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Chemistry Educators' Readiness and Intentions to Integrate Game-Based Software: A Survey

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ABSTRACT

This study explores the readiness and intentions of chemistry educators in Kwara State, Nigeria, to integrate game-based software into their teaching practices. As digital learning tools become increasingly prominent, understanding how educators perceive and adopt such innovations is essential. A descriptive survey design was employed, involving 270 chemistry educators across various educational institutions. Data were collected using a validated 15-item Likert-scale questionnaire. The findings revealed that while most educators were aware of game-based software, many lacked a clear understanding of its pedagogical benefits. Despite this, participants expressed generally positive perceptions of its potential to improve teaching efficiency, student engagement, long-term retention, and access to learning resources. Although educators showed high levels of intention to adopt game-based software, readiness varied due to infrastructural limitations, lack of training, and resistance to change. The study recommends comprehensive training, improved technological infrastructure, and pilot projects to support the effective implementation of game-based software in chemistry education.

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1. INTRODUCTION

Education, whether formal, informal, or non-formal, is intended to develop an individual's cognitive, affective, and psychomotor domains. Its structure evolves to meet the changing needs of society (Ackey *et al*., 2023). Science and technology are universally acknowledged as drivers of national and global advancement, and a foundational understanding of science is essential for full societal participation. Chemistry, as a core component of science, plays a significant role in everyday life by helping students make sense of their environment (Byusa *et al*., 2022). However, science education, particularly chemistry, continues to face major challenges at all educational levels.

Students often struggle with chemistry due to the abstract nature of its concepts, limited problem-solving skills, lack of spatial reasoning, and minimal student-teacher interaction (Erman, 2017). The traditional teacher-centered approach—characterized by lectures and limited engagement—often fails to address these challenges effectively (Nzeyimana & Ndihokubwayo, 2019). In contrast, learner-centered pedagogies grounded in social-cognitive and constructivist theories promote active participation and collaboration. These methods—such as cooperative learning, simulations, and game-based instruction—enhance engagement, comprehension, and knowledge retention (Byusa *et al*., 2022; Cahyana *et al*., 2017).

Game-based learning (GBL) is increasingly recognized as an innovative approach that aligns with the principles of constructivism (Hafeez, 2022; Hartt *et al*., 2020; Hooshyar *et al*., 2021). It involves the integration of game elements into educational contexts to promote meaningful, student-driven learning (Mikrouli *et al*., 2024; Hussein *et al*., 2019). GBL has the potential to boost student motivation, improve academic outcomes, and support the development of problem-solving and critical-thinking skills (Priyaadharshini *et al*., 2020; Barz *et al*., 2024). Specifically in chemistry education, GBL enables learners to explore scientific phenomena in interactive and immersive ways, which traditional methods may not facilitate effectively (da Silva Júnior *et al*., 2021; Syal & Nietfeld., 2024).

Despite its advantages, several barriers hinder the implementation of game-based software in education, including inadequate ICT infrastructure, limited teacher training, and institutional resistance to change (He *et al*., 2024). In Nigeria, while some institutions have begun integrating e-learning platforms and digital tools, the overall adoption of GBL remains limited, especially in science education (Bolaji & Adeoye, 2022). Teachers' perceptions, readiness, and intentions are critical to the successful implementation of GBL, as they shape the learning environment and influence students' access to technological innovations (Oye *et al*., 2012).

This study aims to assess the readiness and intentions of chemistry educators in Kwara State, Nigeria, to use game-based software for teaching (Pellas & Mystakidis, 2020). It investigates their awareness, perceptions, and institutional preparedness, as well as the challenges and opportunities associated with integrating GBL into the chemistry curriculum (Noroozi *et al*., 2020). The findings contribute to the broader discourse on digital transformation in education and offer practical recommendations for policymakers and educators seeking to enhance science instruction through innovative technologies.

The main purpose of this study was to investigate the perspectives of Chemistry educators regarding their readiness and intentions to use game-based software for teaching Chemistry in Kwara State. The specific objectives were to;

(i) Assessed the awareness of chemistry educators regarding the use of game-based software for teaching chemistry in Kwara State,

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(ii) Examined the perception of chemistry educators regarding the use of game-based software for teaching chemistry in Kwara State,
(iii) Explored the chemistry educators' perspectives on their readiness to use game-based software for enhancing chemistry teaching in Kwara State,
(iv) Examined the intention of chemistry educators to use game-based software for enhancing chemistry teaching in Kwara State.

