CHEMISTRY STUDENTS' AWARENESS, ACCESSIBILITY AND UTILIZATION OF ARTIFICIAL INTELLIGENCE IN COLLEGES OF EDUCATION IN SOUTH-WEST NIGERIA

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Abstract: *This study investigated Chemistry students' awareness, accessibility and utilization of artificial intelligence (AI) in Colleges of Education in South-West Nigeria. The study was guided by three research questions and three hypotheses. This study adopted descriptive survey research design. The population consisted of 834Chemistry students from five Federal College of Education, with a purposive sample of 340 students (94 males, 246females) from three Colleges of Education. Students' awareness, accessibility and utilization of artificial intelligence for learning Chemistry (SAAUAILC) adapted from Enebechi et al. (2024) and Zudonu et al. (2024) was the instrument used for data collection. The instrument was validated by three experts in relevant areas. The internal consistency reliability index of SAAUAILC was established as 0.80 using Cronbach Alpha. Mean and standard deviation were used to answer research questions while t-test was used to test the hypotheses at 0.05 level of significance. Findings of the study revealed that there are low level of awareness, accessibility and utilization of AI resources amongst Chemistry students. Gender had no significant influence on*

Chemistry Students' awareness, accessibility and utilization of artificial intelligence. Based on the findings of the study, it was recommended amongst others that government should organize workshops, conferences and seminars in Colleges of Education for increased students' sensitization and integration of AI in learning Chemistry.

Keywords: *chemistry student; awareness; accessibility; utilization; artificial intelligence.*

Instruction

Education is a complex and multidimensional process that aims to facilitate students' development in various aspects of life (Ragni et al., 2023). Currently, students have entered the era of education in the 21st century, reflecting a significant transformation in the learning paradigm. This era presents new challenges as well as broad opportunities in producing individuals who are ready to face a world that continues to develop. In the 21st-century learning era, teachers are faced with demands to always be creative and innovative in teaching (Almazroa & Alotaibi 2023). With advances in technology, globalization, and social change, education is no longer just about the acquisition of knowledge, but also about the development of critical skills, adaptability and creativity. Advances in artificial intelligence (AI) have brought new possibilities in the realm of information and communications technology (ICT) (Jakub & Akbar, 2024). The foundation of artificial intelligence (AI) is the idea that human intelligence can be described in a way that makes it simple for a machine to replicate and carry out simple to complex tasks. It is undeniable that the most recent developments in knowledge reasoning, machine learning and deep learning are ushering in the era of intelligence (Khanzode & Sarode, 2020). Artificial Intelligence (AI) has become the main catalyst in drastic transformation in various fields of science, one of which is chemistry. The application of AI in chemistry learning includes several important aspects. One of them is the prediction of molecular properties. By utilizing machine learning techniques, AI is able to accurately predict chemical properties based on molecular structure.

Chemistry is the scientific study of structure and properties of matter, reactions and the use of such reactions to form new substances. Chemistry is essential for meeting our basic needs of food, clothing, shelter, health, energy and clean air, water, and soil. Chemical technologies enrich our quality of life in numerous ways by providing

new solutions to problems in health, materials and energy usage. Chemistry is a challenging subject that necessitates a deep understanding of the relationships that exist between structure, properties and reactions of matter. AI tools have the potential to improve students' comprehension of these ideas.

Chemistry is taught using different artificial intelligence tools such as virtual labs, adaptive learning platforms, educational apps, intelligent tutoring systems, data analysis and visualization tools. Others include natural language processing (NLP) tools, virtual reality (VR) and augmented reality (AR) and concept mapping tools are just a few of these AI tools. Reiss (2021) asserts that the use of AI tools has altered the paradigm of education, as traditional approaches to teaching chemistry frequently depended on lectures, textbooks and physical models. Algorithms for machine learning, for instance, can examine data on students' achievement to pinpoint areas in which certain students might be having difficulty. Personalized learning plans that concentrate on the particular areas where every student needs to improve can then be created by educators using this information (Hansen et al., 2015). Additionally, student writing can be examined using natural language processing techniques, which can then be used to provide feedback on grammar, syntax and other language-related issues (Graesser et al., 2014). Moreover, interactive simulations or visualizations of chemical reactions are being made using AI-powered virtual reality (VR) and augmented reality (AR) technologies, providing a more intuitive and immersive understanding of the subject (Chang et al., 2018).

