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PERCEIVED ROLE OF ARTIFICIAL INTELLIGENCE IN TEACHING AND LEARNING CHEMISTRY IN SECONDARY SCHOOLS IN IMO STATE, NIGERIA

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Abstract

The study examines the role of artificial intelligence in teaching and learning chemistry in secondary schools in Imo State. The study is based on two objectives and two research questions. The study employed a descriptive survey design, with a simple random sample as the population. The instrument for data collection was designed on a four-point rating scale. The instrument was face and content validated by experts in the chemistry department. The instrument was titled "Perceived Role of Artificial Intelligence in teaching and learning chemistry in secondary schools" PRAITLCSS 20 students were used to test the reliability of the instrument outside the study area. Reliability of the instrument was established using the Cronbach Alpha coefficient 0.82, showing that the instrument is reliable 284 copies of the instrument were administered and retrieved on the spot to ensure a higher rate of return. Mean and standard deviation were used to answer the research question. It was revealed that chemistry teachers and students agreed on the importance of artificial intelligence in teaching and learning chemistry in secondary school in Imo state, Nigeria. It was recommended towards that there is a need for an educational board to implement policies towards employing and the immediate use of artificial intelligence in teaching and learning chemistry in secondary schools in Imo state, Nigeria.
KEYWORDS: Artificial Intelligence, Teaching, Learning, Chemistry.

Introduction

The modern educational system is one that which creates competencies that allow people to participate in the economic sphere of life. The history of educational systems is closely linked with the development of the industrial society, and wage labour is still a central organizing principle in industrial societies and their everyday life (Trisoni, Ardiani, Herawati, Mudinillah, Maimori, Khairat, David, &Nazliati, 2023). In high-level policy discussions, education is therefore often understood as a source of employment. Education, in this interpretation, is a key driver of economic productivity and competitiveness, and educational policies are framed in the context of economic growth using an analytical approach. It is therefore important to ask, also in the context of the application of artificial intelligence (AI) to education, how AI will transform teaching and learning. For secondary schools, a central question has been whether an analytical approach can be effective with the use of artificial intelligence.

Artificial Intelligence integrates two components as the cardinal point: (1) thinking that is like humans, and (2) rational actions (Russell &Norvig, 2009). Primarily, the name given to machines or computers that mimic man's cognitive functions, like teaching and learning, as well as the ability to solve problems as perfectly as humans, are called AI tools in education.

Technologies, in one form or another, have always been part of the teaching and learning environment. It is part of the teacher's professional toolbox. In other words, it is among the resources that teachers use to help facilitate student learning. Technology has changed dramatically over recent decades (Mircea, 2023). The increasing variety and accessibility of technology has expanded the toolbox and the opportunities teachers have to use technology for effective teaching (Brown, &Mbati, 2015). Technology such as Artificial Intelligence has become increasingly present in our lives, having a significant impact in various fields, including education. Education has undergone a series of changes, and under the impact of artificial intelligence, which brings with it the opportunity to transform, to adapt the way the teaching/learning process is carried out. Artificial intelligence refers to the development of systems and machines that can simulate intelligent human behavior, such as learning, reasoning, and problem-solving (Mircea, 2023). Lainjo, and Tmouche, (2023) sees AI can be described as a digital platform analogous to the human mind with the capability of achieving formidable outcomes using complex and sophisticated algorithms to solve complicated problems. Artificial Intelligence involves the use of algorithms and complex mathematical models to enable machines to learn and improve their analytical approach and to exhibit specific to human intelligence. In line with Zhang, and Chen, (2022); and Chen, (2022) Artificial Intelligence or commonly abbreviated as AI is an application and instructions that are connected to computer programming to be able to do something that in the human view is intelligent or can be understood as a lesson on how to make computers able to do things that are currently done better than humans.

When AI is utilized during teaching and learning, especially in the form of cobots, enhanced learning experiences of students are fostered (Chassignol et al., 2018). Cobots have been applied to teach children tasks like spelling and pronunciation and they adjust to the student's abilities (Timms, 2016).

Learning by utilizing the function of AI is personalized learning (learning that adapts to student needs) so that it can improve student learning experiences and make students better understand a subject matter (Jiang, Li, Wang, & Wang, 2021; & Dong, Huang, & Lin, 2021). The application of AI in teaching economics is focused on the analytical, statistical, and methodological approach of the subject area.

