

ENHANCING BIOLOGY TEACHING THROUGH ARTIFICIAL INTELLIGENCE: A CASE STUDY OF UNIVERSITY OF NIGERIA, NSUKKA

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Abstract

The purpose of this paper was to investigate the roles, challenges and possible solutions of enhancing biology teaching through Artificial Intelligence in the University of Nigeria, Nsukka. Three research questions guided the study. The study adopted a descriptive survey research design. The population of the study comprised 206 Biology lecturers, 15 lecturers from Science Education Department and 191 lecturers from Biological Sciences, for the 2024/2025 academic session. The sample size of the study consisted of 136 Biology lecturers. The instrument for data collection is a 30-item questionnaire titled Roles, Challenges and Solutions of Artificial Intelligence in Biology Teaching Questionnaire (RCS-AIBTQ). The instrument was validated by four experts from biological Sciences and Science Education, and the reliability of the three clusters of the instrument were determined using Cronbach Alpha which yielded reliability coefficients of 0.94, 0.94, 0.97 respectively with an overall Reliability of 0.95. The research questions were answered using mean and standard deviation. The findings of the study revealed that Artificial Intelligence plays important roles in enhancing Biology teaching, including improving visualization of concepts, supporting inquiry and problem-solving through virtual labs, providing personalized learning and feedback through intelligent tutoring systems among others. It was also found that lecturers encountered several challenges in using Artificial Intelligence and possible solutions to these challenges were proffered. Based on the findings, recommendations were made such as Integrating Artificial Intelligence into Biology teaching to enhance visualization of concepts, support personalized learning, and increase students' engagement.

KEYWORDS: Biology, Artificial Intelligence, Teaching, Challenges of AI

Introduction

Biology is a branch of natural science concerned with the study of living organisms and life processes. In the contemporary world, a country's ability to innovate, enhance public health, be environmentally sustainable and technologically competitive is largely determined by the quality of our knowledge of Biology. Within this mandate, Biology occupies a particularly strategic position because it has become increasingly evident that the biological sciences are deeply interconnected with critical areas such as global health, food security and agriculture, and environmental sustainability (Abdallah, 2026). It is fundamental in medical innovation and

advancements which contributes to sustainable solutions and environmental conservation. Biology provides essential knowledge that enables learners to appreciate life processes and apply scientific reasoning to real world problems. Knowledge of Biology not only enhances scientific literacy but also prepares future professionals capable of addressing global health and ecological challenges (Smith, 2023).

Despite the importance of Biology, studies have shown that students' achievement in biology has remained consistently poor in many contexts. Eze (2020) observed that secondary and university students often struggle to attain expected outcomes in biology due to factors such as rote memorization, abstract content, and insufficient use of innovative teaching strategies. In the same vein, Hnin Wai Oo, et al., (2020) identified obstacles such as difficult topics (such as, plant and animal cells, bacterial cell) and inadequate use of instructional materials as contributing factors to the poor academic achievement of students in biology. This has affected biology students; hence they lack deep conceptual understanding, which negatively affects their academic performance, practical skills, and long-term retention of knowledge. Hence, there is a need to look into how biology is being taught in our tertiary institutions.

Teaching of biology at the tertiary level frequently confronts persistent instructional difficulties such as the abstract nature of some concepts in Biology. Agboola (2025) argued that many schools lack adequate laboratory facilities, which forces a reliance on rote memorization instead of the essential experiential learning needed for scientific inquiry. This persistent underachievement has placed renewed pressure on Biological Sciences and Science Education Departments to adopt modern technologies like Artificial Intelligence that can make teaching and learning of biology more engaging, personalized, and effective. Against this background, Artificial Intelligence (AI) has emerged as one of the most influential educational innovations of the 21st century, offering tools capable of extending what lecturers can do in planning, teaching, supporting learners, and assessing progress.

