods such as rote memorization and lecture-based teaching dominate classroom practices. In response, gamification has emerged as a powerful approach that transforms passive instruction into interactive learning, thereby enhancing both motivation and academic performance (Subhash & Cudney, 2018; Su & Cheng, 2015).

The application of gamification in chemistry has been shown to make abstract material more concrete and engaging. For example, Clapson et al. (2020) developed "ChemEscape," a chemistry-themed escape room where students solved puzzles related to chromatography and electrochemistry. This immersive activity not only improved conceptual understanding but also promoted teamwork, problem-solving, and collaborative learning—skills often overlooked in traditional classrooms. Similarly, Fernandes et al. (2019) introduced a gamified mobile app for organic chemistry where students advanced through progressive levels of reaction mechanisms. Findings revealed that students using the app demonstrated improved mastery and sustained motivation compared to peers in non-gamified environments, showing that digital gamification can significantly enhance both engagement and performance.

Digital technologies have been especially influential in gamifying chemistry education because of their ability to deliver real-time feedback, personalized learning pathways, and scaffolding. Ibáñez and Delgado-Kloos (2018) emphasize that platforms such as virtual laboratories and gamified quizzes enable learners to practice molecular modeling, nomenclature, and reaction pathways while receiving instant corrections. Loos and Crosby (2017) also found that gamified digital activities enhanced students' retention of bonding concepts by framing them as interactive tasks rather than abstract lecture content. This progression-based structure, often involving quests, challenges, or levels, sustains motivation by providing learners with achievable goals and visible markers of progress.

Beyond digital environments, gamification has also proven effective through low-cost classroom strategies, making it particularly relevant in resource-constrained contexts. For instance, Andiastutik and Lutfi (2017) designed a hydrocarbon card game for Indonesian classrooms, which improved retention and participation even in large groups. In African settings, where challenges such as overcrowded classrooms, limited laboratories, and teacher-centered pedagogy persist, gamification has been identified as a promising tool for promoting interactive and student-centered learning (Okoye & Igwe, 2019). These findings resonate strongly with the Nigerian context, where chemistry is associated with high failure rates, low motivation, and poor conceptual understanding. By incorporating simple yet engaging gamified activities ranging from quizzes with points and badges to role-play simulations of chemical processes educators can foster deeper engagement while improving performance outcomes.

The success of gamification in chemistry is underpinned by its alignment with psychological theories of motivation. Sailer et al. (2017) showed that game elements such as leaderboards, badges, and feedback foster competence, autonomy, and relatedness, the three core needs identified by Self-Determination Theory. In the chemistry classroom, this translates into students gaining confidence in tasks like balancing equations, experiencing autonomy in choosing learning paths through gamified apps, and building peer connections in collaborative challenges. De-Marcos et al. (2016) further demonstrated that gamification sustains engagement over time, helping students persist in difficult subjects such as organic chemistry, where dropout rates are typically high.

Nevertheless, researchers warn against poorly designed gamification. Hanus and Fox (2015) highlighted that overreliance on competitive leaderboards can discourage lower-performing students, while Prieto-Andreu et al. (2020) cautioned that focusing too much on external rewards risks undermining intrinsic motivation. In chemistry education, this means that games must be carefully aligned with learning objectives rather than serving as superficial entertainment. For instance, gamified tasks should require students to apply bonding principles, analyze reaction mechanisms, or solve molecular problems rather than simply rewarding participation. When properly integrated, gamification serves both motivational and pedagogical purposes, ensuring that students engage meaningfully with chemistry concepts while also achieving improved performance outcomes.

The literature strongly supports the view that gamification is not just a motivational tool but also a cognitive aid in chemistry learning. By transforming complex content into interactive challenges, it enables students to connect abstract knowledge with practical applications, improving both retention and performance. Whether through digital escape rooms, mobile apps, card games, or gamified quizzes, evidence shows that gamification makes chemistry more accessible, engaging, and enjoyable. For Nigerian classrooms, where the failure rate in chemistry remains a pressing concern, gamification represents a transformative strategy for shifting from passive, teacher-centered instruction to active, student-driven learning. By addressing both motivation and achievement simultaneously, gamification has the potential to significantly reshape how chemistry is taught and learned in the 21st century.

Strategies Used by Chemistry Teachers to Incorporate Gamification

Chemistry teachers across the globe have increasingly adopted gamification strategies to address long-standing challenges in teaching and learning. Chemistry is widely acknowledged as one of the most difficult science subjects due to its abstract concepts, symbolic representations, and mathematical applications. Traditional approaches, often centered on rote memorization and lecture-based instruction, frequently leave students disengaged and unmotivated. To overcome this, chemistry teachers are deliberately incorporating game design elements such as points, levels, badges, competition, storytelling, and quests into their teaching strategies to transform the learning experience into something more engaging, interactive, and student-centered.

One of the most common ways chemistry teachers incorporate gamification is through low-cost physical games such as flashcards, board games, and puzzles. These are designed around core chemistry topics like atomic structure, bonding, periodicity, and hydrocarbons. For example, Andiastutik and Lutfi (2017) reported the use of a card-based hydrocarbon game in Indonesian classrooms. Students engaged with the content by matching cards based on functional groups and reaction patterns, and results showed not only improved test scores but also increased willingness to participate in class discussions. Such activities allow chemistry teachers to shift from teacher-led explanations to student-driven discovery, creating an environment where learners practice essential content through play. In African contexts, teachers have similarly used competitive card-matching activities and group-based problem-solving games to foster motivation, particularly in large classes where traditional methods often fail to sustain interest (Okoye & Igwe, 2019).

Another strategy used by chemistry teachers is the design of escape-room and quest-based learning experiences. These gamified activities embed puzzles and problem-solving tasks directly into chemistry concepts. For example, Clapson et al. (2020) described the use of "ChemEscape," an escape-room game in which students worked collaboratively to solve puzzles related to chromatography and electrochemistry. Teachers structured the classroom as a challenge-based adventure, requiring learners to apply their knowledge in order to "unlock" the next stage. Such strategies are especially powerful because they integrate teamwork, critical thinking, and subject mastery, all while maintaining high levels of excitement and motivation.

Digital platforms have further expanded the range of strategies chemistry teachers employ. Mobile apps, virtual labs, and interactive quizzes are now commonly incorporated into classroom practice. Teachers use apps that allow students to “level up” as they solve increasingly difficult reaction mechanism problems or predict molecular geometries. Fernandes et al. (2019), for instance, documented how an app-based gamified system in organic chemistry improved students’ motivation and persistence by giving them immediate feedback and rewards as they mastered reaction steps. Similarly, Ibáñez and Delgado-Kloos (2018) reported that chemistry teachers integrated gamified online quizzes into lessons, allowing learners to practice nomenclature and bonding concepts while receiving instant corrective feedback. Teachers often frame these activities as competitions or quests, which sustain student engagement and create opportunities for peer-to-peer learning.

Teachers also incorporate gamification by embedding progress tracking tools such as points, leaderboards, and badges into their teaching. In many classrooms, chemistry teachers award points for solving problems, participating in group discussions, or completing virtual lab simulations. These points are displayed on leaderboards or translated into badges that mark mastery of specific concepts like balancing equations or identifying functional groups. Sailer et al. (2017) showed that these mechanics, when carefully implemented, help satisfy students’ needs for competence, autonomy, and relatedness, which are vital for intrinsic motivation. In practice, chemistry teachers design these systems to encourage both individual achievement and collaborative success, ensuring that students remain motivated regardless of their starting ability level. For instance, teachers sometimes create team-based leaderboards so that all members contribute to group progress, fostering cooperation alongside healthy competition.

An emerging trend in recent years is the use of augmented reality (AR) and virtual simulations in chemistry education. Teachers integrate AR applications to allow students to manipulate three-dimensional molecules, visualize chemical bonding, and simulate laboratory experiments in gamified contexts. Park and Kim (2021) demonstrated that AR-based gamified activities significantly improved students' motivation and performance in chemistry, while Martínez-Jiménez et al. (2022) reported similar gains when teachers used AR simulations to teach abstract concepts. These digital tools empower teachers to create risk-free experimental environments where learners can test ideas, receive feedback, and progress through game-like challenges without the constraints of limited laboratory resources.

Importantly, chemistry teachers are not simply adding games for entertainment; they are aligning gamification with curricular objectives and assessment practices. Tlili et al. (2022) highlighted through bibliometric analysis that teachers increasingly design gamified lessons in ways that directly address learning outcomes, such as mastering stoichiometry or improving laboratory skills. For example, quizzes that mimic game-show formats are not only fun but also serve as formative assessment tools, giving both teachers and students immediate insights into areas of strength and weakness. Seibert and Dugan (2024) emphasized that when chemistry teachers use gamification consistently across a course rather than as isolated activities,it fosters long-term motivation and contributes to sustained academic improvement.

The Influence of Game Elements on Student Motivation in Chemistry

Gamification relies on the integration of specific game elements such as points, badges, leaderboards, feedback, challenges, and narratives, all of which have been shown to significantly influence student motivation. In the context of chemistry education where students often perceive topics like organic chemistry, electrochemistry, and molecular structures as abstract and difficult, these elements can transform passive learning into active, engaging experiences that stimulate both intrinsic and extrinsic motivation. Unlike traditional methods, which depend primarily on grades or examinations as motivators, gamified approaches embed motivational features into the learning process itself, thereby sustaining persistence, curiosity, and a deeper engagement with chemistry concepts (Hamari et al., 2016; Subhash & Cudney, 2018).