The following research questions were answered in this study:

(i) What is the awareness of chemistry educators regarding the use of game-based software for teaching chemistry in Kwara State?
(ii) What is the perception of chemistry educators regarding the use of game-based software for teaching chemistry in Kwara State?
(iii) What are the chemistry educators' perspectives on their readiness to use game-based software for enhancing chemistry teaching in Kwara State?
(iv) What is the intention of chemistry educators to use game-based software for enhancing chemistry teaching in Kwara State?

2. METHODS

This study adopted a descriptive survey research design to investigate the readiness and intentions of chemistry educators in Kwara State, Nigeria, to use game-based software for teaching. The descriptive approach was appropriate for collecting detailed information from a broad population without manipulating any variables.

The population of the study consisted of chemistry educators from both public and private institutions in Ilorin, Kwara State. A total of 270 participants were selected using a combination of purposive and random sampling. Institutions were purposively chosen to ensure representation from various educational levels, including one federal university, one state university, one private university, one federal college of education, one state college of education, one private college of education, one federal secondary school, one state-owned secondary school, and one private secondary school. Within these institutions, participants were randomly selected to participate in the study.

Data were collected using a researcher-designed questionnaire. **Tables 1, 2, and 3** provide a breakdown of the survey responses. The questionnaire consisted of 15 items structured into five parts: demographic information, awareness, perception, readiness, and intention regarding game-based software. The instrument was validated by three science education experts and two computer science lecturers to ensure content relevance and clarity (Lopez-Fernandez *et al*., 2021). Suggestions provided by the validators were integrated into the final version of the questionnaire. A pilot study was conducted, and the reliability of the instrument was determined using Cronbach's Alpha, which confirmed that the items had acceptable internal consistency.

During the data collection process, ethical standards were strictly followed. Approval was obtained from institutional authorities, and respondents were informed about the objectives of the research. Participation was voluntary, and confidentiality and anonymity were assured. The researcher also emphasized that the responses would be used solely for academic purposes. The questionnaires were distributed and retrieved on the spot with the help of trained research assistants to ensure completeness and accuracy.

Data were analyzed using descriptive statistics such as frequency counts and percentages. This method was suitable for identifying trends in educators' awareness, perceptions,

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readiness, and intentions regarding the use of game-based software for teaching chemistry. The results were presented in tables to facilitate clarity and interpretation.

3. RESULTS AND DISCUSSION

3.1. Findings

Table 1 presents the findings on the awareness and understanding of Game-based software for teaching chemistry. For the first question, the majority of participants, 45 individuals (86.5%), indicated that they were aware of the concept of Game-based software for teaching chemistry, while 7 individuals (13.5%) reported being unaware. Regarding the integration of game-based software for teaching chemistry, 31 participants (59.6%) reported having heard about the integration of Game-based software in chemistry teaching, while 21 participants (40.4%) indicated that they had not heard about it. In terms of understanding how Game-based software can enhance the teaching of chemistry in Kwara State. 24 participants (46.2%) stated that they understood how Game-based software can enhance chemistry teaching, while 28 participants (53.8%) reported not having a clear understanding of it.

Table 1. Awareness and understanding of game-based software.

No	Question	Yes (Frequency/Percentage)	No (Frequency/Percentage)
1.	Are you aware of the concept of Game-based Software?	45 (86.5%)	7 (13.5%)
2.	Have you heard about the integration of Game-based software for teaching Chemistry?	31 (59.6%)	21 (40.4%)
3.	Do you understand how game-based software can enhance Chemistry teaching?	24 (46.2%)	28 (53.8%)

These findings suggest that while a significant proportion of participants are aware of the concept of Game-based software and have heard about its integration into Chemistry teaching, there is still room for improvement in understanding how Game-based software can enhance the teaching of chemistry in Kwara State. Research shows that educators are generally well-informed about educational technologies, including game-based learning tools. For instance, some researchers (Qian & Clark, 2016) discovered that many teachers are familiar with game-based learning and appreciate its potential educational benefits (Li *et al*., 2021; Liu *et al*., 2020). This finding is consistent with the 86.5% of participants who reported awareness of game-based software for teaching chemistry. Despite this high level of awareness, studies have shown that the actual implementation of game-based software in teaching varies.

