ASEAN Journal of Educational Research and Technology

Journal homepage: https://ejournal.bumipublikasinusantara.id/index.php/ajert

Awareness and Utilization of Artificial Intelligence-Based Intelligent Tutoring Systems (ITS) In Enhancing Chemistry Education Through Information and Communication Technology (ICT)

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ABSTRACT

This study explores the awareness and utilization of Artificial Intelligence (AI)-based Intelligent Tutoring Systems (ITS) in enhancing chemistry education through Information and Communication Technology (ICT) in Nigerian universities. Using a descriptive survey design, data were collected from 182 chemistry education lecturers across six geopolitical zones. The study assessed lecturers' levels of awareness, accessibility, usage, and extent of integration of ITS platforms. Results revealed moderate to high awareness and a generally positive perception of ITS's value in improving teaching and learning outcomes. However, disparities in accessibility, institutional infrastructure, and practical integration hinder widespread adoption. While many lecturers acknowledged the benefits of ITS, challenges such as inadequate resources, limited institutional support, and inconsistent usage patterns remain. The study underscores the need for targeted training, institutional support, and policy reforms to facilitate the seamless adoption of ITS in chemistry education. These efforts are essential to harness the transformative potential of AI and ICT in the Nigerian higher education system.

ARTICLE INFO

Article History:
Submitted/Received 09 Jan 2025
First Revised 10 Feb 2025
Accepted 27 Apr 2025
First Available online 28 Apr 2025
Publication Date 01 Sep 2025

Keyword:
Awareness,
Chemistry education,
Intelligent tutoring systems,
Nigerian universities,
University lecturers.

1. INTRODUCTION

Numerous academic disciplines, including biology, engineering, health, and health, view chemistry as a pure science with practical applications. According to some researchers (Freire *et al*., 2019), chemistry is one of the scientific subjects that can encourage students to investigate nature and the transformations it undergoes, which can aid intellectual development. Chemistry, according to some researchers (Valipouri & Nassaji 2013), is the study of matter, or anything that has mass and space, as well as the transformations that matter can go through in response to different circumstances and environments. The study of chemistry focuses on how and why matter undergoes certain changes, such as merging with another material, freezing after two weeks, or changing color when exposed to excessive amounts of sunlight. The study of chemistry encompasses all of these properties of matter, such as a chemical element's mass or composition.

Chemistry is a branch of science that investigates the nature, structure, and properties of matter. This innovative field, which is frequently referred to as the central science, focuses primarily on atomic and molecular structure and how it changes, such as through chemical interactions. Some researchers reported that chemistry is the study of matter; it looks at how these elements change during chemical processes by looking at their composition, characteristics, and behavior. It can consequently be viewed as a subfield of actual science, in a similar classification as physical science, cosmology, and studies of the planet like topography (Oviedo *et al*., 2022). Science is the investigation of substances (determined as components and mixtures), their properties, creation, and construction, as well as the progressions they go through and the energy they retain or deliver simultaneously).

As stated by some researchers every substance, man-made or natural, is made up of one or more of the approximately 100 different types of atoms that are known as elements in science. These atoms are the basic components of chemicals, even though they are composed of simpler particles. For instance, an atom of oxygen, mercury, or gold cannot be smaller than an atom of that material (Muoneke & Muoneke, 2022). According to some researchers (Muoneke & Muoneke, 2022), chemistry is not concerned with the subatomic domain but rather with the characteristics of atoms, the rules that govern their combinations, and how these characteristics can be utilized to achieve particular objectives. The significance of chemistry education in our society cannot be overstated. Chemistry education is a subset of STEM education or discipline-based education research. It includes the investigation of educating and learning science (Hernandez, 2023).

It covers many subjects, for example, how children learn science and what the best method for showing the subject is. According to research on chemistry education, chemistry curricula and learning objectives must continue to be updated. Chemistry education focuses on teaching students about matter's composition, interactions, transformations, and properties. As a result, acquiring knowledge about the universe necessitates a methodical approach to learning the fundamentals of chemistry. It is possible to view the acquisition of chemistry-related concepts or knowledge as a component of the extensive and complex scope of chemistry education. Education in chemistry is important because it is so important to the world. While people depend on the normal movement of synthetic responses inside their bodies, the laws of science govern the universe (Arfin *et al*., 2023).

Science is supposed to be the "focal science," overcoming any barrier between the applied and organic sciences and the actual sciences. Chemistry has many uses in the food industry, medical field, environmental field, and other fields. Chemistry can help students improve their critical thinking, logical reasoning, problem-solving, communication, and understanding

DOI:
p- ISSN: 2828-4887 e- ISSN: 2828-4860

of the scientific method (Asmiyunda *et al*., 2025). Early chemistry education ignites children's curiosity in STEM subjects. Furthermore, chemistry students gain extremely transferable skills that apply to any industry. To attain the targeted learning objectives in chemistry, a collaborative effort involving passionate educators, dedicated and involved learners, suitable teaching methods, essential materials, and an exceptionally encouraging atmosphere is required (Nkiko, 2021).

Chemistry education in Nigerian universities can be improved through a variety of means, including the integration of artificial intelligence (AI) in the form of intelligent tutoring systems (ITS), classroom instruction, laboratory exercises, demonstrations, and chemistry instructors receiving the necessary training (Muoneke & Muoneke, 2022). The development of computerized systems that are capable of imitating human thought and behavior is referred to as artificial intelligence (AI). The phrase is typically used by the general public to describe computers' or machines' ability to think and behave like people (Gocen & Aydemir, 2020). As a result, artificial intelligence can be defined as technologies or algorithms that are adept at imitating human thought processes or actions (Markose & Dewtwal, 2023). The goal of the artificial intelligence (AI) field in computer science is to create intelligent programs or systems that can complete tasks that typically call for human intelligence (Martini *et al*., 2024).