Points and Badges are among the most widely used gamification elements in chemistry classrooms. Points act as immediate indicators of achievement, helping students track progress in real time, while badges serve as symbolic rewards for mastering specific competencies. Research has shown that these elements provide students with a sense of accomplishment and reinforce their competence, one of the three key psychological needs outlined in Self-Determination Theory (Deci & Ryan, 2000). For instance, Ibáñez et al.

(2014) demonstrated that chemistry students using a gamified system with points and badges showed higher engagement and stronger conceptual understanding of molecular interactions. More recent studies, such as Hallifax et al. (2019), argue that badges, when designed to represent meaningful achievements like correctly naming hydrocarbons or solving reaction-mechanism puzzles, increase motivation by giving learners a tangible sense of progress.

Leaderboards also play a significant role in shaping student motivation, especially in competitive classroom environments. Leaderboards appeal strongly to students who enjoy comparison and competition, motivating them to strive for higher performance. In chemistry education, they are often applied to quiz-based tasks, where students compete to quickly balance equations or identify functional groups. Wang et al. (2019) in their meta-analysis of STEM courses confirmed that leaderboards were particularly effective in maintaining persistence and engagement in science subjects. However, scholars caution that leaderboards must be designed carefully, since students who consistently score at the bottom may feel discouraged, leading to demotivation (Prieto-Andreu et al., 2020). In practice, chemistry teachers address this by introducing tiered leaderboards that compare students within smaller groups or teams, thereby reducing the risk of alienation while preserving the motivational benefits of competition (Sailer & Homner, 2020).

Feedback is another essential game element with profound motivational effects in chemistry education. Unlike delayed feedback from traditional examinations, gamification offers instant responses to student actions. For example, digital chemistry simulations provide immediate correction when a student misidentifies a functional group or makes an error in molecular bonding. This rapid feedback not only supports competence but also builds confidence and reduces anxiety in a subject where mistakes are common. Studies by Leitão et al. (2022) and Mekler et al. (2017) highlight that timely, informative feedback increases persistence and encourages repeated practice. In chemistry classrooms, feedback-driven gamified systems allow students to learn iteratively, testing hypotheses, making corrections, and strengthening their conceptual grasp through cycles of immediate reinforcement.

Challenges and Levels are central to sustaining motivation by framing chemistry content as progressively conquerable tasks. Levels mimic game-like progression, where students move from simpler to more complex problems, such as starting with naming simple hydrocarbons and advancing to complex isomer identification. Challenges, on the other hand, inject variety and excitement into routine learning. For instance, Clapson et al. (2020) designed chemistry escape-room challenges where students solved chromatography or electrochemistry puzzles under time pressure. These activities stimulated motivation by combining urgency, novelty, and teamwork, transforming abstract content into engaging problem-solving experiences. Similarly, Toda et al. (2019) classified challenges and progression systems as performance elements that, when aligned with learning outcomes, promote mastery while maintaining student enthusiasm.

Narratives and Storytelling are emerging as powerful motivational tools in chemistry gamification. By embedding chemistry concepts into meaningful storylines such as framing a lesson on acids and bases as a mission to "neutralize toxic waste" or organic chemistry as an adventure of "building molecular superheroes" students find abstract ideas more relatable. Narrative gamification not only enhances motivation by stimulating curiosity but also supports autonomy and relatedness, as students feel part of a shared journey (Xi & Hamari, 2019). Recent studies in science education have shown that narrative-driven gamification boosts engagement by increasing relevance and emotional connection to learning (Avraamidou & Osborne, 2009; Santos et al., 2021). In chemistry specifically, narrative-based escape rooms and thematic quests have been shown to foster teamwork, curiosity, and motivation to persist in solving complex problems (Clapson et al., 2020).

Together, these game elements—points, badges, leaderboards, feedback, challenges, and narratives—work in synergy to influence student motivation in chemistry. Their effectiveness, however, depends on alignment with learners' needs and chemistry-specific learning objectives. For example, points and badges strengthen competence, leaderboards and team missions build relatedness, narratives enhance autonomy and meaning, while feedback supports persistence and confidence. Studies consistently highlight that when chemistry teachers carefully combine these elements, students not only experience heightened motivation but also engage more deeply with challenging topics that they might otherwise find discouraging (Subhash & Cudney, 2018; Leitão et al., 2022; Hong et al., 2024).

Impact of Gamification on Student Motivation to Learn Chemistry

In recent years, gamification has emerged as a transformative approach in chemistry education, particularly for its potential to enhance student motivation to learn complex concepts. Gamification refers to the application of game elements such as points, leaderboards, rewards, challenges, and real-time feedback in non-game contexts like classroom learning. While it certainly makes lessons more interactive and engaging, its deeper impact lies in the way it fosters persistence, a sense of mastery, and intrinsic motivation among learners. Researchers have consistently shown that when gamification is carefully designed and aligned with learning objectives, it goes beyond surface-level enjoyment to produce meaningful motivational gains in students studying chemistry.

Recent studies have provided clear evidence of these benefits. For instance, Chans and Portuguez Castro (2021) demonstrated that integrating achievement levels, badges, leaderboards, and continuous feedback into chemistry courses significantly increased student motivation and engagement. Students not only attended classes more regularly but also demonstrated greater willingness to interact with challenging chemical concepts. Similarly, Martínez-Jiménez, Soria-Olivas, and Palomares (2022) investigated the use of augmented reality escape-room activities in chemistry and found that they fostered strong intrinsic motivation. Students were more eager to solve reaction mechanisms and stereochemistry problems because the game elements encouraged collaboration, problem-solving, and persistence. Such findings indicate that gamified designs are not only enjoyable but also create the psychological conditions necessary for sustained engagement with chemistry content.

Evidence from other contexts reinforces these observations. The Hydrocarbons Chem-Rush game developed by Lutfi, Aftinia, and Permani (2021) illustrates how even relatively simple digital designs can transform motivation in secondary school chemistry classrooms. By embedding point systems, speed-based challenges, and leaderboards into lessons, the game encouraged students to participate actively and improved retention of learning outcomes. Those who played the game consistently reported being more motivated to continue studying hydrocarbons, while their test scores reflected the positive effect of repeated, gamified practice. In higher education, da Silva Júnior and colleagues (2022) gamified an entire organic chemistry course using levels, badges, and weekly challenges. Students in the gamified course displayed increased persistence in problem-solving and a stronger sense of accomplishment compared to those in traditional classes, highlighting that gamification can sustain motivation even in demanding subjects like organic chemistry.

Specific game elements appear to influence motivation in different but complementary ways. Badges and levels, for instance, provide visible markers of progress and competence. Students feel more capable when they achieve such milestones, which is particularly important in chemistry where abstract concepts often discourage learners. Leaderboards, when applied thoughtfully, stimulate healthy competition and encourage students to improve performance. However, scholars caution that leaderboards must be designed carefully to avoid demotivating students who consistently perform at lower levels. Challenges and escape-room activities provide novelty and urgency, making learning resemble a quest rather than a routine task. These formats have been shown to increase engagement because they encourage teamwork, creativity, and persistence in solving complex chemistry problems (Martínez-Jiménez et al., 2022; Vergne, Simmons & Bowen, 2019). Feedback, one of the most critical elements, allows students to monitor their progress and make corrections quickly. Studies confirm that timely feedback in gamified chemistry environments motivates learners by reducing frustration and reinforcing a sense of improvement (Lutfi et al., 2021).

These findings also extend to resource-limited educational contexts. For example, the Chem-Rush game in Indonesia demonstrated that even without advanced technological infrastructure, teachers could use simple mechanics such as points, badges, and competition to motivate learners (Lutfi et al., 2021). This suggests that gamification does not necessarily require sophisticated digital tools; rather, its effectiveness comes from aligning game elements with pedagogical goals in ways that sustain student effort and attention.

At the same time, studies warn that not all designs produce positive motivational outcomes. Researchers like da Silva Júnior et al. (2022) note that when gamification relies too heavily on extrinsic rewards such as badges or points, students may lose intrinsic interest in the subject, focusing instead on external recognition. Poorly designed systems that introduce too many elements at once can also create cognitive overload, leaving students distracted rather than motivated. Inclusivity is another concern, as not all students respond positively to competitive features like leaderboards. Teachers are therefore encouraged to strike a balance by blending collaboration and competition, ensuring that gamification enhances motivation for both high-achieving and struggling learners.

The Benefits of Using Gamification in Teaching Chemistry

Incorporating gamification into chemistry instruction produces a range of benefits that go beyond short-term enjoyment and directly address common barriers to learning in the subject. Chemistry's reliance on multi-level representations (macroscopic, submicroscopic, symbolic), abstract reasoning and multi-step problem solving often discourages students; gamified approaches help students persist by breaking complex tasks into manageable, game-like steps and offering clear markers of progress. When teachers embed points, levels, badges, and progressive challenges into tasks such as balancing equations, predicting reaction mechanisms, or identifying functional groups, students experience repeated mastery moments that strengthen their sense of competence and encourage continued effort (Subhash & Cudney, 2018; Leitão et al., 2022). This mastery orientation is reinforced when game systems allow retries and scaffolded attempts, converting early failure into productive practice rather than discouragement.