Globally, Artificial Intelligence is redefining how knowledge is delivered, accessed and managed. In higher education, AI is not only transforming traditional pedagogical practices but also enhancing administrative efficiency, research capacity, and learner engagement (Holmes, et al., 2019). As institutions of learning embrace digital transformation, Artificial Intelligence is becoming a key enabler of personalized learning, intelligent tutoring, automated grading, academic advising, and predictive analytics (UNESCO, 2021). The rapid advancements of the 21st century have introduced new opportunities for improving biology teaching. One of such opportunity is Artificial Intelligence (AI), which refers to the simulation of human like intelligence in machines capable of learning, reasoning, and decision making. AI has its applications across medicine, business, engineering, and importantly in education. In biology teaching, AI has the potential to make teaching of biology more engaging, personalized, and effective by providing students with interactive simulations, personalized learning experiences, and other tools that help them understand complex biological concepts (Rahoui et al. 2024). It is evident in the modern way of learning that AI plays a significant role.

The role of Artificial Intelligence in teaching can be described as multi-dimensional. This paper emphasizes on the roles of AI in enhancing biology teaching. Within the context, understanding the roles of AI provides a useful lens for examining how Artificial Intelligence can function meaningfully to address persistent teaching and learning issues. When viewed as a functional contributor to instructional effectiveness, the role of AI becomes particularly significant in

relation to recurring concerns about students' achievement and conceptual understanding in biology. AI serves as a tool for personalizing learning, enhancing visualization of abstract biological concepts, such as cell division or genetic mapping, through simulations and virtual laboratories. According to Telaumbanua (2025), AI plays an important role in facilitating the visualization of complex biological concepts, providing adaptive learning experiences tailored to students' individual abilities, and offering virtual laboratories that allow biological experiments without the limitations of physical facilities. Shireesha, et al., (2024) explained that AI also provides intelligent tutoring systems adapted to individual students' learning pace and promote inclusivity by supporting learners with diverse backgrounds and abilities. The use of AI-powered tools such as chatbots, virtual lab simulations, adaptive learning platforms, and data analytics can help address challenges of overcrowded classrooms, shortage of academic staff, and poor service delivery in Nigerian universities. Artificial Intelligence has proven to support teachers by automating assessment, analyzing student data, and offering predictive insights into learning progress. Notwithstanding the documented potentials of Artificial Intelligence to enhance biology teaching, its effective integration into higher education instructional practices remains constrained by several systemic and pedagogical challenges.

Researchers have identified some challenges associated with the use of AI in our tertiary institution. Empirical evidence from Nigerian higher institutions indicates that financial limitations, including the steep costs associated with AI software, hardware, licensing fees, and staff training, significantly hinder AI implementation (Edeh, et al., 2025). According to Mkhwanazi, et al., (2025), AI integration is hindered by inadequate digital infrastructure, unreliable connectivity, and limited access to devices in under-resourced rural schools. Also, cost of AI resources and time constraints constitute barriers to the usage of AI in biology lessons. Within biological Sciences and science education departments, these challenges are often compounded by limited infrastructural support and insufficient policy frameworks guiding the use of emerging technologies in teaching. Such infrastructural deficiencies not only limit access to AI technologies but also deepen disparities in teaching and learning opportunities, thereby undermining the potential benefits of AI in biology instruction. Consequently, the potential of Artificial Intelligence to improve conceptual understanding, promote active learning, and support effective assessment in biology teaching may remain largely underutilized. A key conceptual gap for this paper is that while AI is widely discussed as a transformative educational innovation, there is limited context-specific evidence on what AI practically represents within Biology teaching in the Biological Sciences and Science Education Department, University of Nigeria, Nsukka, especially regarding the roles, related challenges and solutions of AI in enhancing Biology teaching within University of Nigeria, Nsukka. This situation suggests the need for systematic inquiry into the roles, challenges and possible solutions to how Artificial Intelligence can meaningfully enhance biology teaching within the Biological Sciences and Science Education Department of the University of Nigeria, Nsukka.