AI systems can learn from data, identify trends, and make judgments with little to no human input. These frameworks interact with tremendous volumes of information precisely and quickly by intertwining strong calculating assets with complex calculations. This makes them helpful assets for researchers working in different areas who need to break down huge, mind-boggling data or figure out future events. Researchers studying climate change, for instance, have turned to artificial intelligence (AI) to perform simulations at a faster rate than ever before and obtain insights into the effects of environmental factors on global temperatures over much longer periods than any one scientist could investigate on their own (Rolnick *et al*., 2022). According to some researchers (Gocen & Aydemir, 2020), the current system may create the illusion that artificial intelligence will be included in home computers.

It could show up in our lives with different structures and limits. Some researchers (Harris, 2011) suggest that the new energy of the advanced age is computerized reasoning. According to some researchers (Claudy *et al*., 2015), artificial intelligence has the potential to significantly contribute to the financial trend, making it a strong contender to be positioned as the primary component of the Fifth Modern Transformation. Perhaps as a result of this, when it invested $40 billion in artificial intelligence in 2017, China set a new record (Dunleavy & Margetts 2025). By 2030, it is anticipated that China's GDP will increase by 26%, or $7 trillion, in line with AI profits. Some researchers (Gocen & Aydemir, 2020) predict that North America will see a gain of 14.5 percent (or $3.7 trillion) during the same period. These facts clarify the advantages of artificial intelligence and its global implications for education and, in our case, the economy in the future.

The workforce and education both shape the future and lay the groundwork for the next industrial revolution (Loumourdi, 2024; Rijwani *et al*., 2025). A thorough investigation into artificial intelligence will have an impact on how classrooms and schools are run, how students are taught, and how society is reorganized overall. Schools, which are expected to embrace the digital age and incorporate skills relevant to the 21st century into their curriculum, stand to benefit the most from the development of artificial intelligence. According to some researchers (Karsenti, 2019), new technologies will permeate our lives and captivate our children, forcing schools to adapt. Computers used artificial intelligence (AI) in the 1970s to teach. Understanding information better and building PCs that can perform

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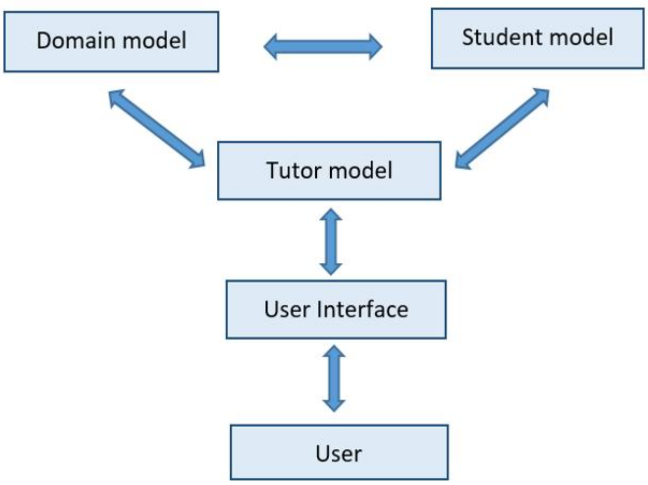
p- ISSN: 2828-4887 e- ISSN: 2828-4860

complex errands that individuals can't are the aftereffects of man-made brainpower. AI tutors work one-on-one with students of varying skill levels and incorporate agents that are aware of the social, emotional, and cognitive characteristics of those students.

These agents can talk to the students, find learning issues, and play back content as needed. Oversee and keep an eye on how students' movement opportunities, common challenges, and content-based learning are progressing. Computerized reasoning methods have prompted the expression "self-improvement instructors," as teachers can approve their learning. AI-powered tutoring systems enable students to receive individualized guidance and feedback .As indicated by some researchers (Jackson *et al*., 2009), the Knowledge Mentoring Framework PC programming utilizes man-made reasoning to show an instructor who knows about who it is showing and the ropes. Put in an unexpected way, ITS supervises the administration of understudies' information and evaluates their abilities. Some researchers, assert that many students now have access to the ITS system.

Using these systems, which can adapt to students' learning styles and provide individualized instruction and support, can improve learning outcomes for students. These technologies have the potential to sustain students' motivation and interest in their studies by providing them with prompt feedback. Carnegie Learning's AI-powered tutoring system provides instant feedback and individualized learning paths based on each student's mathematical strengths and weaknesses. As well as offering intuitive guidance and practice issues, the framework acclimates to every understudy's singular learning rate. Educators can utilize ITS to screen understudy progress, convey custom-made schooling, and pinpoint regions in which understudies need more support. Some examples include Carnegie Learning, Knewton, and ALEKS (Radovan & Radovan, 2024; Fan *et al*., 2025).

Two elements have driven scientists to turn their consideration toward ITS: first, to fill in information holes in regards to processes that add to instructive association, and second, to address down-to-earth needs. Because the ITS is at the intersection of computer science, cognitive psychology, and educational research, researchers can work with a variety of hypotheses from cognitive psychologists, AI scientists, and educational theorists in a great environment. In addition, there are some effects that can be achieved with ITS that cannot be achieved with human tutors. The essential avocation for utilizing wise mentoring frameworks is their capacity to offer altered learning conditions that take care of every understudy's necessities. Various modules make up the Smart Mentoring Framework's (ITS) design, which helps with its activity. **Figure 1** outlines the ITS design.