Some researchers (Kebritchi *et al*., 2010) noted that while many educators are aware of these tools, fewer have adopted them in their classrooms due to challenges like limited resources and insufficient training. This parallels the study's finding that 59.6% of participants had heard about the integration of game-based software in chemistry teaching, whereas 40.4% had not. Furthermore, there is often a significant gap between awareness and understanding of how to effectively use game-based learning to enhance education. Some researchers found that although many educators recognize game-based learning, their understanding of how to implement it successfully is limited. This aligns with the finding that

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only 46.2% of participants understood how game-based software could improve chemistry teaching, while 53.8% did not.

Table 2. Perceptions of chemistry educators on game-based software.

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Game-based software can improve the efficiency of Chemistry teaching.	10 (19.2%)	28 (53.8%)	10 (19.2%)	3 (5.8%)	1 (1.9%)
Game-based software can enhance the performance of chemistry students.	8 (15.4%)	29 (55.8%)	10 (19.2%)	4 (7.7%)	1 (1.9%)
Game-based software can provide long-time retention among chemistry students.	7 (13.5%)	30 (57.7%)	12 (23.1%)	2 (3.8%)	1 (1.9%)
Game-based software can arouse the interest of the chemistry students to learn chemistry concepts.	9 (17.3%)	26 (50%)	12 (23.1%)	4 (7.7%)	1 (1.9%)
Game-based software can enable personalized recommendations for chemistry educators.	6 (11.5%)	27 (51.9%)	13 (25%)	5 (9.6%)	1 (1.9%)
Game-based software can facilitate remote access to different chemistry resources.	11 (21.2%)	29 (55.8%)	8 (15.4%)	3 (5.8%)	1 (1.9%)
Game-based software can improve the chemistry students' experience in the classroom.	12 (23.1%)	29 (55.8%)	8 (15.4%)	2 (3.8%)	1 (1.9%)

Table 2 presents the perceptions of Game-based software in teaching chemistry as indicated by participants' agreement or disagreement with a series of statements. The majority of the participants held predominantly positive perceptions regarding the potential benefits of Game-based software in teaching chemistry. Concerning the efficiency of chemistry teaching, a majority of participants (53.8%) agreed, and a further 19.2% strongly agreed that Game-based software can enhance efficiency. Conversely, only a small percentage expressed disagreement or strong disagreement with this statement. Likewise, a significant proportion of participants shared the belief that Game-based software can bolster the performance of chemistry students, with 55.8% agreeing and 15.4% strongly agreeing. Similarly, regarding the provision of long-time retention of chemistry concepts, 57.7% agreed, while 13.5% strongly agreed.

In the context of arousing the interest of chemistry students to learn chemistry, the majority of participants (50% agreed, 17.3% strongly agreed). Regarding personalized recommendations for chemistry educators, over half of the participants (51.9%) agreed that Game-based software can facilitate this functionality. Additionally, participants acknowledged the potential benefits of Game-based software in terms of enabling remote access to different chemistry resources (55.8% agreed, 21.2% strongly agreed) and improving the overall chemistry students' experience in the class (55.8% agreed, 23.1% strongly agreed). Taken together, these findings reflect the positive perceptions held by participants regarding the potential advantages of Game-based software in the various institutions in Kwara State.

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Specifically, they highlight the potential for improving efficiency, enhancing students' performance, providing long-term retentions, arousing chemistry students' interest, offering personalized recommendations, facilitating remote access, and enhancing the chemistry students' experience.

Previous research (Ogunduyile *et al*., 2019) shows that game-based learning can significantly enhance the efficiency and performance of students in science subjects, including chemistry. Their study revealed that students who engaged with educational games demonstrated improved understanding and retention of scientific concepts. This finding is consistent with the majority of participants (53.8% agreed and 19.2% strongly agreed) who believed that game-based software could enhance the efficiency of chemistry teaching, 55.8% who agreed, and 15.4% who strongly agreed that it could improve student performance. Similarly, some researchers (Adeyemo *et al*., 2018) investigated the impact of digital game-based learning in Nigerian secondary schools and found that such tools not only improve long-term retention of knowledge but also significantly boost student engagement and interest in learning science subjects.