Research questions

The following research questions were posed to guide the study:

1. What are the roles of Artificial Intelligence in enhancing Biology teaching?
2. What are the challenges facing the use of Artificial Intelligence in enhancing Biology teaching?

3. What are the possible solutions to the challenges facing the use of Artificial Intelligence in enhancing Biology teaching?

Methods

The research design for this study was the descriptive survey research design. According to Nworgu (2015), a descriptive survey is a research approach in which a group of people or items was studied by collecting and analyzing data from a selected few considered to be representative of the entire population. By adopting the survey approach, this research aimed to gather data on roles, challenges and possible solutions of the use of Artificial Intelligence (AI) in enhancing Biology teaching in the Biological sciences and Science Education Department at the University of Nigeria Nsukka. The study was carried out in Biological sciences and Science Education Department in UNN. The reason for the choice of this area of study is because it is directly involved in the teaching and learning of biology, and provides a suitable environment for examining how Artificial Intelligence can enhance instructional practices within the field. The population of the study comprised a total of 206 Biology lecturers, specifically; 15 Science Education lecturers and 191 Biological Sciences lecturers, for the 2024/2025 academic session. The sample size of the study consisted of 136 Biology lecturers which were determined using Taro Yamane's formula at confidence level of 95% and 5% margin of error. The instrument for Data Collection was a questionnaire. The questionnaire was divided into three clusters. The first cluster was a Questionnaire on the Roles of Artificial Intelligence in enhancing Biology Teaching. The second cluster was a Questionnaire on the Challenges of Artificial Intelligence in Enhancing Biology Teaching while the third cluster was a Questionnaire on the Possible Solutions to the Challenges of Artificial Intelligence in enhancing Biology Teaching. This instrument had a rating scale of strongly agree (SA) which had 4 points, agree (A) which had 3 points, disagree (D) which had 2 points and Strongly Disagree (SD) which had 1 point. The instrument was subjected to face validity by four experts from biological Sciences and Science Education. The instrument was trial tested and subjected to a test of internal consistency using Cronbach's alpha reliability coefficient method. The reliability coefficients for the clusters were 0.94, 0.94, and 0.97 with an overall reliability index of 0.95 was obtained indicating that the instrument is reliable. The instruments for this study were administered to Biological sciences lecturers teaching biology courses and Biology Education lecturers of the University of Nigeria, Nsukka. Mean and standard deviation was used to analyse the data. A benchmark of 2.5 was used to interpret the results. Any mean 2.5 or above was seen as agree; while any mean below 2.5 was seen as disagree.

Results

The results of this study were presented in tables according to research questions that guided the study.

Research Question One

Table 1: Mean and Standard Deviation on the roles of artificial intelligence in the enhancing Biology teaching

S/N	ITEM STATEMENT: AI enhances	X	SD	Remark
1	Student's understanding of Biology concepts	2.87	1.41	Agree
2	Delivery of interactive Biology lessons using inquiry and problem-solving through virtual labs	3.13	1.19	Agree

3	Student's engagement in Biology classrooms	2.87	0.99	Agree
4	Provides Personalized/ Individualized learning in Biology	3.40	1.06	Agree
5	The accuracy and ease of assessment/feedback through intelligent tutoring systems in Biology	2.53	1.19	Agree
6	Effective visualization and simulation of Biology concepts/ experiments	3.00	1.31	Agree
7	Use of AI tools that led to noticeable improvement in students' performance in Biology	2.53	1.36	Agree
8	Teachers' productivity in delivering Biology content	2.80	1.08	Agree
9	Biology teaching manage time and resources efficiently	2.93	0.88	Agree
10	The goal of modern Biology teaching	3.13	1.19	Agree
Cluster Mean		2.91	1.17	Agree

KEY: X = Mean, SD = Standard Deviation.