Figuge 1. The ITS components.

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p- ISSN: 2828-4887 e- ISSN: 2828-4860

The Learning Environment module will be used to send these comments to the students. The student's module is updated to reflect their newfound understanding of these topics. Some researchers investigated how students interact with an ITS for chemistry education at the university level. The review took a gander at how understudies connected with an ITS utilized for science guidance at the college level. By carefully analyzing log data, the researchers discovered that students primarily used the system on weekends and after school, outside of scheduled instructional times. Additionally, they discovered that students primarily used the system to study course materials and practice problem-solving activities. The study also demonstrated that different student cohorts had distinct usage patterns, such as those with varying degrees of prior chemistry knowledge. Some researchers (Ünal *et al*., 2006) looked into what students thought about an ITS used in university chemistry classes.

Through system logs and questionnaires, the researchers discovered that students considered the ITS to be a useful resource for additional study and test preparation. They were highly complementary of the system's adaptive feedback and individualized learning components. Additionally, the study demonstrated that during exam times, students utilized the system more frequently and engaged in greater exam preparation. Some researchers directed an examination of understudy collaborations with a savvy mentoring framework in college science courses. The study conducted a descriptive analysis of student interactions with an ITS in college-level chemistry classes. Through extensive usage records and surveys, the researchers discovered that students used the system to improve their ability to solve problems and comprehend complex chemistry concepts. According to the study, students used the system outside of regular class times more frequently on weekends and at night. In addition, the researchers discovered a positive correlation between students' engagement with the system and their performance on course assessments. As a result, the goal of this research is to find out the awareness level and the use of the ITS in revolutionizing Chemistry Education in Nigeria Universities.

The general purpose of this study is to examine the awareness level and use of ITS in revolutionizing Chemistry education in Nigerian universities. Specifically, the following purposes would guide the conduct of this study:

(i) Assess the awareness level of university lecturers regarding the ITS in revolutionizing Chemistry education in Nigerian universities;
(ii) Find out the accessibility rate of ITS in revolutionizing Chemistry education among university lecturers;
(iii) Examine the use of ITS in revolutionizing Chemistry education among university lecturers;
(iv) Determine the extent of use of ITS among university lecturers for revolutionizing Chemistry education in Nigerian universities.

Research Questions are in the following:

(i) What is the awareness level of university lecturers regarding the ITS in revolutionizing Chemistry education in Nigerian universities?
(ii) What is the accessibility rate of ITS in revolutionizing Chemistry education among university lecturers?
(iii) What is the use of an ITS in revolutionizing Chemistry education among university lecturers?
(iv) What is the extent of use of the ITS among university lecturers for revolutionizing Chemistry education in Nigerian universities?.

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p- ISSN: 2828-4887 e- ISSN: 2828-4860

2. METHODS

This study was conducted through a survey method of descriptive research. The target population was Chemistry Education University students in Nigeria. Purposive sampling techniques were adopted to select six Federal Institution from each of the six geo-political zones of Nigeria. These include the South-South, South-East, South-West, North-Central, North-East, and North-West. However, a convenience sampling method was also adopted to reach out to the participants of the study using an online survey method, which was shared through a linked-contacted person in each of the institutions belonging to the Department of Chemistry Education. As a result of distance, safety, and time barriers, physical distribution of the questionnaire was not possible. Therefore, an alternative method was deployed, which resulted in the digitization of the instrument.

However, a structured survey consisting of pre-designed questions related to the study's objectives was created. The survey included instructions on how to complete it and an explanation of the concept of an Intelligent Tutoring System. The questionnaire has five sections (A, B, C, D, & E), which examine the respondent's demography, awareness level, accessibility rate, use of ITS, and extent of use of the ITS, respectively. The questionnaire was validated by five experts comprised of two Computer Science Education lecturers, two Educational Technology lecturers, and one Chemistry Education lecturer. The observations and suggestions raised by the experts were effected to produce the final draft, which was subjected to the reliability test of Cronbach Alpha Correlation Coefficient. Afterward, the online survey link was shared with the contact-linked person to get it posted to the participants through WhatsApp platforms owned by the Science Education Departments across six selected universities in the six geopolitical zones in Nigeria.

Through the linked-contacted person, the participants of the study were also informed that they were free to withdraw from the study if they felt it was counterproductive to them. After the period of 6 of instrument administration, it was revealed on the data dashboard that 182 responses were obtained and subjected to descriptive statistical analysis. Research questions 1, 2, 3, and 4 were answered using frequency count and simple percentage ratio. The result and analysis were verified over time and used final presentation. Ethical considerations were taken into account, and informed consent was obtained from the contact-linked persons, who willingly agreed to participate in the study in each of the selected universities. **Tables 1, 2, 3, and 4** provide a breakdown of the survey responses.

3. RESULTS AND DISCUSSION

Regarding awareness of ITS and its impact on chemistry education, findings reveal notable (40 respondents, 21.98%), moderate (60 respondents, 32.97%), satisfactory (50 respondents, 27.47%), limited (24 respondents, 13.19%), and minimal awareness (8 respondents, 4.40%). A substantial portion of respondents demonstrated moderate to notable awareness, indicating a broad recognition of ITS's potential impact. In terms of understanding ITS capabilities in chemistry education, responses varied from notable (35 respondents, 19.23%) to minimal understanding (17 respondents, 9.34%). Notably, a significant proportion displayed moderate to notable understanding, indicating a grasp of ITS's potential within the domain. Regarding engagement with literature on ITS in chemistry education, responses ranged from high (20 respondents, 10.99%) to minimal frequency (12 respondents, 6.59%) See **Table 1**.