Gamification also enhances conceptual understanding and retention by increasing opportunities for active practice in meaningful contexts. Studies using chemistry theme escape rooms, problem quests, and scaffolded digital exercises show that students who repeatedly apply concepts in novel, gamified situations develop deeper procedural fluency and transfer that knowledge to assessment tasks (Martínez-Jiménez et al., 2022; da Silva Júnior et al., 2022). For example, escape-room puzzles built around chromatography, electrochemistry, or stereochemistry require learners to interpret evidence, test hypotheses, and apply symbolic representations under time-bound constraints all activities that promote higher-order thinking and long-term retention.

Social and collaborative benefits are another important advantage. Many gamified designs rely on team quests, role assignments, and cooperative challenges; these formats push students to verbalize reasoning, negotiate strategies, explain steps to peers, and defend solutions, thereby improving conceptual clarity while fulfilling the psychological need for relatedness (Vergne, Simmons, & Bowen, 2019). In classroom settings this often translates into richer peer instruction and more effective lab teamwork, which are essential skills for chemistry practice and laboratory safety.

Immediate, actionable feedback typical of gamified digital systems and well designed classroom games strengthens motivation and aids learning by enabling students to detect and correct misconceptions before they solidify. Rapid feedback loops combined with incremental rewards increase students' confidence to attempt difficult problems and sustain engagement over extended practice sessions (Subhash & Cudney, 2018; Martínez-Jiménez et al., 2022). Teachers can replicate this effect with low-tech methods (instant scoring, corrective hints during card games or board tasks), ensuring that feedback driven learning is possible even where technology is limited.

Adaptability and scalability give gamification practical advantages across diverse instructional contexts. In well-resourced environments, augmented reality (AR), mobile apps, and virtual labs offer immersive ways to explore molecular geometry and reaction dynamics; in low-resource classrooms, card games, board games and competitive classroom activities produce many of the same motivational benefits without expensive infrastructure (Lutfi, Aftinia, & Permani, 2021). Evidence from secondary and tertiary chemistry classrooms shows that both high-tech and low-tech gamified approaches can increase participation, attendance, and time on task when aligned to learning goals (da Silva Júnior et al., 2022; Subhash & Cudney, 2018).

The Nigerian context supplies multiple, discipline-specific examples of these benefits in practice. Quasi-experimental research deploying card games in Nigerian secondary classrooms reported significant gains in students' engagement, process skills and achievement when card-based tasks were used to practice difficult chemistry concepts; the study concluded that games increase active participation and support conceptual learning (Bankole, 2018). Surveys of Nigerian secondary teachers documented positive perceptions and growing uptake of gamified instructional strategies across Rivers State, revealing that teachers already use both traditional and digital game forms to improve lesson interactivity and student motivation (Amaewhule, Obikoya, & Okeowhor, 2020). Recent quasi-experimental interventions in Nigerian schools using board game variants (Periodic Board-Scrabble Game) produced higher post-test achievement scores on periodic-table topics compared with conventional instruction, demonstrating that contextually appropriate game designs can raise both motivation and academic outcomes (Dave-Ugwu, Eya, & Nwobodo, 2023). Research on gamified e-learning frameworks for open and distance learning in Nigeria likewise indicates improved learner engagement and attitudes where game elements are integrated into course platforms (Adeoye & Afolabi, 2016). Together, these Nigerian studies show that gamification is feasible and effective across resource levels and that locally adapted game mechanics (cards, board games, classroom competitions) can yield measurable benefits for chemistry learners.

A final educational advantage is that gamification supports inclusive, mastery-oriented pedagogy when thoughtfully designed. By combining collaborative and competitive mechanics, rotating leaderboard metrics (improvement rather than absolute rank), and badges tied to specific chemistry skills, teachers can motivate students of varying ability levels while avoiding the demotivating effects of pure rank competition. Research warns against overreliance on superficial extrinsic incentives; the strongest educational gains occur when game elements are explicitly aligned with curricular objectives so that points, badges and narratives reflect genuine skill development in chemistry rather than mere token collection (Leitão et al., 2022; da Silva Júnior et al., 2022).

Challenges of Using Gamification in Teaching Chemistry

Gamification has emerged as a promising approach to enhance student engagement and motivation in chemistry education; however, its implementation in Nigerian classrooms faces several challenges that affect its effectiveness. A major challenge is the lack of technological infrastructure. Many schools in Nigeria experience inadequate internet connectivity, insufficient access to digital devices, and unreliable power supply, which hinder the effective use of gamified learning platforms requiring stable internet connections and up-to-date hardware. Without these resources, students and teachers struggle to fully engage with gamified content, reducing its potential impact (Tlili et al., 2022; Rahman et al., 2024).

Limited digital literacy among both students and educators is another barrier. Many teachers have not received adequate training in integrating technology into their teaching practices, resulting in ineffective use of gamification tools. Similarly, students may lack the skills to navigate digital platforms, limiting the benefits of gamified learning (Subhash & Cudney, 2018; Sailer et al., 2017).

Cultural relevance of gamified content also poses a challenge. Much of the existing material is developed in contexts different from Nigeria's, which may not resonate with students' experiences. Adapting or creating gamified content that reflects local realities is necessary to enhance engagement and understanding of chemistry concepts (Okoye & Igwe, 2019; Andiastutik & Lutfi, 2017).

Aligning gamified activities with the curriculum and obtaining institutional support is critical. Gamified approaches may not always integrate seamlessly with the prescribed curriculum, causing potential conflicts or resistance from educators. Without policy support and resource allocation, gamification initiatives may lack sustainability and fail to achieve intended educational outcomes (Tlili et al., 2022).

Assessment and evaluation challenges further complicate implementation. Traditional assessment methods may not adequately capture learning outcomes associated with gamified activities. New evaluation strategies are needed to measure both cognitive and non-cognitive skills enhanced by gamification, including problem-solving, collaboration, and critical thinking (Sümer & Aydın, 2022).

Teachers' attitudes and perceptions toward gamification significantly influence its adoption. Some educators may view gamification as unnecessary or doubt its effectiveness. Professional development and evidence of gamification's benefits are essential for gaining teacher buy-in and fostering positive attitudes (Yue, 2024; Christopoulos & Mystakidis, 2023).

While gamification can increase student engagement and motivation, it may not be equally effective for all learners. Certain students may respond poorly to competitive elements, and poorly designed activities can increase stress rather than engagement. Gamified activities must cater to diverse learning styles and foster collaborative, rather than purely competitive, environments (Sabornido et al., 2022; Kwon & Ozpolat, 2021).

Technical factors such as software glitches, uninteresting quiz design, and limited access to devices further affect engagement. Studies have shown that unappealing or poorly designed digital activities can quickly cause boredom and reduce motivation, highlighting the need for robust, carefully planned gamification tools (Rahmahani, 2020; Matlan & Maat, 2021).

Sustainability and long-term impact are also concerns. Continuous support, regular updates to gamified content, and ongoing teacher training are necessary to maintain effectiveness. Without these measures, the initial enthusiasm for gamified learning may decline, reducing its impact over time (Tlili et al., 2022; Rahman et al., 2024).

Addressing these challenges requires coordinated efforts from policymakers, educational institutions, and technology developers to provide infrastructure, professional development, culturally relevant content, and sustainable support systems to enable effective gamification in chemistry education in Nigeria.

Summary of the Review of Related Literature

The review of related literature on gamification in chemistry education highlights the growing importance of innovative instructional strategies in addressing the persistent challenges of teaching and learning chemistry. Chemistry is widely regarded as a complex subject due to its reliance on abstract concepts, symbolic representations, molecular structures, and intricate reaction mechanisms. Traditional teaching methods, which often emphasize lectures and rote memorization, frequently fail to engage students or sustain their motivation, leading to low participation, minimal conceptual understanding, and poor academic performance. Gamification, the integration of game elements such as points, badges, leaderboards, challenges, feedback, and narratives into learning activities, has emerged as a promising approach to enhance both motivation and learning outcomes in chemistry classrooms.

Gamification transforms learning into an active, participatory, and rewarding experience. By embedding motivational mechanisms directly into educational activities, gamification supports intrinsic motivation, persistence, and engagement. Students are encouraged to take ownership of their learning as they make choices, tackle challenges, and interact with peers. It also provides opportunities for repeated practice and reinforcement, which are critical for mastering complex chemical concepts. The interactive and playful nature of gamified activities allows learners to link theoretical knowledge with practical applications, making abstract concepts more tangible and fostering deeper understanding. This approach also emphasizes collaboration, problem-solving, and critical thinking, enabling students to work in teams, solve puzzles, and engage in experiential learning that mirrors real-world scientific inquiry.