The analysis of the result in Table 1 shows the mean and standard deviation on the roles of artificial intelligence in the enhancement of Biology teaching. The result shows that all the ten items show mean ratings 2.53 to 3.40 which are above 2.50 set as bench mark. Moreso, the table shows a grand mean of 2.91 which is above 2.50 set as bench mark, with standard deviation of 1.17. This implies that all the items are the roles of artificial intelligence in enhancing Biology teaching.

Research Question Two

Table 2: Mean and Standard Deviation on the challenges facing the use of artificial intelligence in enhancing Biology teaching

S/N	ITEM STATEMENT	X	SD	Remark
1	Limited access to AI technologies/ tools in Biology teaching	3.00	1.31	Agree
2	Inadequate technical and pedagogical training of lecturers	3.40	1.06	Agree
3	Technical issues hinder the smooth use of AI Biology teaching	3.07	0.70	Agree
4	Experience difficulties integrating AI tools with existing Biology curriculum	3.20	1.20	Agree
5	Students lack knowledge on the use and benefits of AI tools	3.07	0.80	Agree
6	Cost of AI resources are barrier to the usage	2.60	1.24	Agree
7	Time constraints prevent the regular use of AI in Biology lessons	3.53	0.83	Agree
8	Limited internet connectivity affects the use of AI in Biology classes	3.40	0.91	Agree
9	Insufficient administrative support for AI implementation	3.53	0.83	Agree
10	Lack of awareness about available AI tools for Biology teaching	3.20	1.08	Agree
Cluster Mean		3.2	1.00	Agree

KEY: X = Mean, SD = Standard Deviation.

The analysis of the result in Table 2 shows the mean and standard deviation on the challenges facing the use of artificial intelligence in enhancing Biology teaching. The result shows that all the ten items show mean ratings 2.60 to 3.53 which are above 2.50 set as bench mark. This is an indication that each of the items is a challenge facing the use of artificial intelligence in enhancing Biology teaching. Furthermore, the table also shows a grand mean of 3.2 which is

above 2.50 set as bench mark, with standard deviation of 1.00. This implies that all the items are challenges affecting the use of artificial intelligence in Biology teaching.

Research Question Three

Table 3: *Mean and Standard Deviation on the possible solutions to the challenges facing the use of artificial intelligence in enhancing Biology teaching*

S/N	ITEM STATEMENT	X	SD	Remark
1	Providing free or affordable access to AI tools will improve the usage	3.27	1.22	Agree
2	Organization AI training programme will help Biology teachers use AI effectively	2.60	1.40	Agree
3	Regular technical support should be made available to assist AI implementation	3.47	0.52	Agree
4	Curriculum developers should integrate AI into the Biology education frame work	3.67	0.82	Agree
5	Students should be properly oriented on the use and benefits of AI tools	3.47	0.64	Agree
6	Government should help subsidize the cost of AI resources	3.40	1.06	Agree
7	Flexible teaching schedules should be created to allow time for AI integration	2.73	1.33	Agree
8	Use of offline capable AI tools can help ensure Biology lessons continue effectively without constant internet access	2.60	1.40	Agree
9	Adequate policy frameworks guiding the use of emerging technologies such as AI should be enacted	3.07	1.33	Agree
10	Creating an AI resource guide or manual for teachers can improve awareness of available AI tools for Biology lessons	2.53	1.36	Agree
Cluster Mean		3.08	1.11	Agree

KEY: *X = Mean, SD = Standard Deviation.*

The analysis of the result in Table 3 shows the mean and standard deviation on the possible solutions to the challenges facing the use of artificial intelligence in enhancing Biology teaching. The result shows that all the ten items show mean ratings 2.53 to 3.67 which are above 2.50 set as bench mark. This is an indication that each of the items is a possible solution to the challenges facing the use of artificial intelligence in enhancing Biology teaching. However, the table also shows a grand mean of 3.08 which is above 2.50 set as bench mark, with standard deviation of 1.11. This implies that all these are the possible solutions to the challenges facing the use of artificial intelligence in enhancing Biology teaching.