In a similar way, automated laboratory platforms help in conducting experiments with minimal human intervention, improving precision and reproducibility (Ananikov 2024).AI-powered platforms can offer interactive simulations, virtual labs and adaptive learning modules that let students investigate chemical concepts practically (Nathaniel et al., 2023). AI tools can fill in resource gaps, particularly for educational institutions with little access to specialized equipment or laboratory space. AI tools can help chemistry teachers by automating administrative tasks, providing real-time feedback on student progress and making suggestions for instructional improvement. They can also help students develop skills that are increasingly valuable in the modern workforce by allowing them to participate in virtual experiments and observe phenomena that may not be possible in a traditional classroom setting. For example, students can prepare for careers in pharmaceuticals, or chemical research by becoming familiar with machine learning algorithms tools. This frees up teachers to

concentrate more on leading conversations, assisting students with their questions and offering personalized support.

Numerous fields, including chemistry, biology, computer science and data science are impacted by artificial intelligence. Students can explore interdisciplinary connections and gain a comprehensive understanding of how various fields intersect to solve complex problems by incorporating AI tools into chemistry education. The use of AI tools in chemistry classes signals a change in the direction of more dynamic, interactive and individualized teaching methods. This change has the potential to improve students' comprehension, engagement and preparedness for challenges in the chemistry in the future.

Artificial intelligence (AI) in education gives teachers access to important data that they might not otherwise have; examples of this data include tracking each student's progress and comprehension of different subjects. On the other hand, Shiyun (2024) believes that the introduction of artificial intelligence into education could displace teachers in the classroom, stifle students' innate knowledge and impair their ability to think critically. The majorities of researchers were concerned that integrating AI into the classroom would decrease students' interaction and consequently lead to communication barriers. Additionally, they think that it will make students less emotionally intelligent and more likely to be lazy (Chang & Lu, 2019).

Furthermore, the potential for transforming the pedagogical landscape exists with the incorporation of Artificial Intelligence (AI) into education. Roll and Wylie (2016) delineated two possible paths—evolutionary and revolutionary—that academic institutions could pursue in order to leverage artificial intelligence within the next seventeen years. The capabilities of AI, such as its aptitude for evaluating vast amounts of data, customizing learning experiences, and improving assessment procedures, indicate a profound revolution in the field of education. According to Bharati, (2017), artificial intelligence (AI) orchestrates innovation in the field of educational planning, ushering in an era of intelligent learning. Literature has revealed that there was little agreement among researchers about how much awareness and use of AI tools for teaching and learning. Lackner (2019) found that many biology instructors feel ill-equipped to teach with AI tools, due to lack of training and resources. Similarly, Mahajan and Waghmare (2020) reported that while there is growing interest in AI tools among biology students, many students feel unsure about how to use these tools effectively. Study carried out by (Alimi et al., 2021), showed that there is no significant difference in university students'

awareness and use of artificial intelligence for learning between male and female students.

Research on the degree of AI awareness among engineering faculty students (Dergunova et al., 2022) found that students had a good degree of AI awareness. Owolabi et al., 2022) conducted a study on Nigeria Polytechnic students' awareness of and readiness for implementing AI in libraries. Results showed that although the students acknowledged that they needed to have a basic understanding of computers to be more relevant in this day and age, they were aware that artificial intelligence (AI) was used in library operations and had learned about it during library orientation programs. According to a study by Kuo et al. (2019), although students' opinions of AI-supported learning were generally positive, there were also worries about the tools' accuracy and dependability as well as the possibility that they could eventually replace human teachers.

As far as the researchers are aware and as per the literature that is currently accessible, there is no much information on how gender variations in Colleges of Education settings, particularly in South-West, Nigeria, affect students' awareness, accessibility and use of AI. Gender according to Omotayo (2014) is a social connotation that has sound psychological background and it is used to specify attributes of both males and females. The arbitrary assigning roles and expectations to different sex (male and female) within society has given rise to such misconceptions that made some people perceive science as a masculine and male domain only. The problem is even compounded by the fact that most science educators give a masculine outlook to science subjects such as physics and chemistry, encouraging females to enrol in biology, agricultural science and home economics which they consider to be more female-friendly science (Nnorom, 2015). According to Adeneye and Adelege (2011) males and females are fond of having different academic interests, choice of subjects and co-curricular activities and also perform differently in their school tests and examination. Researchers also reveal that, despite all of AI's advantages, teachers are hesitating to employ it in the classroom (Ismail, 2022; Yungei& Han, 2022). This results in students' unaware, accessibility and utilization of some of the AI learning tools in learning. Therefore, the purpose of this study is to determine Chemistry students' awareness, accessibility and utilization of artificial intelligence (AI) in Colleges of Education in South-West Nigeria.