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Table 1. Awareness level of its in revolutionizing chemistry education among university lecturers in Nigeria.

SN	Items	HA	MA	A	SA	RA
1	How aware are you of ITS and their role in revolutionizing chemistry education?	40 (21.98%)	60 (32.97%)	50 (27.47%)	24 (13.19%)	8 (4.40%)
2	To what extent are you aware of the capabilities of ITS in chemistry education?	35 (19.23%)	55 (30.22%)	45 (24.73%)	30 (16.48%)	17 (9.34%)
3	How frequently are you aware of literature (journals, articles, etc.) related to ITS in the context of chemistry education?	20 (10.99%)	40 (21.98%)	65 (35.71%)	45 (24.73%)	12 (6.59%)
4	To what extent are you aware of incorporating ITS in your teaching practices for chemistry courses?	25 (13.74%)	50 (27.47%)	40 (21.98%)	45 (24.73%)	22 (12.09%)
5	How important do you aware are ITS in revolutionizing chemistry education?	50 (27.47%)	30 (16.48%)	35 (19.23%)	55 (30.22%)	12 (6.59%)

A considerable number of respondents reported adequate frequency, signifying active engagement with relevant literature. Based on the awareness of integrating ITS into teaching practices for chemistry courses, responses varied from notable (25 respondents, 13.74%) to minimal awareness (22 respondents, 12.09%). Notably, a notable proportion displayed moderate to notable awareness, indicating openness to integrating ITS into teaching methodologies. Perceived importance of ITS in advancing chemistry education ranged from high (50 respondents, 27.47%) to minimal importance (12 respondents, 6.59%). Significantly, a substantial number of respondents expressed moderate to notable levels of importance, highlighting ITS's perceived value in advancing chemistry education. Findings underscore varying levels of awareness, understanding, engagement, and perceived importance of ITS within the context of chemistry education. Notably, awareness and moderate understanding received the highest ratings among respondents.

Previous studies (Smith *et al*., 2021) shed light on the increasing acknowledgment of ITS within the realm of education. The findings reveal moderate to notable levels of awareness among respondents, indicating a widespread recognition of ITS's potential to revolutionize teaching and learning practices. This resonance with the educational technology literature underscores ITS's pivotal role in fostering personalized learning experiences and enhancing student outcomes. Moreover, the substantial proportion of respondents displaying moderate to notable understanding of ITS capabilities reflects a deepening comprehension within the academic community regarding the versatile applications of ITS, particularly in specialized domains such as chemistry education. Similarly, recent research (Lee and Kim, 2022) corroborates the significance attributed to ITS in advancing chemistry education.

The study highlights a notable proportion of respondents expressing moderate to notable levels of importance, mirroring the growing emphasis on technology-enhanced learning strategies in higher education (Cai *et al*., 2024; Chong *et al*., 2025; Odoom *et al*., 2025; Iryanti *et al*., 2024; Bower *et al*., 2024). Underscore educators' recognition of ITS as invaluable tools for tackling the complexities inherent in teaching subjects like chemistry, with an emphasis on promoting active learning and delivering personalized instruction. Additionally, the study emphasizes the imperative for further research and professional development initiatives to deepen educators' engagement with ITS. This aligns with the broader literature on educational technology adoption, which emphasizes the crucial role of ongoing support and training in optimizing the benefits of innovative technologies within educational settings.

DOI:
p- ISSN: 2828-4887 e- ISSN: 2828-4860

Table 2 shows that a significant portion of respondents perceive ITS platforms as moderately accessible, yet noteworthy proportions also categorize them as highly accessible or entirely inaccessible. This signals a multifaceted accessibility landscape among educators, reflecting varying degrees of ease in utilizing ITS. Regarding the availability of essential resources for accessing ITS, respondents report divergent levels of accessibility. While a considerable number acknowledges some degree of availability, substantial percentages highlight limited or completely unavailable resources. This suggests discrepancies in access to crucial tools necessary for effectively utilizing ITS within chemistry education. The integration of ITS into teaching practices seems favorable for a notable segment of respondents, although challenges persist for others. While many find integration moderately or highly straightforward, significant proportions indicate varying levels of difficulty, underscoring the intricacies of integrating technology into pedagogical approaches.

Table 2. Accessibility rate of its in revolutionizing chemistry education among university lecturers in Nigeria.