This supports the findings where 57.7% of participants agreed, 13.5% strongly agreed that game-based software aids long-term retention of chemistry concepts, 50% agreed, and 17.3% strongly agreed that it increases students' interest in chemistry. Additionally, some researchers (Nwosu & Anene, 2020) underscored the potential of game-based learning software to deliver personalized learning experiences and facilitate remote access to educational resources. Their research demonstrated that these technologies could provide tailored recommendations and enable students to access a wide range of chemistry resources remotely, thereby enhancing the overall learning experience. This aligns with the findings that over half of the participants (51.9%) agreed that game-based software can offer personalized recommendations, 55.8% agreed, and 21.2% strongly agreed that it can enable remote access to chemistry resources.

3.2. Perspectives of Chemistry Educators on their Readiness to Use Game-based Software for Enhancing the Teaching of Chemistry in Kwara State

Participants were asked to explain whether they are ready to use Game-based software for enhancing chemistry teaching, as well as to define what they perceive as readiness to use Game-based software in chemistry teaching.

The majority of participants noted that they are partially prepared for the utilization of Game-based software for teaching chemistry, according to the findings. While justifying the reason for their agreement, some explanations were offered. For instance, a respondent emphatically indicated that:

"I can boldly say that secondary schools in Kwara State are not fully ready for the integration of Game-based software for enhancing the teaching of chemistry. This is based on my understanding that most of the institutions in Nigeria have partially accepted the changes that are currently evident in chemistry education, technically as a result of the application of ICT in science education teaching. This is shown in their expression of lethargic willingness to invest in the things that will help them conform to the change brought by ICT application in chemistry teaching".

Few participants had mixed sentiments about the readiness of Chemistry educators to integrate Game-based software into their teaching and learning process, but they did point out the specific institutions that are ready. To back up this claim, a respondent stated:

Indeed, it is evident that not all institutions, including secondary schools, possess the necessary equipment to be ready for the integration of Game-based software for teaching

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chemistry. The majority of government universities, colleges, and secondary schools face this readiness deficit. One of the primary reasons for this is the inadequate availability of ICT facilities within these institution settings. Additionally, the maintenance of existing facilities is noticeably lacking, which further compounds the issue. Moreover, a concerning trend is the prevailing negative attitude among secondary school teachers when it comes to embracing ICT for their teaching. To effectively bridge this readiness gap, it is imperative to address these challenges comprehensively. This involves tackling the issues of ICT infrastructure, improving facility maintenance, and fostering a positive mindset among some chemistry educators towards adopting Game-based software in teaching and learning chemistry throughout Kwara State.

The feedback from the participants indicates that various institutions in Nigeria, including those in Kwara State, generally lack the necessary preparedness to integrate Game-based software, especially at the secondary school level. Most of these institutions have not fully embraced automation, as highlighted by the participants. Nevertheless, there are a few institutions that deserve recognition for their proactive approach to incorporating technologies like cloud computing, social media, e-resources, and online databases to enhance their teaching. These institutions serve as trailblazers, demonstrating a commitment to leveraging technological advancements to improve the quality, effectiveness, and interactive teaching of chemistry. However, it is crucial to acknowledge that there remains a significant need for wider adoption and integration of Game-based software across Nigerian institutions.

This is essential to keep up with the ever-evolving digital landscape and effectively meet the evolving needs and interests of chemistry students. Numerous studies have identified insufficient ICT infrastructure as a major obstacle to implementing game-based learning tools in educational environments. Some researchers highlight the scarcity of computers, unreliable internet connectivity, and lack of technical support in Nigerian schools as significant barriers to the effective use of ICT in education. This mirrors the situation in Kwara State, where educators reported challenges related to the availability and upkeep of ICT facilities. The successful integration of new technologies heavily depends on the attitudes and preparedness of teachers. Negative attitudes toward ICT and a lack of confidence stemming from inadequate training are major hindrances to adopting technology in teaching (Oye *et al*., 2012).