Statement of the problem

Since the emergence of Artificial Intelligence (AI), some learned individuals have identified with it for problem-solving. The integration of AI tools in education has the potential to revolutionize learning experiences, particularly in subjects like Chemistry. However, there is a gap in understanding the level of awareness, accessibility and extent of utilization of AI tools for learning Chemistry among Colleges of Education students in South-West Nigeria. Therefore, this study seeks to establish the level of Chemistry students' awareness, accessibility and utilization of artificial intelligence (AI) in Colleges of Education in South-West Nigeria.

Also, could there be any disparities in the awareness, accessibility and utilization of AI tools for learning Chemistry caused by gender?

Purpose of the Study

The purpose of this study is to examined Chemistry students' awareness, accessibility and utilization of artificial intelligence (AI) in Colleges of Education in South-West Nigeria. Specifically, the study sought to:

1. determine the level of Chemistry students' awareness of AI tools used in learning.
2. examine the level of Chemistry students' accessibility of AI tools used in learning.
3. ascertain the extent of Chemistry students' utilization of AI tools used in learning.

Research Questions

1. What is the level of Chemistry students' awareness of AI tools used in learning?
2. What is the level of Chemistry students' accessibility of AI tools used in learning?
3. What is the extent of Chemistry students' utilization of AI tools in used learning?

Hypotheses

1. There is no significant difference in the level of male and female Chemistry students' awareness of AI tools used in learning?
2. There is no significant difference in the level of male and female Chemistry students' accessibility of AI tools used in learning?
3. There is no significant difference in the extent of male and female Chemistry students' utilization of AI tools used in learning?

Methodology

The study employed descriptive survey research design. The population consisted of 834 Chemistry students from five Federal College of Education in the 2023/2024 academic session. A purposive sample of 340 Chemistry students consisting of (94 males and 246 females) were used for the study. Students' awareness, Accessibility and Utilization of artificial intelligence for learning Chemistry (SAAUAILC) adapted from Enebechi et al. (2024) and Zudonu et al. (2024) was the instrument used for data collection. The instrument consists of two sections. Section A consists of the identification number and gender of the students. Section B comprised three clusters students' awareness, Accessibility and Utilization of artificial intelligence for learning Chemistry (SAAUAILC). The three clusters consisted of ten (10) item statements, giving a total of 30 items structured using four-point modified Likert scale of Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (SD). The responses were scored as SA = 4, A = 3, D = 2 and SD = 1. The instrument was face validated by three experts in the field of Chemistry Education, Computer Science and Measurement and Evaluation. The internal consistency reliability index of SAAUAILC was established as 0.80 using Cronbach Alpha. The students' awareness, accessibility and utilization of artificial intelligence for learning Chemistry was administered to the students by the researchers. Mean and standard deviation were used to answer research questions while t-test was used to test the hypotheses at 0.05 level of significance. Decision making was based on mean score of 2.50 and above as high and mean score below 2.50 as low for research questions and hypothesis was accepted if the calculated p-value is less than 0.05 and not accepted if the value is greater than 0.05.

Results

Research Question One: What is the level of Chemistry students' awareness of AI tools used in learning?

Table 1: Mean and Standard Deviation of the level of Chemistry Students' Awareness of AI Tools used in Learning.

S/N	AI tools used in learning Chemistry	N	$\bar{x}$	SD
	Virtual laboratory	340	2.30	1.12
	Adaptive learning platform	340	2.21	0.94
	Education Apps	340	2.46	0.86
	Intelligent tutoring systems	340	2.28	0.93
	Data analysis and visualization tools	340	2.52	1.30
	Natural language processing (NLP) tools	340	2.34	1.11

Virtual reality (VR)	340	2.50	0.82
Augmented reality (AR)	340	2.27	1.12
Concept mapping tools	340	2.16	1.12
Machine learning Algorithm	340	2.46	0.78
Overall Mean and Standard Deviation		340	2.35 1.01

Results in Table 1 reveals an overall mean of 2.35 and SD of 1.01. The mean of 2.35 is less than 2.50set as a benchmark, hence, the level of Chemistry students' awareness of AI tools used in learning is low.

Hypothesis One: There is no significant difference in the level of male and female Chemistry students' awareness of AI tools used in learning?