S/N	Items	HA	MA	A	SA	RA
1	How would you rate the accessibility of ITS platforms for chemistry education?	30 (16.48%)	50 (27.47%)	40 (21.98%)	40 (21.98%)	22 (12.09%)
2	How readily available are the necessary resources (software, hardware, internet connection) for accessing ITS in chemistry education?	25 (13.74%)	40 (21.98%)	55 (30.22%)	35 (19.23%)	27 (14.84%)
3	How easy is it for you to integrate ITS into your teaching practices for chemistry courses?	20 (10.99%)	45 (24.73%)	30 (16.48%)	55 (30.22%)	32 (17.58%)
4	How sufficient is the institutional infrastructure (such as IT support, funding, and policies) to facilitate the accessibility of ITS for chemistry education?	35 (19.23%)	30 (16.48%)	40 (21.98%)	45 (24.73%)	32 (17.58%)
5	To what extent do you find ITS resources (tutorials, simulations, practice exercises) readily available for integration into your teaching materials for chemistry courses?	40 (21.98%)	35 (19.23%)	45 (24.73%)	50 (27.47%)	12 (6.59%)

Perceptions regarding the sufficiency of institutional infrastructure for supporting ITS accessibility are mixed. While a notable portion perceives the infrastructure as sufficient, significant proportions voice concerns about its adequacy, signaling the necessity for enhancements in institutional support for the implementation of ITS. Regarding the availability of ITS resources for integration into teaching materials, respondents perceive a moderately to highly available landscape. However, a minority reports limited availability, suggesting areas for improvement in ensuring accessibility to ITS resources. Overall, the findings depict a nuanced scenario concerning the accessibility of ITS in shaping chemistry education among university lecturers in Nigeria. While positive perceptions exist regarding integration ease and resource availability, challenges related to accessibility and institutional infrastructure persist.

These findings were obtained through total enumeration techniques, with the highest-rated categories revealing key insights into the perceptions of educators regarding ITS accessibility and utilization. Recent studies in educational technology adoption (Chen and Huang, 2020) underscore the nuanced nature of educators' perceptions towards technology accessibility. Their findings reveal that while a considerable segment of educators views

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p- ISSN: 2828-4887 e- ISSN: 2828-4860

educational technology tools as moderately accessible, significant proportions categorize them as highly accessible or entirely inaccessible. This observation resonates with the current study's outcomes, indicating a diverse spectrum of accessibility perceptions among educators concerning ITS. They stressed the significance of comprehending educators' varying perceptions and addressing accessibility barriers to facilitate the seamless integration of technology into teaching practices.

Furthermore, research focusing on infrastructure and resource allocation in educational settings (Kim & Lee, 2021) sheds light on the disparities in access to essential resources for technology integration. Their study unveils that while some educators enjoy adequate access to requisite resources for technology integration, substantial percentages encounter limitations or complete unavailability of resources. This parallels the findings of the present study concerning the availability of essential resources for accessing ITS in the realm of chemistry education. Kim and Lee's research underscores the importance of equitable resource allocation and infrastructure enhancement to rectify discrepancies in access and foster the effective utilization of educational technologies like ITS.

The investigation into university lecturers' attitudes towards integrating ITS into chemistry education teaching methods reveals a diverse spectrum of viewpoints (**Table 3**). Roughly 35% of respondents recognize the potential advantages and actively incorporate ITS into their teaching strategies. However, a substantial proportion, comprising 52%, maintains a neutral stance or harbors reservations regarding its efficacy. Similarly, opinions regarding the efficacy of ITS in enhancing student learning outcomes span a wide range. While approximately 52% express confidence in its effectiveness, around 32% remain uncertain or skeptical, indicating a necessity for further examination and validation of ITS impact on learning. The perception of the usability and effectiveness of ITS platforms for chemistry education varies among participants.

Approximately 49% find these platforms user-friendly and effective, while roughly 27% encounter challenges or express reservations. This underscores the significance of enhancing user experience and support mechanisms. Observations regarding increased student engagement with ITS present a mixed picture, with some educators reporting positive effects while others remain uncertain or skeptical. This underscores the challenge of accurately assessing the impact of ITS on student engagement and motivation. Lastly, attitudes toward the transformative potential of ITS in revolutionizing chemistry education exhibit considerable diversity. Around 46% express strong support and optimism, while approximately 41% harbor skepticism or reservations. These divergent perspectives underscore the necessity for further research and dialogue to gain a deeper understanding of the potential benefits and challenges associated with integrating ITS into educational settings.

In summary, these findings underscore the nuanced nature of attitudes towards the use of ITS in revolutionizing chemistry education among university lecturers in Nigeria. They emphasize the ongoing need for exploration and evaluation to inform effective pedagogical practices in the field. Some researchers (Adedokun *et al*., 2020) in Nigeria offer valuable insights into university lecturers' attitudes toward integrating educational technologies, including ITS, into their teaching methodologies. Their study unveiled a spectrum of viewpoints among educators, wherein a substantial cohort acknowledged the potential benefits of technology integration while others expressed reservations. Similarly, some researchers (Ibrahim & Abdullahi, 2021) delved into technology adoption within Nigerian higher education institutions, shedding light on the diverse opinions regarding the efficacy and usability of educational technologies. Their research resonates with other findings,

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p- ISSN: 2828-4887 e- ISSN: 2828-4860

particularly concerning the varied perceptions of ITS effectiveness and usability among university lecturers in Nigeria.

Table 3. Use of its in revolutionizing chemistry education among university lecturers in Nigeria.