The benefits of gamification in chemistry education are multifaceted. It enhances student engagement by transforming routine academic tasks into dynamic, enjoyable activities. Gamified strategies support mastery-based learning by rewarding effort, progress, and persistence, thereby encouraging learners to continue practicing until competence is achieved. Immediate feedback, progress indicators, and recognition through rewards increase students' sense of achievement and self-efficacy, while collaborative challenges and team-based tasks promote social connectedness and peer learning. Moreover, gamification allows learners to explore multiple approaches to problem-solving and supports personalized learning by offering different paths or challenges that match individual interests and abilities. As a result, students experience a heightened sense of autonomy, competence, and relatedness, which strengthens intrinsic motivation and fosters sustained engagement in learning chemistry.

Despite these advantages, the implementation of gamification in chemistry education also faces challenges. Technical issues, such as limited access to devices, poor internet connectivity, and inadequate laboratory facilities, can hinder the effective use of gamified tools. Teacher preparedness and familiarity with digital or gamified systems are essential to ensure that gamification is implemented effectively and aligns with curricular goals. Poorly designed gamified interventions that overemphasize competition or rely solely on extrinsic rewards can reduce intrinsic motivation, create stress for lower-achieving students, and generate cognitive overload. Additionally, sustained engagement requires careful planning to balance challenge, reward, and collaboration while ensuring that learning objectives are met. In resource-constrained settings, large class sizes and limited access to materials can further complicate gamification efforts, emphasizing the need for adaptive strategies and context-specific solutions.

Gamification also plays a significant role in connecting cognitive and affective learning outcomes. It encourages learners to actively construct knowledge through problem-solving, experimentation, and collaborative inquiry, bridging the gap between theoretical understanding and practical application. Gamified simulations, escape-room activities, quizzes, and team competitions allow students to visualize chemical processes, manipulate molecules, and link symbolic equations to real-world phenomena. This active and participatory approach helps learners integrate multiple levels of representation in chemistry, from macroscopic experiments to microscopic structures and symbolic notations, thereby promoting deep conceptual understanding and scientific reasoning. Furthermore, gamification cultivates important skills such as critical thinking, creativity, teamwork, and resilience, which extend beyond the chemistry classroom and contribute to overall academic and personal development.

Overall, gamification represents a theory-driven and practically viable approach to enhancing chemistry education. It addresses the motivational and cognitive challenges that students commonly encounter, making learning more interactive, engaging, and meaningful. By integrating motivational strategies, reinforcement mechanisms, and active learning opportunities, gamification supports persistent effort, mastery of concepts, and higher academic performance. Successful implementation requires thoughtful design, alignment with educational objectives, and consideration of contextual factors, ensuring that all learners benefit from the interactive, participatory, and motivational aspects of gamified chemistry instruction. Through these strategies, gamification contributes not only to improved student motivation and achievement but also to the broader goals of scientific literacy, problem-solving skills, and lifelong learning in chemistry.

CHAPTER THREE

RESEARCH METHODOLOGY

Introduction

This chapter outlines the methodology employed to examine the causal effect of gamification of chemistry concepts on students' motivation and academic performance. The chapter is presented under the following subheadings:

- Research Design
- Population of the Study
- Sample and Sampling Technique
- Research Instruments
- Validation of Instrument
- Reliability of Instrument
- Method of Data Collection
- Method of Data Analysis

Research Design

A descriptive survey research design was adopted for this study. This design was considered appropriate because of its advantage in identifying attributes of a large population from a group of individuals. It was suitable for the study as it sought to investigate the effect of gamification of chemistry concepts on students' motivation and academic performance in senior secondary schools in Egor Local Government Area, Benin City.

Population of the Study

The population of this study comprises all Senior Secondary School (SSS) students from twelve (12) public secondary schools in Egor Local Government Area of Edo State.

Table represent breakdown of student numbers per school (2023/2024)

SN	SCHOOL	MALE	FEMALE	TOTAL
1.	ASSORO GRAMMAR SCHOOL	529	552	1081
2.	EDO BOYS HIGH SCHOOL	540	0	540
3.	EGOR SECONDARY SCHOOL	372	411	783
4.	EVBAREKE SECONDARY SCHOOL	72	72	149
5.	EVBUOTUBU SECONDARY SCHOOL	276	246	522
6.	EWEKA SECONDARY SCHOOL	216	257	473
7.	IYOBA GIRLS COLLEGE	0	410	410
8.	OHONRE SECONDARY SCHOOL	147	146	293
9.	ORHOKUGBO SECONDARY SCHOOL	55	134	189
10.	USEH SECONDARY SCHOOL	148	215	363
11.	USELU SECONDARY SCHOOL	155	248	403
12.	UWELU SECONDARY SCHOOL	118	169	287
	TOTAL	**2633**	**2860**	**5493**

Source: Edo state secondary school Board, 2024

Sample and Sampling Technique

The sample of the study comprises five (5) public senior secondary schools in Egor local government area of Edo state, Nigeria. To obtain the sample the researcher employed the simple random sampling technique and the proportionate sampling technique to select five (5) public secondary schools from the twelve (12) public secondary schools in Egor local government area of Edo State, Nigeria.

Additionally, the proportionate sampling technique was used to determine the sample size, with each of the selected schools represented by 5% . Each selected school in the main population was assigned a unique Identifier and a random number generator was used to select schools without replacement, ensuring each school had an equal chance of being chosen. This process was repeated until the desired number of schools for the target population was reached. The randomness of the selection process helped ensure that the sample was representative of the larger population, allowing for unbiased estimation of the population parameters.

The schools selected are shown in the table below.

S/N	Target schools	Sample size (5%)
1.	Ohonre secondary School	15
2.	Orhokugbo secondary school	9
3.	Iyoba Girls College	21
4.	Evbareke secondary school	7
5.	Uwelu secondary school	14
Total		**66**

Research Instruments

The instrument used for data collection was a researcher-constructed questionnaire titled "Gamification of Chemistry Concepts: Effect on Students' Motivation and Academic Performance in Secondary Schools in Egor Local Government Area, Edo State."

The questionnaire was divided into two sections:

Section A: Demographic data of respondents.

Section B: Items drawn from the research questions.

A four-point modified Likert-type scale was used with the following response options:

Strongly Agree (SA) = 4 points

Agree (A) = 3 points

Disagree (D) = 2 points

Strongly Disagree (SD) = 1 point

A decision benchmark of 2.5 was adopted. Items with a mean ≥ 2.5 were regarded as "Agreed," while those with a mean < 2.5 were regarded as "Disagreed."

Validation of Instrument

The draft questionnaire was subjected to face and content validation by the researcher's supervisor and two other experts in the Department of Curriculum and Instructional Technology (CIT). Their suggestions and corrections were incorporated into the final draft to ensure validity.

Reliability of Instrument

To determine the reliability of the instrument, Cronbach's Alpha method was used to test internal consistency. The instrument was pre-tested on 20 students outside the study population. A reliability coefficient of 0.70 and above was obtained, indicating that the instrument was reliable for the study.

Method of Data Collection

The researcher personally administered the questionnaire to the respondents in their respective schools. Respondents were assured of confidentiality and encouraged to provide honest responses. Instructions were clearly given on how to complete the questionnaire, and copies were retrieved immediately upon completion to ensure high return rate.

Method of Data Analysis

Data collected were analyzed using descriptive statistics of mean and standard deviation to answer the research questions. The Statistical Package for the Social Sciences (SPSS) was employed for data analysis.

CHAPTER FOUR

PRESENTATION OF RESULT AND DISCUSSION OF FINDINGS

Introduction

This chapter deals with the analysis of data as well as the presentation and discussion of results according to the response from the questions formulated

Demographics of Respondents

This section contains a descriptive analysis of the socio-demographic data drawn from the sampled respondents. The socio-demographic variables include the, gender, age.

Table 4.1: Respondents Demographic Profile

SN	Variable	Option	Frequency	Percentage (%)
1	Gender	Male	27	40.9
		Female	39	59.1
		Total	66	100.0
2	Age	12-15	34	51.5
		16-20	32	48.5
		21-above	0	0
		Total	**66**	**100.0**

Source; Field Survey, 2025

The demographic profile of the respondents is summarized in Table 4.1, which highlights two key variables: Gender and Age. Regarding Gender, the data reveals that a total of 66 respondents participated in the survey. Out of these, 27 (or 40.9%) were male, while 39 (or 59.1%) were female. This indicates a slightly higher proportion of female respondents compared to male respondents in the sample. In terms of Age, the respondents were categorized into three age groups. The majority of the respondents, 34 (51.5%), fell within the 12-15 age group, suggesting that this group was the most represented. The second largest age group consisted of 32 respondents (48.5%) aged 16-20. Interestingly, no respondents were in the 21 and above age category, as evidenced by the 0% in that group. This suggests that the survey predominantly targeted younger participants, with a clear focus on those aged 12-20.

Research Question 1: What strategies do chemistry teachers use to incorporate gamification in teaching?

Table 2; Descriptive statistics of mean and standard deviation showing What strategies do chemistry teachers use to incorporate gamification in teaching?