Table 2: T-test Mean Difference of the Level of Chemistry Students' Awareness of AI Tools used in Learning.

Gender	N	$\bar{x}$	SD	Df	t-cal.	t-crit.	P-val.	Alpha val.	Decision
Male	94	2.40	1.03						
				338	1.42	1.96	0.08	0.05	Not Significant
Female	246	2.30	0.98						

Table 2 revealed that male students have mean and standard deviation scores of 2.40 and 1.03 while the female students have mean and standard deviation scores of 2.30 and 0.98. With a degree of freedom of 338, the calculated t-value of 1.42 is not significant because the probability value of 0.08 is greater than the Alpha value of 0.05. Therefore, the null hypothesis is accepted. This implies that there is no significant difference in the level of male and female Chemistry students' awareness of AI tools used in learning.

Research Question Two: What is the level of Chemistry students' accessibility of AI tools used in learning?

Table 3: Mean and Standard Deviation of the Level of Chemistry Students' Accessibility of AI Tools used in Learning.

S/N	Statement	N	$\bar{x}$	SD
1	There is available and reliable internet access, devices and electricity in my school and community to access AI tools.	340	1.98	0.84
2	I can afford AI technologies and related resources for			

	the learning of chemistry lessons.		
340	1.75	0.94	
3	I have adequate knowledge and implications in utilization of AI technologies in learning Chemistry.		
340	2.20	1.02	
4	I understand the languages utilized in AI technologies and Relatedresources		
340	2.12	1.01	
5	Seminars and workshops have been held in my school for effective integration of AI into classroom teaching and learning.	340	1.96 0.83
6	AI is suitable and relevant to provide educational content for different learners in chemistry.		
	340	2.31	1.08
7	The policies and regulations of the government support and promote utilization of AI in classroom teaching and learning of chemistry.	340	1.861.03
8	AI could adapt to the learning style of chemistry students.	340	1.96 1.10
9	Parents and community members support AI use in teaching and learning of chemistry.	340	1.831.02
10	There is effective investment in research to improve accessibility And utilization of AI resources in teaching and learning of Chemistry.	340	2.13 0.93
	Overall Mean and Standard Deviation	340	2.01 0.98

The results in Table 3 shows an overall mean of 2.01 and SD of 0.98. The mean of 2.01 is less than 2.50set as a benchmark, hence, the level of Chemistry students' accessibility of AI tools used in learning is low.
Hypothesis Two: There is no significant difference in the level of male and female Chemistry students' acceptability of AI tools used in learning?

Table 4: T-test Mean Difference of the Level of Chemistry Students' Acceptability of AI Tools used in Learning.

Gender	N	$\bar{x}$	SD	Df	t-cal.	t-crit.	P-val.	Alpha val.	Decision
Male	94	1.98	1.00						
				338	1.76	1.96	0.07	0.05	Not Significant
Female	246	2.04	0.96						

Table 4 revealed that male students have mean and standard deviation scores of 1.98 and 1.00 while the female students have mean and standard deviation scores of 2.04 and 0.96. With a degree of freedom of 338, the calculated t-value of 1.76 is not significant because the probability value of 0.07 is greater than the Alpha value of 0.05. Therefore, the null hypothesis is accepted. This implies that there is no significant difference in the level of male and female Chemistry students' acceptability of AI tools used in learning.

Research Question Three: What is the extent of Chemistry students' utilization of AI tools in learning?

Table 5: Mean and Standard Deviation of the Extent of Chemistry Students' Utilization of AI Tools used in Learning.

S/N	Statement	N	$\bar{x}$	SD
1	I believe AI will destroy students' natural thinking ability.	340	2.41	1.02
2	I feel AI will replace human teachers in the chemistry classroom, leading to loss of jobs.	340	2.30	1.10
3	I believe AI will be more useful in educational research than in teaching and learning of chemistry.	340	2.12	1.05
4	AI-technologies are new and changing constantly, thus, should not be used in teaching and learning of chemistry.	340	2.33	1.08
5	I believe I can get reliable feedback to improve my learning Style without the help of AI-tools.	340	2.14	1.06
6	I am open to integrate AI-powered tools to enrich learning of chemistry.	340	1.98	0.96
7	I am convinced that learning of chemistry will become easier with the integration of AI into chemistry classes.			