From the foregoing, the relevance of AI in teaching and learning via the Internet and the development that has given access to both teachers and students to acquire the information they need cannot be overemphasized. Therefore, the need to enforce the utilization of AI and apply it in the plan of the curricula, teaching methods, and evaluation to have an efficient scholarship cannot be overemphasized (Eltabakh, 2019). Inasmuch as an immense prospect is proffered by AI in education, its comprehensive utilization in the field of science education cannot ensure that teachers will apply it during teaching and learning. It also does not surety the standard of teaching since instructors have yet to imbibe the implementation steps of AI-based instruction (Ayanwale et al., 2022).

Chemistry is central to every facet of life. It is the study of properties and composition of matter; its chemical reactions, structure, and associated changes. It is primarily concerned with atoms and their interactions with other atoms, and particularly with the properties of chemical bonds. Chemistry is a science springing from the principles of physics with its applications in other sciences such as life sciences, engineering, technology, earth sciences, and medicine (Suchocki, 2014; Davies, 2008; Abanikannda, 2016; RSC, 2021). Chemistry graduates are engaged across the globe in rewarding careers in pharmaceutical, metallurgical firms, commercial laboratories, scientific research institutes, forensic scientists in the criminal justice system, universities, health services, food processing, petroleum and Petro-chemical industry, biotechnology, toxicology, hazardous waste management, manufacturing industry, mining and extractive industry, medical technology, agriculture and forestry (Ababio, 2013; Helmenstine, 2019). The interdisciplinary nature of chemistry also lends its graduates to collaborating with engineers, physicists and biologists in proffering solutions to a wide spectrum of societal problems. Chemistry is globally adjudged a prerequisite subject for the study of engineering, medicine, and other basic and applied science courses in any tertiary institution. Oloruntegbe and Oduntuyi (2008) averred that a student who is deficient in chemistry and has good grades in other science subjects will hardly be able to offer any course in the faculties of science, medicine, and engineering in the universities.

Teaching and learning of Chemistry revolve around the intricate interplay of passionate lecturers, willing and serious students, deployment of appropriate pedagogy, requisite facilities, as well as a most enabling ambience for the actualization of a predetermined learning outcome (Adesoji&Olatunbosun, 2008; Emendu&Okoye, 2015). This ideal scenario is however, is distorted by the prevalence of examination practices where students who had not engaged in meaningful learning, coupled with the lackadaisical attitude of some teachers thriving in a dysfunctional environment, resort to diverse cheating techniques to obtain credit passes in Chemistry in the School Certificate Examinations (Angyaye, 2007). The illusion of obtaining a credit pass in Chemistry rather than gaining mastery of the subject becomes the rat race. Many secondary schools in an attempt to please parents, promote this malaise, with the resultant effect of students gaining admission into the universities with a defective background and a false sense of achievement. Corollary to the foregoing is the syndrome of alternative to practical chemistry

introduced by schools with inadequate and ill-equipped laboratories for demonstration and experiments, resorting to what is termed alternative to practical. The practice, which is also tacitly endorsed by Examination Boards, has the propensity to weaken the capabilities of the students for good experimental work. It reduces laboratory activities to an extension of the theoretical class rather than a place to carry out hands-on investigation. Chemistry practical is envisaged to enhance students' understanding of scientific concepts; imbue in them scientific practical skills and problem-solving abilities (Adane&Admas, 2011; Koller, Olufsen, Stojjanovska, &Petrusevski, 2015). The practice of alternatives to practical classes cannot sufficiently replace actual practical Chemistry classes. It stands to reason that students with such a background will lack the requisite independence and confidence for undertaking Chemistry at the university level. Studies have equally shown that other issues militating against the effectiveness of teaching and learning of chemistry in Nigeria include: poor funding, lack of qualified teachers, problem of infrastructure, pedagogical problem, and phobia for chemistry, absence of and/or insufficient field trips, poor libraries and inadequate textbooks (Jegede, 2007; Edomwonyi-out &Avaa, 2011; West African Examinations Council, 2014; Emendu&Okoye, 2015; Abanikannda, 2016). Literature is replete with some strategies that have been adopted by other climes to facilitate improvement in the teaching and learning of chemistry. Yildizay and Leman (2017) reported the effectiveness of Problem-based Learning in the teaching of chemistry in Turkey. Yusuf (2017), Sadykov and Ctrnactova (2019) explored the impact of digital technologies on the teaching and learning of chemistry, as well as providing ample evidence of the embedded capability of bridging identified gaps in knowledge. Digital technologies are now regarded as a critical catalyst for improving, supporting, and extending teaching and creative learning in higher education across the globe (Bell, Dempsey, &Fister, 2015; Brown &Malenfant, 2015; Horizon Report, 2015; Mabweazara, 2018). Kristen, Malinda, Monica, and Kendra (2017) equally underscored the relevance of targeted tutorial aimed at providing special support to assist students in overcoming particular chemistry deficiencies and thus boost their confidence level for effective engagement. Finding a real solution to the declining enrolment in Chemistry requires interrogating the teaching and learning of the subject with a view to understanding issues implicated thereof, or matters arising, and then proffering strategies for effective intervention while taking cognizance of local peculiarities. Zouhaier, (2022) study revealed that AI will significantly impact higher education in many areas, such as learning and teaching methods, assessing and grading, analytical skills required for future work, and future graduate careers.