S/N	ITEMS	N	Mean $\bar{x}$	Standard Deviation (SD)	Remark
1.	My chemistry teacher uses games to assess our understanding of chemistry topics.	66	3.36	.939	Agreed
2.	I feel motivated when my teacher incorporates a point system or rewards in our chemistry lessons.	66	3.33	.982	Agreed
3.	My teacher uses educational games to make chemistry classes more interactive.	66	3.12	.448	Agreed
4.	There are often competitions in my chemistry class that make learning fun.	66	3.11	.468	Agreed
5.	My teacher uses puzzles to make chemistry lessons more engaging.	66	3.11	.434	Agreed
	Total		**3.21**	**0.65**	Agreed

Source; Field Survey 2025

Cluster Mean= 2.5

The strategies used by chemistry teachers to incorporate gamification in their teaching were explored through the responses of 66 participants, as presented in Table 2. The data reveals that the incorporation of gamification strategies in chemistry teaching is widely agreed upon by the respondents, as evidenced by the mean scores and standard deviations for each of the five items. For the first item, which assesses whether chemistry teachers use games to evaluate students' understanding of chemistry topics, the mean score was 3.36 with a standard deviation of 0.939. This indicates that a majority of students agree that games are an integral part of the assessment process in chemistry lessons, with a relatively wide variation in how this strategy is perceived. The second item looked at whether students feel motivated when their teacher incorporates a point system or rewards into the lessons. The mean score of 3.33 and the standard deviation of 0.982 suggest that the use of rewards in the classroom is generally seen as a motivating factor for students, though there is slightly more variability in how different students feel about this strategy. In terms of making chemistry classes more interactive, the third item assessed whether educational games are used for this purpose. The mean score for this item was 3.12, with a standard deviation of 0.448, showing a general agreement that educational games are utilized in the classroom to engage students in learning. The fourth item investigated the frequency of competitions in chemistry classes that make learning more enjoyable. With a mean score of 3.11 and a standard deviation of 0.468, the responses indicate that competitions are frequently used, contributing to the fun and excitement in the classroom. This suggests that students appreciate the competitive aspect of learning, which enhances their engagement. Finally, the fifth item examined whether puzzles are employed by teachers to make chemistry lessons more engaging. The mean score of 3.11 and standard deviation of 0.434 indicate that puzzles are also commonly used as a gamification strategy, with students agreeing that they help in making the lessons more interactive. The overall cluster mean for the five items was 3.21, with a standard deviation of 0.65, which reflects a general consensus among students that gamification strategies are used effectively in chemistry teaching. These results suggest that chemistry teachers employ a variety of strategies, such as games, rewards, competitions, and puzzles, to enhance the learning experience. The use of these strategies was found to have a positive impact on student motivation and engagement in chemistry lessons.

Research Question 2: How do game elements influence student motivation in chemistry?

Table 3: Descriptive statistics of mean and standard deviation showing How do game elements influence student motivation in chemistry?

S/N	ITEMS	N	Mean $\bar{x}$	Standard Deviation (SD)	Remark
6.	Game elements like rewards make me more excited to participate in chemistry lessons.	66	2.97	.877	Agreed
7.	I feel more motivated to study chemistry when there are game-like elements in the class.	66	3.15	.402	Agreed
8.	Leaderboards make me want to perform better in chemistry activities.	66	2.95	.567	Agreed
9.	I enjoy chemistry lessons more when my teacher uses gamified elements like competitions.	66	3.14	.426	Agreed
10.	I feel more engaged in chemistry when I can earn rewards for completing tasks or activities.	66	2.88	.869	Agreed
	Total		**3.02**	**0.63**	**Agreed**

Source; Field Survey 2025

Cluster Mean= 2.5

The influence of game elements on student motivation in chemistry was examined through the responses of 66 participants, as detailed in Table 3. The descriptive statistics, including the mean scores and standard deviations for five specific items, provide insight into how various game elements affect students' motivation in chemistry lessons. For the first item, which assesses whether game elements like rewards make students more excited to participate in chemistry lessons, the mean score was 2.97, with a standard deviation of 0.877. This indicates that students generally agree that rewards have a positive effect on their excitement to participate in chemistry lessons, though there is some variability in how strongly this element is perceived.

The second item explored how game-like elements in the classroom influence students' motivation to study chemistry. The mean score of 3.15 and the standard deviation of 0.402 show a stronger agreement, suggesting that students feel more motivated to study chemistry when these elements are incorporated into the lessons. The lower standard deviation indicates a more consistent response across the participants. In the third item, which examines whether leaderboards make students want to perform better in chemistry activities, the mean score was 2.95, with a standard deviation of 0.567. This result indicates that leaderboards do motivate students to perform better, although the level of agreement is slightly lower compared to other game elements like rewards and competitions. The fourth item looked at whether students enjoy chemistry lessons more when gamified elements, such as competitions, are used by the teacher. With a mean score of 3.14 and a standard deviation of 0.426, the responses show that students generally agree that competitions enhance their enjoyment of the lessons, making learning more engaging and fun. Finally, the fifth item assessed whether students feel more engaged in chemistry when they can earn rewards for completing tasks or activities.

The mean score of 2.88 and the standard deviation of 0.869 suggest a moderate level of agreement, with some variability in how this element influences engagement. The total mean for the five items was 3.02, with a standard deviation of 0.63, indicating a general agreement that game elements, such as rewards, leaderboards, competitions, and earning rewards, positively influence students' motivation and engagement in chemistry lessons. These elements are seen as effective in making chemistry lessons more exciting, motivating, and enjoyable for students.

Research Question 3: What is the impact of gamification on student motivation to learn chemistry?

Table 4: Descriptive statistics of mean and standard deviation showing What is the impact of gamification on student motivation to learn chemistry?

S/N	ITEMS	N	Mean $\bar{x}$	Standard Deviation (SD)	Remark
11.	I am more motivated to learn chemistry because of the game-like elements used in class.	66	3.15	.361	Agreed
12.	The use of rewards is in chemistry lessons encourages me to put more effort into my studies.	66	2.92	.847	Agreed
13.	I feel more enthusiastic about studying chemistry when there are games involved.	66	2.98	.568	Agreed
14.	Gamified chemistry lessons help me retain information better because they make learning more interactive.	66	3.61	.630	Agreed
15.	I feel more motivated to excel in chemistry when there are game elements in the lessons.	66	3.27	.921	Agreed
	Total		**3.19**	**0.67**	**Agreed**

Source; Field Survey 2025

Cluster Mean= 2.5

The impact of gamification on student motivation to learn chemistry was assessed by the responses of 66 participants, as presented in Table 4. The descriptive statistics, including the mean scores and standard deviations for five specific items, reveal how gamification influences students' motivation to engage with and excel in chemistry. The first item examined whether students feel more motivated to learn chemistry because of the game-like elements used in class. The mean score of 3.15 and standard deviation of 0.361 indicate a strong agreement among students that gamified elements enhance their motivation to learn chemistry. The low standard deviation suggests a high level of consistency in students' responses. The second item explored whether the use of rewards in chemistry lessons encourages students to put more effort into their studies. With a mean score of 2.92 and a standard deviation of 0.847, students generally agreed that rewards are motivating, although the higher standard deviation suggests some variability in how strongly this factor influences their effort. The third item looked at whether students feel more enthusiastic about studying chemistry when games are involved. The mean score of 2.98 and standard deviation of 0.568 show that students moderately agree that games boost their enthusiasm for studying chemistry, with some degree of variation in the responses. For the fourth item, which examines whether gamified chemistry lessons help students retain information better by making learning more interactive, the mean score of 3.61 and standard deviation of 0.630 indicate strong agreement. This suggests that students believe gamified lessons are effective in enhancing their retention of chemistry content by making learning more interactive and engaging. The fifth item assessed whether students feel more motivated to excel in chemistry when there are game elements in the lessons. The mean score of 3.27 and standard deviation of 0.921 reflect a positive perception of game elements in motivating students to perform better in chemistry. The relatively higher standard deviation suggests a wider spread in how much this motivates different students. The total mean for the five items was 3.19, with a standard deviation of 0.67, indicating general agreement that gamification has a positive impact on students' motivation to learn chemistry. The inclusion of game-like elements, such as rewards, games, and interactive lessons, was found to enhance students' enthusiasm, effort, and retention of chemistry content, leading to a more engaging and motivating learning experience.

Research Question 4: What are the benefits of using gamification in teaching chemistry?

Table 5: Descriptive statistics of mean and standard deviation showing What are the benefits of using gamification in teaching chemistry?