S/N	Items	SA	A	N	D	SD
1	I incorporate ITS into my teaching methodologies for chemistry education	20 (10.99%)	45 (24.73%)	60 (32.97%)	35 (19.23%)	24 (13.19%)
2	I believe that ITS effectively enhances student learning outcomes in chemistry education	55 (30.22%)	40 (21.98%)	30 (16.48%)	45 (24.73%)	14 (7.69%)
3	I find ITS platforms easy to navigate and utilize for chemistry education	40 (21.98%)	50 (27.47%)	45 (24.73%)	30 (16.48%)	19 (10.44%)
4	I observe increased student engagement when using ITS in chemistry education	45 (24.73%)	30 (16.48%)	40 (21.98%)	45 (24.73%)	24 (13.19%)
5	I believe that ITS are valuable tools for revolutionizing chemistry education	50 (27.47%)	35 (19.23%)	25 (13.74%)	45 (24.73%)	29 (15.93%)

Table 4 reveals an approximately 29% of respondents acknowledge the integration of ITS into their university's curriculum, suggesting a degree of progress in adoption. However, a significant proportion, around 47%, remains neutral or expresses reservations about this integration, indicating potential barriers or challenges hindering full integration. Regarding the frequency of ITS incorporation into teaching practices, roughly 41% of lecturers report frequent utilization. However, a notable 38% either infrequently incorporate ITS or do not use them at all, pointing to variability in adoption rates among educators. Notably, the item "I frequently incorporate ITS into my teaching practices for chemistry courses" garnered the highest rating among respondents. In terms of engagement with ITS features and functionalities, around 39% of respondents actively utilize them in their teaching activities.

Conversely, a similar proportion, approximately 38%, exhibits less engagement or minimal utilization, suggesting differing levels of interaction with ITS among lecturers. Student interaction with ITS presents a mixed scenario, with approximately 41% of lecturers indicating regular student engagement. However, around 36% report limited student interaction, highlighting disparities in student involvement with ITS across teaching contexts. Perceptions of the effectiveness of ITS in teaching reveal a divided opinion among lecturers. While roughly 36% believe ITS significantly enhance teaching effectiveness, an equal percentage does not share this view, indicating divergent perspectives on the impact of ITS. Overall, these findings underscore the complexity surrounding the integration and utilization of ITS in chemistry education among university lecturers in Nigeria.

They emphasize the importance of ongoing support, training, and exploration to maximize the potential benefits of ITS in enhancing teaching and learning outcomes in the field. Some researchers conducted research on technology adoption within Nigerian higher education institutions, shedding light on the diverse perceptions and challenges associated with integrating Intelligent Tutoring Systems (ITS). Their study echoed the varied opinions and adoption rates among university lecturers, highlighting the need for targeted interventions and support mechanisms to overcome barriers hindering full ITS integration. Some researchers delved into the impact of ITS integration on teaching effectiveness and student outcomes in Nigerian universities.

Table 4. Extent of use of its in revolutionizing chemistry education among university lecturers in Nigeria.

S/N	Items	SA	A	N	D	SD
1	ITS are well-integrated into the chemistry curriculum at my university.	18 9.78%	35 19.02%	45 24.46%	60 32.61%	26 14.13%
2	I frequently incorporate ITS into my teaching practices for chemistry courses.	25 13.59%	50 27.17%	40 21.74%	45 24.46%	24 13.04%
3	I actively engage with various features and functionalities of ITS in my teaching activities for chemistry education.	30 16.30%	40 21.74%	45 24.46%	35 19.02%	34 18.48%
4	My students regularly interact with ITS as part of their learning experience in chemistry courses.	20 10.87%	45 24.46%	55 29.89%	40 21.74%	24 13.04%
5	ITS has significantly enhanced the effectiveness of my teaching in chemistry education.	35 19.02%	30 16.30%	40 21.74%	45 24.46%	34 18.48%

Their findings provided additional insights into lecturers' perceptions of ITS effectiveness, complementing the divergent opinions highlighted in the interpretation of findings. Similarly, some researchers explored educators' attitudes towards educational technology integration in Nigerian universities. Their study aligned with the interpretation presented, emphasizing the importance of ongoing support and exploration to optimize the effectiveness of ITS in teaching and learning practices. Together, these studies contribute to understanding the complexities surrounding ITS integration and utilization in Nigerian higher education, emphasizing the necessity for tailored interventions and continuous support to maximize its potential benefits. In addition, we added the questionnaire used in **Tables 5-7**. This questionnaire is aimed at finding out the Awareness Level and Use of ITS in Revolutionizing Chemistry Education in Nigerian Universities. Students are assured that the data collected will only be used for research purposes and treated confidentially.

Table 5. Section A demographic information.

No	Questions
1	Name (Optional)
2	Gender: Male or Female
3	Academic Rank: Lecturer II, Lecturer I, Senior Lecturer, Associate Professor, or Professor
4	Years of Teaching Experience: 0-2, 3-5, 6-8, or 9 years and above
5	Field of Study/Specialization

Table 6. Section B: awareness level of university lecturers. it indicates the level of awareness with the following statements using a five-point likert scale (ha = highly aware, ma = moderately aware, a = aware, sa = slightly aware, ra = rarely aware).

S/N	Items	HA	MA	A	SA	RA
1	How aware are you of ITS and their role in revolutionizing chemistry education?					
2	To what extent are you aware of the capabilities of ITS in chemistry education					
3	How frequently are you aware of literature (journals, articles, etc.) related to ITS in the context of chemistry education					
4	To what extent are you aware of incorporating ITS in your teaching practices for chemistry courses					
5	How important do you aware ITS are in revolutionizing chemistry education					

DOI:
p- ISSN: 2828-4887 e- ISSN: 2828-4860

Table 7. Section C accessibility rate of ITS in revolutionizing chemistry education. It indicates the level of agreement with the following statements using a five-point Likert scale. HA= Highly Access, MA = Moderately Access, A = Access, SA = Slightly Access and RA = Rarely Access.