The analytical chemistry approach has been a serious concern in the course of study due to its high utilization of analytical and statistical methodological approaches, which has affected students’ choice of studying the course. Going by the opinion of the United Nations (2018), the twenty-first century has posed many challenges to the new world order. The application of artificial intelligence in teaching students’ analytics approach in chemistry are two crucial areas, among many others, worth studying. Therefore, researchers here try to review the importance of

the application of Artificial Intelligence in teaching students' analytics approach in chemistry. Can using AI at the secondary level improve student analytics concepts?

Objective of sturdy

The main purpose of the study was to examine the role of Artificial Intelligence in teaching and learning chemistry in secondary schools. Specifically, the study sought to:

1. Determine the importance of artificial intelligence in teaching and learning chemistry in secondary school.

2. Determine the challenges of using artificial intelligence in teaching and learning chemistry in secondary school.

Research Questions

The following research questions were formulated by the researcher in line with the purpose to guide the study

1. What is the importance of artificial intelligence in teaching and learning chemistry in secondary schools?

2. What are the challenges of using of artificial intelligence in teaching and learning chemistry in secondary schools?

Methodology

The study adopted a descriptive survey design. The study was carried out in secondary schools in Imo State. The population of the study was made up of 284 chemistry students and chemistry teachers in Owerri, Imo State. A simple random sampling technique was used to sample 248 students and 36 lecturers for the study. The instrument for data collection was a structured questionnaire that was face and content validated by experts in the chemistry department, Alvan Ikoku Federal University of Education, Owerri, Imo State. The instrument was titled "Role of Artificial Intelligence in teaching and learning chemistry in secondary Schools" RAITLCSS. The instrument was designed in a four-point rating scale of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD) weighted 4, 3, 2, and 1 point(s) respectively. 20 students were used to test the reliability of the instrument and were tested using Cronbach's Alpha Coefficient, which yielded a reliability index of 0.82. Mean and Standard Deviation were used to answer the research questions formulated with a criterion mean value of 2.50 and above as the acceptable minimum value.

Results

The results for this study were presented according to each research question posed in the study as thus:

Research Question 1: What is the importance of artificial intelligence in teaching and learning chemistry in secondary schools?

Table 1: Importance of artificial intelligence in teaching and learning chemistry

S/N	Importance of artificial	Students (248)			Teachers (36)		
		M	S.D	Remarks	M	S.D	Remarks
1	Using AI can increase student productivity in chemistry.	2.86	1.05	Agree	2.52	1.02	Agree
2	AI makes it easier for students to understand and analyze chemistry.	2.97	1.01	Agree	3.34	1.14	Agree
3	It helps student interest towards statistical method in chemistry.	2.75	1.13	Agree	2.82	1.10	Agree
4	AI helps students interest in mathematical concepts.	2.98	1.19	Agree	2.78	1.15	Agree
5	AI helps students obtain answers to high analytical methods assignments given by teachers.	2.84	1.44	Agree	2.97	1.03	Agree
6	AI makes it easier for students to find analytical study contents with easy learning approach.	2.90	1.38	Agree	3.16	1.34	Agree
7	AI can look for best way to teach advance mathematics of chemistry.	2.86	1.10	Agree	2.77	1.08	Agree
8	AI helps students improve more on their individual analytical skills	2.82	1.21	Agree	2.81	1.12	Agree
	Grand Mean/S.D	2.87	1.18		2.89	1.21	

Source filed: 2024

Table 1 shows the mean score of teachers and students on the importance of artificial intelligence in teaching of chemistry in Imo State. The table 1 also indicated that the mean score of students and teachers was on the accepted value of above 2.50, meaning that both students and teachers agreed on each of the items. This is an indication that both students and teachers considered

artificial intelligence important in teaching and learning chemistry in secondary schools in Imo State.

Research Question 2: What are the challenges of using of artificial intelligence in teaching and learning chemistry in secondary schools?