Discussion of Findings

Roles of Artificial Intelligence in Enhancing Biology Teaching

The findings of the present study revealed that AI plays important roles in enhancing Biology teaching such as improving students' understanding, supporting interactive and personalized/individualized learning, strengthening students' engagement, aiding assessment, visualization/simulation, teacher productivity and efficient use of time and resources. This result is so because AI technologies make abstract biological processes easier to understand, create interactive learning experiences and help lecturers deliver content more efficiently.

This result is strengthened by the findings of Telaumbanua (2025), which shows that AI plays an important role in facilitating the visualization of complex biological concepts, providing adaptive learning experiences tailored to students' individual abilities, and offering virtual laboratories that allow biological experiments without the limitations of physical facilities. Also, Rahioui et al. (2024) found out that interactive simulations can help make biology more engaging and memorable for students. Similarly, Shireesha, et al., (2024) are of the opinion that AI creates an equitable learning environment where all students have access to high-quality, personalized educational experiences. However, no studies were found in disagreement with this finding. These findings show the vital roles Artificial Intelligence could play in enhancing the teaching of Biology in UNN.

Challenges facing the use of Artificial Intelligence in Enhancing Biology Teaching

The findings of the study also revealed that, there are challenges affecting the use of AI in enhancing Biology teaching. Such challenges include limited access to AI tools and internet connectivity, technical issues, high costs, lack of awareness, difficulty integrating AI into the curriculum, time constraints, and inadequate administrative support among others. These challenges limit the ability of lecturers to fully integrate AI tools into their teaching, reduce students' access to interactive learning experiences, and slow down the overall adoption of technology in the classroom. The findings of this study revealed that lecturers perceive several challenges that hinder the effective use of artificial intelligence in enhancing Biology teaching. This is in line with the studies of Edeh, et al., (2025) and Mkhwanazi, et al., (2025), stating that AI integration is hindered by high cost of AI software, hardware, licensing fees, staff training, inadequate digital infrastructure, unreliable connectivity, limited access to internet connectivity, among others are challenges facing the use of AI in enhancing Biology teaching. Hence, tackling these challenges would optimize the use artificial intelligence in enhancing Biology teaching.

Solutions to the Challenges facing the use of Artificial Intelligence in enhancing Biology Teaching

The findings of the present study revealed the lecturers' perceived possible solutions that can be addressed through practical and targeted interventions. These include training and workshops, affordable access to AI tools, regular technical support, curriculum integration, proper orientation for students and schools, flexible scheduling, offline-capable AI options and developing AI resource guides/manuals. This is in line with the findings of Telaumbanua (2025) which supports that major obstacles facing AI use in enhancing biology teaching include limited infrastructure, lack of teacher training and high implementation costs. However, no studies were found in disagreement with this finding. The outlined solutions will greatly enhance the use of artificial intelligence in enhancing teaching of Biology.

Conclusion

Based on the findings of this study, it was concluded that artificial intelligence plays significant roles in enhancing Biology teaching through improved visualization of concepts, personalized learning, increased student engagement, and more efficient delivery of instructional content. It was also concluded that the use of AI to enhance biology teaching is faced with so many challenges of which solutions were proffered to mitigate these challenges facing the use of artificial intelligence in enhancing Biology teaching.

Recommendations

In light of the findings of this study, the following recommendations were made:

1. Artificial Intelligence should be used by lecturers in teaching Biology so as to improve students' visualization of concepts, personalized learning, support inquiry and problem-solving through virtual labs and increase student engagement.
2. Provide continuous professional development and training programs on AI to improve lecturers' competence and confidence in its use.
3. Government should provide sufficient digital infrastructure/ AI resources and improve access for both lecturers and students to support effective use of AI in biology teaching.

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