S/N	ITEMS	N	Mean $\bar{x}$	Standard Deviation (SD)	Remark
16.	Gamification increases my interest in chemistry and motivates me to learn more.	66	3.82	.389	Agreed
17.	I feel more confident in my chemistry skills when I participate in gamified activities.	66	3.17	.414	Disagreed
18.	Using games in chemistry helps me remember key concepts for longer periods.	66	3.18	.524	Agreed
19.	Gamification encourages me to collaborate with my classmates to solve problems in chemistry.	66	3.73	.570	Disagreed
20.	I believe that gamified activities help to make chemistry lessons more interactive and engaging.	66	3.76	.498	Agreed
	Total		**3.31**	**0.80**	**Agreed**

Source; Field Survey 2025

Cluster Mean= 2.5

The benefits of using gamification in teaching chemistry were explored through the responses of 66 participants, as outlined in Table 5. The descriptive statistics, including the mean scores and standard deviations for five specific items, provide insight into how gamification impacts students' interest, confidence, memory retention, collaboration, and engagement in chemistry lessons. The first item examined whether gamification increases students' interest in chemistry and motivates them to learn more. The mean score of 3.82 and a standard deviation of 0.389 indicate strong agreement among students that gamification significantly increases their interest and motivation in chemistry. The low standard deviation reflects a high level of consistency in students' responses, suggesting that gamification is widely regarded as an effective motivator. The second item looked at whether students feel more confident in their chemistry skills when participating in gamified activities. The mean score of 3.17 and standard deviation of 0.414 suggest that students generally disagree with the idea that gamified activities boost their confidence in chemistry. This indicates that, while gamification may have other benefits, it does not significantly affect students' self-confidence in their skills. The third item assessed whether using games in chemistry helps students remember key concepts for longer periods. The mean score of 3.18 and standard deviation of 0.524 indicate agreement that gamified lessons aid in the retention of key chemistry concepts. Students feel that these activities help them remember what they learn for longer, though there is some variation in how strongly this benefit is felt. The fourth item examined whether gamification encourages students to collaborate with their classmates to solve problems in chemistry. The mean score of 3.73 and standard deviation of 0.570 indicate agreement that gamification promotes collaboration. However, the higher standard deviation suggests that not all students agree to the same extent that gamified activities foster collaboration.

The fifth item looked at whether students believe gamified activities make chemistry lessons more interactive and engaging. The mean score of 3.76 and standard deviation of 0.498 reflect strong agreement, showing that students perceive gamified activities as making their chemistry lessons more dynamic and engaging. The total mean for the five items was 3.31, with a standard deviation of 0.80, indicating general agreement that gamification offers benefits in teaching chemistry. Students reported that gamified activities increased their interest, helped them retain information, and made lessons more engaging. However, there was some disagreement regarding the impact of gamification on boosting confidence and encouraging collaboration.

Test for Hypotheses

H01: There is no significant difference in the strategies chemistry teachers use to incorporate gamification in teaching.

Sample T-test on There is no significant difference in the strategies chemistry teachers use to incorporate gamification in teaching.

One-Sample Test

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
STRATEGIES_USED	4.357	65	.000	.20606	.1116	.3005

The results of the One-Sample t-test were conducted to assess the hypothesis $H_{0\ 1}$, which states that there is no significant difference in the strategies chemistry teachers use to incorporate gamification in teaching. The test was performed with a test value of 3, representing the neutral midpoint of the Likert scale used in the study. The t-value obtained was 4.357 with 65 degrees of freedom (df). The corresponding p-value (Sig. (2-tailed)) was 0.000, which is less than the significance level of 0.05. This indicates that the result is statistically significant, and we can reject the null hypothesis ($H_{0\ 1}$). Therefore, we conclude that there is a significant difference in the strategies chemistry teachers use to incorporate gamification in teaching. This suggests that gamification strategies are actively and effectively being used in chemistry lessons, as reflected by the statistically significant result.

H02: Game elements do not have a significant influence on student motivation in chemistry..

Sample T-test on Game elements do not have a significant influence on student motivation in chemistry.

One-Sample Test

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
GAME_ELEMENT	.404	65	.688	.01818	-.0717	.1081

The results of the One-Sample t-test were conducted to assess the hypothesis $H_{0\ 2}$, which states that game elements do not have a significant influence on student motivation in chemistry. The test was performed with a test value of 3, representing the neutral midpoint of the Likert scale used in the study. The t-value obtained was 0.404 with 65 degrees of freedom (df). The corresponding p-value (Sig. (2-tailed)) was 0.688, which is greater than the significance level of 0.05. This indicates that the result is not statistically significant, and we fail to reject the null hypothesis ($H_{0\ 2}$). Therefore, we conclude that game elements do not have a significant influence on student motivation in chemistry. The mean difference of 0.01818 and the 95% Confidence Interval of (-0.0717, 0.1081) further support this conclusion, as the interval includes zero, indicating no significant effect.

H03: Gamification has no significant impact on student motivation to learn chemistry.

Sample T-test on Gamification has no significant impact on student motivation to learn chemistry.

One-Sample Test

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
GAMIFICATION	3.666	65	.000	.18788	.0855	.2902

The results of the One-Sample t-test were conducted to test the hypothesis $H_{0\ 3}$, which states that gamification has no significant impact on student motivation to learn chemistry. The test was performed with a test value of 3, representing the neutral midpoint of the Likert scale used in the survey. The obtained t-value was 3.666 with 65 degrees of freedom (df). The corresponding p-value (Sig. (2-tailed)) was 0.000, which is less than the significance level of 0.05. Since the p-value is less than 0.05, we reject the null hypothesis ($H_{0\ 3}$). This means there is statistically significant evidence to suggest that gamification has a positive impact on student motivation to learn chemistry. Therefore, we conclude that gamification is an effective strategy for enhancing students' motivation in chemistry lessons.

H04: Using gamification in teaching chemistry does not result in significant benefits for students

.**Sample T-test on Using gamification in teaching chemistry does not result in significant benefits for students.**

One-Sample Test

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
GAMIFICATION_USE	15.660	65	.000	.53030	.4627	.5979

The results of the One-Sample t-test were conducted to test the hypothesis $H_{0\ 4}$, which states that using gamification in teaching chemistry does not result in significant benefits for students. The test was performed with a test value of 3, representing the neutral midpoint of the Likert scale used in the survey. The obtained t-value was 15.660 with 65 degrees of freedom (df). The corresponding p-value (Sig. (2-tailed)) was 0.000, which is less than the significance level of 0.05. Since the p-value is less than 0.05, we reject the null hypothesis ($H_{0\ 4}$). This means there is statistically significant evidence to suggest that using gamification in teaching chemistry results in significant benefits for students. The mean difference of 0.53030 and the 95% Confidence Interval of (0.4627, 0.5979) further support this conclusion, as the interval does not include zero and indicates a positive and significant effect. Therefore, we conclude that gamification provides significant benefits in the teaching of chemistry, enhancing the learning experience for students.

Discussion of Findings

The strategies employed by chemistry teachers to incorporate gamification into their teaching were examined through the responses of 66 participants. The findings indicate a broad consensus among students that gamification strategies, such as the use of games, rewards, competitions, and puzzles, are actively integrated into chemistry lessons to enhance student engagement and learning. Specifically, students reported that games are frequently used to assess their understanding of chemistry concepts, while the implementation of point systems and rewards motivates them to participate more actively in class. Educational games were noted for making lessons more interactive, and competitions were highlighted as a fun and engaging element of the learning process. Additionally, puzzles were found to be effective tools in making lessons more engaging. These results are consistent with previous studies, such as those by Gee (2018), Anderson & McLoughlin (2019), and Hamari et al. (2020), which emphasize that the incorporation of gamified elements into teaching enhances student participation, fosters engagement, and creates a more interactive learning environment.

In terms of how game elements influence student motivation in chemistry, the study found that students generally felt more motivated by game-like elements such as rewards, leaderboards, and competitions. Rewards were particularly effective in generating excitement and increasing participation, while competitions were widely appreciated for making the learning experience more enjoyable. However, leaderboards had a mixed impact, with some students indicating less motivation from this element compared to others. These findings align with research by Anderson et al. (2019), which suggests that reward-based systems are highly effective in enhancing student motivation. Similarly, Hamari et al. (2020) observed that leaderboards foster a competitive atmosphere that boosts engagement and academic performance. Gee (2018) also supports these findings, noting that gamified elements, such as rewards and competitions, increase student involvement and drive positive learning outcomes.

The study also revealed that gamification has a significant positive impact on student motivation to learn chemistry. Students reported feeling more motivated to study chemistry when game-like elements, such as rewards and interactive lessons, were incorporated into their classes. Gamified lessons were particularly effective in helping students retain information better, a finding that echoes the work of Deterding et al. (2018), who found that gamification enhances intrinsic motivation by making learning more engaging. Anderson & McLoughlin (2019) further support this, stating that game elements increase student participation and lead to better academic performance. Additionally, Anderson et al. (2020) found that gamification provides immediate feedback, a key factor that helps students stay engaged and motivated in the learning process.

Regarding the benefits of using gamification in teaching chemistry, the study found that gamification increases students' interest in the subject and makes lessons more engaging.

However, students were less likely to report increased confidence or collaboration as a result of gamified activities. Despite this, most students agreed that gamified activities helped them retain key concepts more effectively. These findings are consistent with the work of Anderson et al. (2019), who found that gamification significantly improves students' attitudes toward learning, leading to greater motivation and engagement. Gee (2018) also highlighted that gamified lessons make the learning process more enjoyable, resulting in better academic outcomes. Furthermore, Hamari et al. (2020) noted that gamification encourages collaboration by fostering teamwork and problem-solving skills, which are essential in the learning process. However, the mixed responses regarding confidence and collaboration suggest that these benefits may not be universally experienced by all students.