S/N	Items	HA	MA	A	SA	RA
1	How would you rate the accessibility of ITS platforms for chemistry education?					
2	How readily available are the necessary resources (software, hardware, internet connection) for accessing ITS in chemistry education					
3	How easy is it for you to integrate ITS into your teaching practices for chemistry courses					
4	How sufficient is the institutional infrastructure (such as IT support, funding, and policies) to facilitate the accessibility of ITS for chemistry education					
5	To what extent do you find ITS resources (tutorials, simulations, practice exercises) readily available for integration into your teaching materials for chemistry courses					

Table 8. Section d use of its in revolutionizing chemistry education. please indicate your level of agreement with the following statements using a five-point likert scale. sa= strongly agree, a= agree, n= neutral, d= disagree, sd= strongly disagree.

S/N	Items	SA	A	N	D	SD
1	I incorporate ITS into my teaching methodologies for chemistry education.					
2	I believe that ITS effectively enhances student learning outcomes in chemistry education.					
3	I find ITS platforms easy to navigate and utilize for chemistry education.					
4	I observe increased student engagement when using ITS in chemistry education.					
5	I believe that ITS are valuable tools for revolutionizing chemistry education.					

Table 9. Section E extent of use of its in revolutionizing chemistry education in nigerian universities. it indicates your level of agreement with the following statements using a five-point likert scale. sa= strongly agree, a= agree, n= neutral, d= disagree, sd= strongly disagree

S/N	Items	SA	A	N	D	SD
1	ITS are well-integrated into the chemistry curriculum at my university.					
2	I frequently incorporate ITS into my teaching practices for chemistry courses.					
3	I actively engage with various features and functionalities of ITS in my teaching activities for chemistry education.					
4	My students regularly interact with ITS as part of their learning experience in chemistry courses.					
5	ITS has significantly enhanced the effectiveness of my teaching in chemistry education.					

DOI:
p- ISSN: 2828-4887 e- ISSN: 2828-4860

4. CONCLUSION

The findings of the study shed light on the various points of view and difficulties that university lecturers in Nigeria face when trying to incorporate ITS into chemistry instruction. They demonstrate varying degrees of ITS awareness, comprehension, engagement, and esteem for its significance in the educational context. Remarkably, the examination features outstanding mindfulness and a moderate degree of understanding among respondents, demonstrating a far and wide acknowledgment of ITS's possible effect. However, difficulties with accessibility and institutional infrastructure persist despite positive perceptions of integration ease and resource availability. Despite the benefits of ITS, obstacles prevent its full use, highlighting the situation's complexity. This accentuates the continuous requirement for investigation and assessment to illuminate powerful academic practices in science training.

In order to get the most out of ITS's potential to improve outcomes for teaching and learning, the study emphasizes the need for ongoing support, training, and investigation. In conclusion, the findings highlight the significance of targeted interventions as well as persistent efforts to overcome obstacles and maximize the integration of ITS into chemistry education practices among Nigerian university lecturers.

In light of the presented findings and subsequent conclusions, the following recommendations emerge from this study:

(i) Developing comprehensive training programs is vital to equipping university lecturers with the necessary skills and knowledge to seamlessly integrate ITS into their teaching practices;
(ii) Improving institutional support is crucial for the successful integration of ITS;
(iii) Promoting collaboration and knowledge sharing among university lecturers is essential to facilitate the exchange of best practices and innovative strategies for integrating ITS into chemistry education;

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.

6. REFERENCES

Adedokun, A., Oludipe, D., and Ojo, O. (2020). Exploring educators' attitudes towards the Integration of Educational Technologies: A case study of Nigerian Universities. *Nigerian Journal of Educational Technology, 39*(2), 68-82.

Arfin, T., Pillai, A. M., Mathew, N., Tirpude, A., Bang, R., and Mondal, P. (2023). An overview of atmospheric aerosol and their effects on human health. *Environmental Science and Pollution Research*, *30*(60), 125347-125369.

Asmiyunda, A., Asrial, A., Sanova, A., and Miharti, I. (2025). Enhancing cognitive and communication skills in learning chemistry through case-based learning integrated with question and answer and whole-class discussion methods. *Jurnal Pendidikan MIPA*, *26*(1), 01-09.

Bower, M., Torrington, J., Lai, J. W., Petocz, P., and Alfano, M. (2024). How should we change teaching and assessment in response to increasingly powerful generative Artificial

Intelligence? Outcomes of the ChatGPT teacher survey. *Education and Information Technologies*, *29*(12), 15403-15439.

Cai, Q., Lin, Y., and Yu, Z. (2024). Factors influencing learner attitudes towards ChatGPT-assisted language learning in higher education. *International Journal of Human–Computer Interaction*, *40*(22), 7112-7126.

Chen, C.-H., and Huang, Y.-M. (2020). Exploring the relationships between technological pedagogical content knowledge (TPACK) Competency and Teaching Performance among EFL teachers in higher education. *Educational Technology & Society, 23*(3), 144-158.

Chong, Z. Y., Koo, A. C., Rahmat, H., Amir Sharji, E., Lim, K. Y., and Teoh, S. H. (2025). Online interactive resilience programme for final-year university students. *Cogent Education*, *12*(1), 2474797.

Claudy, M. C., Garcia, R., and O'Driscoll, A. (2015). Consumer resistance to innovation—a behavioral reasoning perspective. *Journal of the Academy of Marketing Science*, *43*, 528-544.

Dunleavy, P., and Margetts, H. (2025). Data science, artificial intelligence and the third wave of digital era governance. *Public Policy and Administration*, *40*(2), 185-214.

Fan, Y., Tang, L., Le, H., Shen, K., Tan, S., Zhao, Y., and Gašević, D. (2025). Beware of metacognitive laziness: Effects of generative artificial intelligence on learning motivation, processes, and performance. *British Journal of Educational Technology*, *56*(2), 489-530.