340	2.10	1.02	
8	I believe AI will be useful in learning of difficulty chemistry topics and concepts.		
340	1.84	0.98	
9	I feel that the knowledge and utilization of AI-resources will make me more competent in and out of the classroom as a chemistry student.		
340	2.14	0.97	
10.	Utilization of AI-tools in learning of chemistry is time consuming and stressful, thus, should be not be used chemistry classes.		
340	2.14	0.96	
	Overall Mean and Standard Deviation		
340	2.15	1.02	

The results in Table 5 indicates an overall mean of 2.15 and SD of 1.02. The mean of 2.15 is less than 2.50 set as a benchmark, hence, the level of Chemistry students' utilization of AI tools used in learning is low.

Hypothesis Three: There is no significant difference in the extent of male and female Chemistry students' utilization of AI tools used in learning?

Table 6: t-test mean difference of the extent of Chemistry students' utilization of AI tools used in learning.

Gender	N	$\bar{x}$	SD	Df	t-cal.	t-crit.	P-val.	Alpha val.	Decision
Male	94	2.10	1.04						
				338	1.65	1.96	0.06	0.05	Not Significant
Female	246	2.20	0.98						

Table 6 revealed that male students have mean and standard deviation scores of 2.10 and 1.04 while the female students have mean and standard deviation scores of 2.20 and 0.98. With a degree of freedom of 338, the calculated t-value of 1.65 is not significant because the probability value of 0.06 is greater than the Alpha value of 0.05. Therefore, the null hypothesis is accepted. This implies that there is no significant difference in the extent of male and female Chemistry students' utilization of AI tools used in learning.

Discussion

The analysis of research question one and hypothesis one indicated that there was a low level of Chemistry students' awareness of AI tools used in learning and no significant different between male and female chemistry students' awareness of Artificial Intelligence tools used in learning in Colleges of Education in South-West Nigeria. This indicates that majority of students are unaware that artificial intelligence can be used for learning and not based on gender. This finding is in agreement with Studies carried out by (Alimi et al., 2021), who revealed that there is low level and no significant difference between male and female university students' awareness of the use of artificial intelligence for learning. It is also, in accordance with Enebechi et al. (2024) who reported that there was low and no significant difference on male and female secondary school students' awareness of AI tools used in learning biology in Enugu State. However, the finding was not in accordance with the finding of Owolabi et al.,(2022) who found that Nigeria Polytechnic students' were aware during library orientation programs that artificial intelligence (AI) was used in library operations.

The analysis of research question two and hypothesis two revealed that there was a low level of Chemistry students' accessibility of AI tools used in learning and no significant different between male and female chemistry students' accessibility of Artificial Intelligence tools used in learning. The finding is in line with Alimi et al., (2021) who revealed that there is low level and no significant difference between male and female university students' accessibility of the use of artificial intelligence for learning. The finding is in accordance with Zudonu et al., (2024) who reported that there was low and no significant difference on the perception of the accessibility of AI technology and resources among chemistry teachers in Rivers State.

The analysis of research question three and hypothesis three showed that there was a low extent of Chemistry students' utilization of AI tools used in learning and no significant different between male and female chemistry students' accessibility of Artificial Intelligence tools used in learning. This finding is in agreement with Studies carried out by (Alimi et al., 2021), who revealed that there is low level and no significant difference between male and female university students' use of artificial intelligence for learning. In addition, the finding is in line with Zudonu et al. (2024) who reported that there was low and no significant difference on the perception of the applicability of AI technology and resources among chemistry teachers in Rivers State.

Conclusion

The 21st century educational activities require Artificial intelligence tools. With technology introducing innovations in every aspects of life, it is very important to be aware, access and utilize all the benefits that can come with it so as to look into the downside as well. The general findings of this study show that there is low level of awareness, accessibility and utilization of Artificial Intelligence tools for learning among Chemistry students in Colleges of Education in South-West Nigeria. Furthermore, male and female Chemistry students' awareness, accessibility and utilization of Artificial Intelligence tools used in learning indicated no significant difference.

Recommendations

Considering the findings of this study, the following recommendations were put forward.

The government and stakeholders should organize workshops, conferences and seminars in Colleges of Education for increased students' sensitization and integration of AI in learning Chemistry.

Curriculum planners should revise the science curriculum to incorporate AI into it, to enhance the achievement of its objectives.

School administrators should be made aware of the benefits of integration of AI into Colleges of Education to assists and encourage the learners into using AI-tools.

Government should provide adequate internet facilities and reliable electricity to encourage the utilization of AI tools in Colleges of Education in Nigeria.

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