Educators in Kwara State expressed similar concerns, noting a reluctance among some teachers to invest in and embrace game-based learning tools, underscoring the need for improved training and a shift in attitudes. Proactive technology adoption by institutions can set a positive example for others. Some researchers (Adeoye and Adeniran, 2011) note that some Nigerian educational institutions have begun integrating advanced technologies like e-learning platforms, resulting in increased student engagement and improved learning outcomes. This observation aligns with the situation in Kwara State, where a few institutions have been acknowledged for their efforts in leveraging technological advancements to enhance teaching despite the general lack of readiness.

3.3. The Intention of Chemistry Educators to Use Game-based Software for Enhancing the Teaching of Chemistry

The section investigates the inclination of chemistry educators in Kwara State towards the use of Game-based software to enhance chemistry teaching. To assess their intention, the

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participants were requested to rate their intention to use Game-based software in teaching chemistry using a scale of indicators ranging from 1-5.

Table 3. Intention to use game-based software.

No.	Rating	Frequency	Percentage
1.	I believe using Game-based software will enhance Chemistry teaching.	40	77.0%
2.	I am confident in my ability to use Game-based software in teaching Chemistry.	42	81.0%
3.	I perceive Game-based software as beneficial for Chemistry teaching and learning.	48	92.3%
4.	I am motivated to explore and implement Game-based software into the Chemistry curriculum.	50	96.1%
5.	Using Game-based software in Chemistry teaching is a priority for me	48	92.3%

In **Table 3**, the results regarding the Chemistry educators' intention to use Game-based software for improving the teaching of Chemistry reveal a notably favourable stance towards the adoption of Game-based software. A substantial majority (77.0%) of Chemistry educators expressed confidence in the potential of Game-based software use to enhance the teaching of chemistry. This underscores their belief that using Game-based software can lead to enhanced efficiency and quality in teaching chemistry. An impressive portion (81.0%) of the Chemistry educators conveyed a high level of confidence in their capacity to use game-based software in chemistry teaching. This indicates that they feel sufficiently equipped and competent to deploy Game-based software effectively, thereby fostering a positive attitude towards Game-based integration.

A significant proportion (92.3%) of chemistry educators acknowledged the benefits of Game-based software for enhancing the teaching of chemistry in various institutions in Kwara State. This strong consensus highlights their recognition of the myriad advantages that game-based software offers in improving different facets of chemistry teaching and learning. An overwhelming majority (96.1%) of chemistry educators demonstrated a keen interest in exploring and implementing game-based software solutions within the chemistry curriculum. This enthusiasm underscores their intention to embrace innovation and harness the potential of Game-based software to enhance chemistry teaching. Similarly, a substantial number (92.3%) of chemistry educators identified Game-based software integration as a priority for science teaching, especially chemistry teaching.

This underscores the significance attributed to Game-based software initiatives among chemistry educators, emphasizing its strategic importance in enhancing chemistry teaching. The widespread agreement across all aspects reflects a collective commitment and readiness among chemistry educators to leverage Game-based teaching innovations for the improvement of chemistry teaching. As a result, "I am motivated to explore and implement Game-based software for enhancing chemistry teaching" had the highest rating, with 96.1% of the respondents indicating a high intention. Considering this context, the findings indicate varying levels of enthusiasm and readiness among chemistry educators in Kwara State, Nigeria. Some researchers emphasized that incorporating game-based software into teaching significantly enhances the efficiency and quality of science education.

Their study found that educators believe these tools make lessons more interactive and engaging, thus improving students' understanding and retention of complex concepts. This finding aligns with the 77.0% of chemistry educators who expressed confidence in the potential of game-based software to improve chemistry teaching. Similarly, some researchers

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(Adeyemo *et al*., 2018) revealed that a high percentage of Nigerian teachers feel confident and competent in integrating digital tools, including game-based software, into their teaching methods. This is consistent with the finding that 81.0% of chemistry educators in Kwara State feel equipped to effectively use game-based software, indicating a positive attitude toward such innovations. Furthermore, some researchers investigated Nigerian educators' perceptions of the benefits of game-based learning in science education. Their study found a strong consensus on the advantages of these tools, such as enhanced student engagement and learning outcomes. This supports the finding that 92.3% of chemistry educators recognized the benefits of game-based software and considered its integration a priority for enhancing chemistry teaching.