Farhan, W., Razmak, J., Demers, S., and Laflamme, S. (2019). E-learning systems versus instructional communication tools: Developing and testing a new e-learning user interface from the perspectives of teachers and students. *Technology in Society, 59*, 101192.

Freire, M., Talanquer, V., & Amaral, E. (2019). Conceptual profile of Chemistry: A framework for enriching thinking and action in Chemistry education. *International journal of science education*, *41*(5), 674-692.

Gocen, A., and Aydemir, F. (2020). Artificial intelligence in education and schools. *Research on Education and Media*, *12*(1), 13-21.

Harris, L. R. (2011). Phenomenographic perspectives on the structure of conceptions: The origins, purposes, strengths, and limitations of the what/how and referential/structural frameworks. *Educational Research Review*, *6*(2), 109-124.

Hernandez, R. (2023). Discipline-based diversity research in chemistry. *Accounts of Chemical Research*, *56*(7), 787-797.

Ibrahim, M., and Abdullahi, M. (2021). Technology Adoption in Nigerian Higher Education Institutions: A case study of university lecturers' Perceptions. *Journal of Information Technology Impact, 21*(1), 1-17.

Iryanti, H. D., Hidayati, D. N., Tyas, E. N., and Amurao, J. M. (2024). Exploring Quizizz-based learning media for teaching maritime English vocabulary: A needs analysis for marine engineering students. *Journal of English Language and Pedagogy*, *7*(2), 61-78.

DOI:
p- ISSN: 2828-4887 e- ISSN: 2828-4860

Jackson, D. L., Gillaspy Jr, J. A., and Purc-Stephenson, R. (2009). Reporting practices in confirmatory factor analysis: An overview and some recommendations. *Psychological methods*, *14*(1), 6.

Karsenti, T. (2019). Artificial intelligence in education: The urgent need to prepare teachers for tomorrow’s schools. *Formation et Profession, 27*(1), 112–116.

Kim, S., and Lee, J. (2021). Factors influencing teachers’ use of educational technology: A Structural equation modeling approach*. Journal of Educational Technology & Society, 24*(3), 1-15.

Lee, S., and Kim, H. (2022). Enhancing chemistry education through intelligent yutoring systems: Perceptions and practices among university lecturers. *Journal of Science Education and Technology, 31(*1), 45-63.

Loumpourdi, M. (2024). The future of employee development in the emerging fourth industrial revolution: a preferred liberal future. *Journal of Vocational Education & Training*, *76*(1), 25-44.

Mahanan, M. S., Ibrahim, N. H., Surif, J., and Chee, K. N. (2021). AR module for learning changes of matter in chemistry. *International Journal Interactive Mobile Technology*, *15*(23), 72-88.

Markose, M., and Dewtwal, M. K. (2023). Artificial intelligence and teacher education: An exploration. ISSRA Journal of Education, *Linguistics and Literature, 3*(6), 6-9.

Martini, B., Bellisario, D., and Coletti, P. (2024). Human-centered and sustainable artificial intelligence in industry 5.0: Challenges and perspectives. *Sustainability*, *16*(13), 5448.

Muoneke, M. N., and Muoneke, V. C. (2022). Ethical consideration on Chemistry education and practice. *African Education Indices, 12*(1), 276 – 982.

Nkiko, M. O. (2021). Interrogating the teaching and learning of chemistry in Nigerian private universities: Matters arising. *Journal of Education and Learning, 10(3), 1927-5250, 1927-5269*

Odoom, D., Agyepong, L., Dick-Sagoe, C., and Mensah, E. O. (2025). Unveiling the social media landscape: exploring factors influencing usage patterns among tertiary education students in Ghana. *Education and Information Technologies*, *30*(3), 3861-3883.

Oviedo, F., Ferres, J. L., Buonassisi, T., and Butler, K. T. (2022). Interpretable and explainable machine learning for materials science and chemistry. *Accounts of Materials Research*, *3*(6), 597-607.

Radovan, M., and Radovan, D. M. (2024). Harmonizing pedagogy and technology: Insights into teaching approaches that foster sustainable motivation and efficiency in blended learning. *Sustainability*, *16*(7), 2704.

Rijwani, T., Kumari, S., Srinivas, R., Abhishek, K., Iyer, G., Vara, H., and Gupta, M. (2025). Industry 5.0: A review of emerging trends and transformative technologies in the next industrial revolution. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *19*(2), 667-679.

Rolnick, D., Donti, P. L., Kaack, L. H., Kochanski, K., Lacoste, A., Sankaran, K., and Bengio, Y. (2022). Tackling climate change with machine learning. *ACM Computing Surveys (CSUR)*, *55*(2), 1-96.

Smith, J., Johnson, R., and Williams, A. (2021). The role of intelligent tutoring systems in education: A comprehensive review. *Journal of Educational Technology, 15*(3), 127-145.

Ünal, S., Çalık, M., Ayas, A., and Coll, R. K. (2006). A review of chemical bonding studies: needs, aims, methods of exploring students' conceptions, general knowledge claims and students' alternative conceptions. *Research in Science & Technological Education*, *24*(2), 141-172.

Valipouri, L., and Nassaji, H. (2013). A corpus-based study of academic vocabulary in chemistry research articles. *Journal of English for Academic Purposes*, *12*(4), 248-263.

DOI:
p- ISSN: 2828-4887 e- ISSN: 2828-4860