Table 2: Challenges of artificial intelligence in teaching and learning chemistry

S/n	Items	Students (248)			Teachers (36)		
		M	S.D	Remarks	M	S.D	Remarks
9	The existence of AI can reduce students' interest in reading their textbooks	2.67	1.16	Agreed	3.08	0.96	Agreed
10	Students inability to effectively utilize AI tools	2.60	1.07	Agreed	2.94	1.03	Agreed
11	AI replaces the role of teachers as student educators	2.63	0.95	Agreed	2.90	0.91	Agreed
12	The application of AI makes the teachers lazy	2.68	1.04	Agreed	2.80	1.08	Agreed
13	Teachers inability to use AI software’s	3.04	0.97	Agreed	2.97	0.89	Agreed
14	It makes the students lazy	2.90	0.93	Agreed	3.16	0.92	Agreed
15	Lack of skills to handle the application of AI	2.86	1.11	Agreed	2.77	0.98	Agreed
16	It is very essential and costly to obtain by the students	2.72	0.95	Agreed	3.27	0.74	Agreed
17	It can damage without appropriate training on to use the software	2.88	1.02	Agreed	3.04	0.97	Agreed
18	AI can crash without maintenance	2.87	1.04	Agreed	2.62	1.10	Agreed
	Grand Mean/S.D	2.77	0.98	Agreed	2.81	0.94	Agreed

Source filed: 2024

Table 2 shows the mean score of teachers and students on the challenges of artificial intelligence in teaching of chemistry in Imo State. Also, table 2 indicated that the mean score of students and teachers was on the accepted value of above 2.50, meaning that both students and teachers agreed on each of the items. This is an indication that both students and teachers considered artificial intelligence challenging in teaching and learning chemistry in secondary schools in Imo State.

Discussion of Findings

Importance of artificial intelligence in teaching and learning chemistry

The findings of this study showed that using AI can increase student productivity in chemistry. AI makes it easier for students to understand and analyze chemistry, it helps students interest towards statistical methods in chemistry, AI helps students' interest in mathematical concepts, AI helps students obtain answers to high analytical methods assignments given by teachers, and among others. The study also revealed that the mean scores of students and teachers on the importance of artificial intelligence in teaching and learning chemistry in secondary schools in Imo State are in agreement respectively. This is in line with Chassignol et al., (2018). When AI is utilized during teaching and learning, especially in the form of robots, enhanced learning experiences of students are fostered. Similarly, Sadykov and Ctrnactova (2019) explored the impact of digital technologies on the teaching and learning of chemistry, as well as providing ample evidence of the embedded capability of bridging identified gaps in knowledge.

Challenges of artificial intelligence in teaching and learning chemistry

Finally, the findings of on the challenges of application of AI revealed that it makes the students lazy, a Lack of skills to handle the application of AI, it is very essential and costly to obtain by the students, it can damage without appropriate training on to use the software, AI can crash without maintenance, amongst others, which agreed on their responses. It also indicates that both students and teachers considered artificial intelligence challenging in teaching and learning chemistry in secondary schools in Imo State. In line with Ayanwale et al. (2022) in as much although an immense prospect is proffered by AI in education, its comprehensive utilization in the field of science education cannot be assured that teachers will apply it during teaching and learning. It also does not surety the standard of teaching since instructors have yet to imbibe the implementation steps of AI-based instruction. These pose as a serious challenge in the application of AI in teaching and learning, especially in teaching chemistry, which has a background in the application of analytical concepts and mathematical methods.

Conclusion

Artificial Intelligence in teaching and learning chemistry has created a high level of technological impact on both students and teachers in changing their traditional methods of teaching and learning, and improving in the use of AI applications at their fingertips.

AI tools/devices can also help students to identify and address their weaknesses and improve their overall academic performance. However, there are also some potential drawbacks to using AI tools/devices in the chemistry subject. These include: making the students lazy, no full attention to read the textbook or study hard, as AI seems to do everything for them, and problem-

solving skills. Additionally, some critics argue that the use of AI tools/devices may lead to a decrease in the quality of education as teachers may rely too heavily on automated machine systems instead of engaging with their students to be abreast.

Recommendations

Based on the findings, the following recommendations were made:

1. That considering the importance of AI in our school system today, AI should be included in the secondary school curriculum to better Teaching and Learning through ministry of Education. Also, that there is a need for educational board to implement policies towards employing and immediate use of artificial intelligence in teaching and learning chemistry in secondary school in Imo state, Nigeria.
2. That Government should organize workshop for teachers to feature well in the use of AI application in teaching and learning chemistry in secondary schools.

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