4. CONCLUSION

In conclusion, the study conducted on the readiness and intentions to use Game-based software for teaching Chemistry among Chemistry educators in Kwara State yielded significant findings. Firstly, a majority of participants demonstrated awareness of Game-based software, indicating a solid understanding of the concept. However, there remains room for improvement in comprehending how Game-based software can effectively enhance the teaching of chemistry, as more than half of the participants expressed a lack of clarity. The study also revealed positive perceptions among participants regarding the potential benefits of implementing Game-based software in institutions in Kwara State. Participants exhibited agreement and strong agreement towards various statements, indicating that Game-based software can enhance efficiency, performance, long-time retention, interest, resource management, personalized recommendations, remote access, and overall chemistry students' experience. Nevertheless, it is important to acknowledge that the readiness and intentions to incorporate Games-based software varied among chemistry educators. While many expressed high levels of intention toward the incorporation of Game-based software in enhancing the teaching of Chemistry, a non-significant portion of the participants displayed higher intention to incorporate Game-based software for enhancing Chemistry teaching. This result may be attributed to the opportunities that the respondents attached to the use of this technology, which include enhanced efficiency, improved performance, long-time retention, resource management facilitation, personalized recommendations, remote access facilitation, and enhanced Chemistry student experiences.

Based on the findings of the study regarding the readiness and intentions to use the Game-based software in various institutions in Kwara State, the following recommendations can be proposed:

(i) It is crucial to develop comprehensive training programs and raise awareness among Chemistry educators, considering that more than half of the participants expressed a lack of clear understanding regarding the benefits of Game-based software in chemistry teaching. These initiatives should focus on educating Chemistry educators about the practical applications and potential advantages of Game-based software within school settings. By improving their knowledge and comprehension, Chemistry educators will be better equipped to integrate Game-based software into their teaching effectively.

(ii) The study identified limited technological infrastructure and resources as a significant challenge faced by Chemistry educators in Nigeria. To address this issue, it is necessary to invest in upgrading the technological infrastructure of the various institutions in Kwara State, including the secondary schools. This includes ensuring reliable internet access, upgrading hardware and software systems, and ensuring compatibility with Game-based

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software devices. By enhancing the technological infrastructure, schools can establish an environment that is conducive to the successful implementation of Game-based software.

(iii) Collaboration among institutions in Kwara State and beyond can help overcome the challenges associated with limited resources. Schools can collaborate to share knowledge, experiences, and best practices related to the implementation of Game-based software. Collaborative efforts can also facilitate joint procurement of Game-based software and pooling of resources, making it more feasible for individual schools to adopt and integrate Game-based teaching successfully.

(iv) Pilot projects and case studies can provide valuable insights into the practical implementation of Game-based software in the teaching of Chemistry in schools. By conducting small-scale trials and documenting the outcomes, Chemistry educators in Kwara State can evaluate the feasibility, benefits, and challenges associated with incorporating Game-based software. These pilot projects can serve as learning experiences and guide the broader adoption of Game-based software in various institutions in Kwara State.

These recommendations can help bridge the readiness and intention gaps and enable Nigerian institutions, including those institutions in Kwara State, to embrace Game-based software and provide comprehensive, effective, and efficient teaching to their students.

Limitations of the study on using the Game-based software to enhance the teaching of Chemistry among Chemistry educators in Kwara State are as follows:

(i) The study may have had a small number of participants, which could limit the generalizability of the findings. The perspectives and readiness levels of all Chemistry educators and stakeholders in Kwara State or other regions may not be fully represented.

(ii) The study may not have included a diverse range of participants in terms of age, gender, experience level, or qualifications. This limitation restricts the understanding of how different groups within the schools or institutions' environment perceive and prioritize the integration of Game-based software.

(iii) The study focused exclusively on institutions in Kwara State, which limits the generalizability of the findings to other regions. The readiness levels and intentions of Chemistry educators in different contexts or locations may vary significantly.

(iv) The study may not have accounted for external factors that can influence the readiness and intentions to adopt Game-based software, such as budget constraints, policy changes, or evolving technological trends. These factors can affect the feasibility and practicality of implementing Game-based software in Chemistry teaching.

(v) The study primarily concentrated on the readiness and intentions of Chemistry educators, neglecting the perspectives and preferences of Chemistry students. Understanding students' expectations and concerns regarding Game-based software integration is crucial for successful implementation and students' performance.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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