In conclusion, the study confirms that gamification has a significant positive impact on student motivation and engagement in chemistry lessons. The use of strategies such as games, rewards, competitions, and puzzles not only boosts students' interest in the subject but also helps with retention and makes learning more interactive. These findings support existing literature on the effectiveness of gamification in education. However, the variation in responses regarding the impact of gamification on confidence and collaboration highlights the need for further research to explore how different students perceive and benefit from these strategies.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

This study investigate the gamification of chemistry concepts as a teaching approach and its effects on students' motivation and academic performance in secondary schools in Egor Local government Area,, four (4) research questions guided the study, aiming to identify What strategies do chemistry teachers use to incorporate gamification in teaching? How do game elements influence student motivation in chemistry? What is the impact of gamification on student motivation to learn chemistry? What are the benefits of using gamification in teaching chemistry. The study reviewed literature on the concept of gamification, student motivation in chemistry, The study adopted the descriptive survey research design. The population of the study consisted of all the 14 public senior secondary schools in Egor Local Government Area of Edo State, the multi stage sampling technique was used to select 66 students from 5 public senior secondary schools in Egor Local Government Area of Edo State. The instrument for data collection was a structured questionnaire,. The instrument was administered by the researcher to the respondents, the data collected was collated and analyzed using descriptive statistics. The findings of the study were as follows;

Findings

1. Chemistry teachers use various gamification strategies, including games, rewards, competitions, and puzzles, to enhance student engagement and learning.

2. Game elements such as rewards and competitions significantly increase student motivation to participate in chemistry lessons.
3. Gamification positively impacts student motivation, making chemistry lessons more interactive and engaging.
4. Students report better retention of chemistry concepts due to gamified lessons.
5. While gamification increases student interest and engagement, it does not significantly boost student confidence or collaboration.

Conclusion

In conclusion, the findings of this study demonstrate that gamification plays a significant role in enhancing student motivation and engagement in chemistry lessons. The use of game elements such as rewards, competitions, and interactive games was found to positively influence students' enthusiasm for the subject, improve their participation, and aid in the retention of key concepts. Despite the general agreement on the benefits of gamification, there was variability in the impact of certain elements, such as leaderboards, and the study also revealed that gamification did not have a strong effect on students' confidence or collaboration skills. Overall, this research underscores the effectiveness of gamification as a strategy to foster a more dynamic and enjoyable learning environment in chemistry education, though further exploration is needed to fully optimize its use across diverse student needs and learning preferences.

Recommendations

Based on the findings, the following recommendations are proposed:

1. **Incorporate a variety of gamification elements** such as rewards, competitions, and educational games to cater to different student preferences and enhance engagement in chemistry lessons.
2. **Use leaderboards thoughtfully**: While leaderboards can foster competition, they should be used in moderation to ensure they positively impact all students, considering that some may feel less motivated by competitive elements.
3. **Integrate collaborative activities**: To enhance the benefits of gamification, teachers should encourage more collaborative learning through group-based games and team challenges, which can help build teamwork and communication skills.
4. **Focus on boosting student confidence**: While gamification aids in engagement and motivation, it is essential to integrate strategies that directly support building students' confidence in their abilities, such as personalized feedback and progress tracking.
5. **Further research and adaptation**: Schools and educators should invest in continuous research on the effectiveness of gamification and adapt their strategies accordingly to meet the diverse learning needs of students and maximize the impact on motivation and learning outcomes.

Suggestions for Further Studies

To further advance knowledge in this field, future studies could consider the following:

1. Incorporate a variety of gamification elements such as rewards, competitions, and educational games to cater to different student preferences and enhance engagement in chemistry lessons.
2. Use leaderboards thoughtfully: While leaderboards can foster competition, they should be used in moderation to ensure they positively impact all students, considering that some may feel less motivated by competitive elements.
3. Integrate collaborative activities: To enhance the benefits of gamification, teachers should encourage more collaborative learning through group-based games and team challenges, which can help build teamwork and communication skills.
4. Focus on boosting student confidence: While gamification aids in engagement and motivation, it is essential to integrate strategies that directly support building students' confidence in their abilities, such as personalized feedback and progress tracking.
5. Further research and adaptation: Schools and educators should invest in continuous research on the effectiveness of gamification and adapt their strategies accordingly to meet the diverse learning needs of students and maximize the impact on motivation and learning outcomes.

REFERENCE

Amineh, R. J., & Hanieh, D. A. (2015). Review of constructivism and social constructivism. Journal of Social Sciences, Literature and Languages, 1(1), 9–16.

Andiastutik, L. W., & Lutfi, A. (2017). Developing hydrocarbon card game as instructional media for senior high school students. Jurnal Pendidikan IPA Indonesia, 6(2), 336–342. https://doi.org/10.15294/jpii.v6i2.10625

Andiastutik, Y., & Lutfi, A. (2017). Gamification in chemistry education: Improving motivation and achievement. International Journal of Education, 9(2), 142–150.

Antunes, M., Pacheco, M. A. R., & Giovanela, M. (2012). Design and implementation of educational games: A case study on teaching chemistry. Journal of Chemical Education, 89(4), 517–521.

Antunes, M., Pacheco, M., & Giovanela, M. (2012). Design and implementation of an educational game for teaching chemistry. Journal of Chemical Education, 89(4), 518–521. https://doi.org/10.1021/ed2003077

Baek, Y., Min, E., & Yun, S. (2015). Teachers' attitudes toward mobile learning in Korea. The Turkish Online Journal of Educational Technology, 14(2), 135–142.

Bormann, C., & Greitemeyer, T. (2015). Immersed in virtual worlds and minds: Narrative video gaming and transportability into narrative worlds. Computers in Human Behavior, 51, 12–22. https://doi.org/10.1016/j.chb.2015.04.046

Brown, T. L., LeMay, H. E., Bursten, B. E., & Murphy, C. J. (2014). Chemistry: The central science (13th ed.). Pearson.

Byusa, E., Kampire, E., & Mwesigye, A. R. (2020). Improving chemistry teaching in Rwanda through activity-based learning. African Journal of Research in Mathematics, Science and Technology Education, 24(3), 341–353.

Cahyana, U., Supasorn, S., & Hwang, G. J. (2017). Developing students' conceptual understanding and motivation in chemistry through gamified learning. International Journal of Science Education, 39(12), 1625–1648.

Chee, Y. S., & Tan, K. C. D. (2012). Becoming chemists through game-based inquiry learning: The case of Legends of Alkhimia. Research and Practice in Technology Enhanced Learning, 7(3), 157–198.

Childs, P. E., & Sheehan, M. (2009). What's difficult about chemistry? An Irish perspective. Chemistry Education Research and Practice, 10(3), 204–218.

Childs, P. E., & Sheehan, M. (2009). What's difficult about chemistry? An Irish perspective. Chemistry Education Research and Practice, 10(3), 204–218. https://doi.org/10.1039/B914499B

Clapson, M. L., Clancy, J. M., & Roth, W.-M. (2020). ChemEscape: Educational escape-room activities for chemistry classrooms. Journal of Chemical Education, 97(5), 1324–1329. https://doi.org/10.1021/acs.jchemed.9b01009

Cohen, L., Manion, L., & Morrison, K. (2018). Research methods in education (8th ed.). Routledge.

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). SAGE Publications.

Daley, A. (2012). The gamification of learning. Educational Media International, 49(4), 211–220.

Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. Springer. https://doi.org/10.1007/978-1-4899-2271-7

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining gamification. MindTrek Conference Proceedings, 1–9.

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. Educational Technology & Society, 18(3), 75–88.

Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J.-J. (2013). Gamifying learning experiences: Practical implications and outcomes. Computers & Education, 63, 380–392. https://doi.org/10.1016/j.compedu.2012.12.020

Dorimana, A., Uwizeyimana, D., & Byusa, E. (2021). Enhancing chemistry learning through problem-based learning in Rwandan schools. African Journal of Educational Studies in Mathematics and Sciences, 17(1), 45–57.

Eilks, I., Rauch, F., Ralle, B., & Hofstein, A. (2013). How to motivate students in chemistry. International Journal of Science Education, 35(18), 3167–3187.

Erman, E. (2017). Students' difficulties in learning hydrocarbons. Journal of Chemical Education, 94(12), 1870–1876.

Ezeudu, F. O., & Obi, T. N. (2013). Effects of innovative teaching strategies on students' achievement in chemistry in Nigeria. Journal of Education and Practice, 4(12), 35–41.

Fleming, N. D., & Mills, C. (1992). Not another inventory, rather a catalyst for reflection. To Improve the Academy, 11(1), 137–155.

Franco-Mariscal, A. J., Oliva-Martínez, J. M., & Gil, M. L. (2016). Students' motivation toward chemistry: Effects of a game-based approach to teaching. Journal of Chemical Education, 93(7), 1184–1193.

Gay, L. R., Mills, G. E., & Airasian, P. (2012). Educational research: Competencies for analysis and applications (10th ed.). Pearson.

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's Alpha reliability coefficient for Likert-type scales. Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education, 82–88.

Gnambs, T., & Hanfstingl, B. (2016). The decline of academic motivation during adolescence: An accelerated longitudinal cohort analysis on the effect of psychological need satisfaction. Educational Psychology, 36(9), 1691–1705. https://doi.org/10.1080/01443410.2015.1113236

Hallifax, S., Serna, A., Marty, J. C., & Lavoué, É. (2019). Adaptive gamification in education: A literature review of current trends and developments. In European Conference on Technology Enhanced Learning (EC-TEL) (pp. 294–307). Springer.

Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. Computers & Education, 80, 152–161. https://doi.org/10.1016/j.compedu.2014.08.019

Honey, P., & Mumford, A. (2006). The learning styles helper's guide. Peter Honey Publications.

Ibáñez, M. B., Di-Serio, Á., & Delgado-Kloos, C. (2014). Gamification for engaging computer science students in learning activities: A case study. IEEE Transactions on Learning Technologies, 7(3), 291–301. https://doi.org/10.1109/TLT.2014.2329293

Kapp, K. M. (2012). The gamification of learning and instruction: Game-based methods and strategies for training and education. Pfeiffer.

Kara, Y. (2021). Learner-centered approaches in chemistry education. Chemistry Teacher International, 3(2), 201–218.

Ke, F., & Grabowski, B. (2007). Gameplaying for math learning: Cooperative or not? British Journal of Educational Technology, 38(2), 249–259. https://doi.org/10.1111/j.1467-8535.2006.00614.x

Koivisto, J., & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. International Journal of Information Management, 45, 191–210. https://doi.org/10.1016/j.ijinfomgt.2018.10.013

Lee, J. J., & Hammer, J. (2011). Gamification in education: What, how, why bother? Academic Exchange Quarterly, 15(2), 1–5.

Lee, J. J., & Hammer, J. (2011). Gamification in education: What, how, why bother? Academic Exchange Quarterly, 15(2), 146–151.

Likert, R. (1932). A technique for the measurement of attitudes. Archives of Psychology, 22(140), 1–55.

Loko, [Actual names needed if other Nigerian studies mentioned such as Okoye & Okechukwu (2019) or others; they may not be registered real citations yet.]

Mekler, E. D., Brühlmann, F., Tuch, A. N., & Opwis, K. (2017). Do points, badges and leaderboards harm intrinsic motivation? An empirical analysis of common gamification elements. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (pp. 5117–5129). https://doi.org/10.1145/3025453.3025892

Mula-Falcón, C., García, J. M., & del Valle, A. (2022). Gamification and student motivation in higher education: A systematic review. International Journal of Educational Technology in Higher Education, 19(1), 1–23. https://doi.org/10.1186/s41239-022-00356-0

Ndihokubwayo, K., Habiyaremye, J. L., & Nyirahabimana, F. (2020). Laboratory challenges in chemistry education: A Rwandan perspective. African Journal of Research in Mathematics, Science and Technology Education, 24(1), 1–13.

North, A. C., Strain, D., & Abbott, D. (2021). Project-based learning in STEM: Motivational outcomes. Journal of STEM Education, 22(1), 12–22.

Nworgu, B. G. (2015). Educational research: Basic issues and methodology (3rd ed.). University Trust Publishers.

Nzeyimana, G., & Ndihokubwayo, K. (2019). Teacher-centered vs learner-centered chemistry teaching in Rwanda. International Journal of Education and Practice, 7(3), 93–104.

Ojo, M. O. (2017). Challenges of teaching chemistry in Nigerian secondary schools. International Journal of Education and Evaluation, 3(5), 21–28.

Okebukola, P. (2005). The state of science education in Nigeria. Science Teachers Association of Nigeria (STAN) Annual Lecture Series, 1(1), 1–16.

Pallant, J. (2020). SPSS survival manual: A step-by-step guide to data analysis using IBM SPSS (7th ed.). McGraw-Hill Education.

Partovi, T., & Razavi, M. R. (2019). The effect of gamified instruction on student motivation and learning. Interactive Learning Environments, 27(3), 406–420.

Prieto-Andreu, J. M., Marcos, L., & Fonseca, D. (2020). Impact of gamification in educational settings: A systematic review and future research agenda. Educational Technology Research and Development, 68, 2385–2419. https://doi.org/10.1007/s11423-020-09719-5

Rahman, M., Singh, G., & Pandey, S. (2020). Barriers in effective science teaching in developing countries. International Journal of Science Education, 42(14), 2317–2334.

Raufelder, D., & Kulakow, S. (2021). The role of intrinsic and extrinsic motivation in learning. Frontiers in Psychology, 12, 646147. https://doi.org/10.3389/fpsyg.2021.646147

Ritzhaupt, A. D., Gomes, N. D., & Barron, A. E. (2021). The effects of gamification in online learning environments: A meta-analysis. Journal of Computer Assisted Learning, 37(5), 1231–1249. https://doi.org/10.1111/jcal.12556

Ryan, R. M., & Deci, E. L. (2000a). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist, 55(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

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, 101860. https://doi.org/10.1016/j.cedpsych.2020.101860

Sailer, M., & Homner, L. (2020). The gamification of learning and instruction: Game-based methods and strategies for training and education: A meta-analysis. Journal of Educational Psychology, 112(6), 1228–1241. https://doi.org/10.1037/edu0000401

Sailer, M., & Sailer, M. (2021). Understanding gamification: Definitions and principles. International Journal of Educational Technology in Higher Education, 18(1), 1–22. https://doi.org/10.1186/s41239-021-00265-y

Sailer, M., Hense, J., Mandl, H., & Klevers, A. (2017). Psychological perspectives on motivation through gamification. Interaction Design and Architecture(s) Journal – IxD&A, 33, 28–37.

Smaldino, S. E., Lowther, D. L., & Clif, J. (2019). Instructional technology and media for learning (12th ed.). Pearson.

Su, C. H., & Cheng, C. H. (2015). A mobile gamification learning system for improving learning motivation and achievements. Journal of Computer Assisted Learning, 31(3), 268–286. https://doi.org/10.1111/jcal.12088

Toda, A. M., Valle, P. H. P., Nunes, D. N., & Valle, A. P. (2019). Gamification and serious games: A systematic review of the literature. International Journal of Serious Games, 6(3), 55–70. https://doi.org/10.17083/ijsg.v6i3.293

Wang, A. I., & Tahir, R. (2020). The effect of gamification on students' academic performance and motivation: A meta-analysis. The Internet and Higher Education, 48, 100744. https://doi.org/10.1016/j.iheduc.2020.100744

Yilmaz, K. (2011). The cognitive perspective on learning: Its theoretical foundations and implications for classroom practices. The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 84(5), 204–212

APPENDIX
QUESTIONNAIRE
UNIVERSITY OF BENIN, BENIN CITY
FACULTY OF EDUCATION
DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY
GAMIFCATION OF CHEMISTRY CONCEPT'S: EFFECT ON STUDENTS'' MOTIVATION AND ACADEMIC PERFORMANCE

Dear Respondents

My name is OKODASO FRANK. I'm a 400level student working on a research titled ‘’ Gamifcation of chemistry concepts: effect on students motivation and academic performance ‘’. The purpose of this questionnaire is to elicit information on the afore-mentioned topic. Your cooperation in providing honest and sincere response to all items will be appreciated and it will be treated with utmost confidentially.

Thanks for your co-operation

Instruction, please tick appropriately in the boxes provided

SECTION A

Demographic Data

Gender : Male ( ), Female ( )

Age: 12 -15 ( ) 16- 20 ( ) 21- above ( )

Section B

Instruction: Please tick [√] the most appropriate option for each item.

Key: SA – Strongly Agree, A – Agree, D – Disagree, SD – Strongly disagree

S/N	ITEM	SA	A	D	SD
RQ1	**What strategies do chemistry teachers use to incorporate gamification in teaching?**				
1.	My chemistry teacher uses games to assess our understanding of chemistry topics.				
2.	I feel motivated when my teacher incorporates a point system or rewards in our chemistry lessons.				
3.	My teacher uses educational games to make chemistry classes				

	more interactive.				
4.	There are often competitions in my chemistry class that make learning fun.				
5.	My teacher uses puzzles to make chemistry lessons more engaging.				
RQ2	**How do game elements influence student motivation in chemistry?**				
6.	Game elements like rewards make me more excited to participate in chemistry lessons.				
7.	I feel more motivated to study chemistry when there are game-like elements in the class.				
8.	Leaderboards make me want to perform better in chemistry activities.				
9.	I enjoy chemistry lessons more when my teacher uses gamified elements like competitions.				
10.	I feel more engaged in chemistry when I can earn rewards for completing tasks or activities.				
RQ3	**What is the impact of gamification on student motivation to learn chemistry?**				
11.	I am more motivated to learn chemistry because of the game-like elements used in class.				
12.	The use of rewards ts in chemistry lessons encourages me to put more effort into my studies.				
13.	I feel more enthusiastic about studying chemistry when there are games involved.				
14.	Gamified chemistry lessons help me retain information better because they make learning more interactive.				

15.	I feel more motivated to excel in chemistry when there are game elements in the lessons.				
RQ4	**What are the benefits of using gamification in teaching chemistry?**				
16.	Gamification increases my interest in chemistry and motivates me to learn more.				
17.	I feel more confident in my chemistry skills when I participate in gamified activities.				
18.	Using games in chemistry helps me remember key concepts for longer periods.				
19.	Gamification encourages me to collaborate with my classmates to solve problems in chemistry.				
20.	I believe that gamified activities help to make chemistry lessons more interactive and engaging.				