



Perceptions and Challenges of Web-Based Instruction in Biology Education: Evidence from Nigeria Certificate in Education Students in a Nigerian College of Education

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ABSTRACT

This study investigates the perceptions and challenges associated with web-based instruction in Biology education among Nigeria Certificate in Education (NCE) students at the Federal University of Education, Zaria. Specifically, it focuses on NCE III students from the Biology Department, with a total population of 1,568 (867 females and 701 males). Using Krejcie and Morgan's (1970) sample size determination table, a sample of 306 students was selected. A researcher-developed questionnaire, validated through a pilot study yielding a reliability coefficient of 0.78, was used to gather data. Responses were rated on a four-point Likert scale ranging from Strongly Agree (4) to Strongly Disagree (1). Data were analyzed using SPSS version 27, with a mean score of 2.50 set as the benchmark for agreement. The study was guided by four objectives, four research questions, and four hypotheses. Key findings include statistically significant relationships between; Students' awareness of AI-integrated educational tools and their perceptions of these tools in biology instruction, Perceived benefits of AI tools and their application in biology teaching, Current usage of AI tools and the availability of biology instructional materials and Suggested methods to enhance AI adoption and its influence on biology education. The recommendations include organizing professional development programs for teachers on the effective use of AI-based web instruction and establishing a national AI integration framework aligned with science curriculum standards.

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INTRODUCTION

The fast adoption of web-based technologies in educational systems worldwide has changed traditional pedagogical models, specifically in the sciences. As the demand for pliable, convenient, and student-centered learning environments increases, digital tools such as learning management systems, instructional videos, E-labs, and real-time feedback platforms have become central to content delivery (Bao, 2020; Levicky-Townley, 2021). In biology education, which requires both conceptual

understanding and experiential learning, these tools provide original possibilities to visualize theoretical concepts, simulate experiments, and engage learners in collaborative learning environment.

Notwithstanding, the benefits of digital teaching to improve instruction outcomes, its importance remains very dependent on learners' attitudes, online competency, and their perspectives of technology-mediated education (Amponsah et al., 2022). While strong economy nations have extensively examine these

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dynamics, studies from developing contexts especially among pre-service teachers in Colleges of Education remain limited. This gap is particularly evident in Nigeria, where infrastructural disparities, digital divides, and contextual socio-cultural variables shape students' engagement with educational technology (Binshehab, 2021).

Additionally, whereas Nigerian national policies progressively champion for the utilization of Information and Communication Technologies (ICTs) in educational institutions, there is limited empirical evidence examining learners' real knowledge and perspectives, especially in the area of teaching biology and other related subjects (Ramafi, 2022). Knowing how students perceive things is important not just because it influences their motivation and learning results, but also because these students will soon be required to use similar technologies in the classroom when they become teachers (Havik & Westergård, 2020). Therefore, this study examines how Nigeria Certificate in Education students at the Federal College of Education, Zaria, see web-based technology in biology instruction. By exploring how students interpret, interact with, and evaluate these digital tools, the study aims to provide evidence-based insights to inform policy, pedagogy, and future research. In doing so, it addresses a critical research gap at the intersection of educational technology, science education, and teacher preparation in sub-Saharan Africa.

Problem Statement

A fundamental change in modern scientific literacy is represented by the incorporation of web-based technology into classroom instruction, especially in biology, a topic that greatly benefits from interactive learning, visual presentation, and hands-on experience. Although the use of web-based tools to improve teaching and learning outcomes is becoming more and more popular worldwide, implementation in many teacher training institutes in developing countries is still dispersed, uneven, and poorly assessed (Bao, 2020; Amponsah et al., 2022).

Web-based technologies have started to be used in biology classes in Nigerian colleges of education, which are required to prepare future science teachers. The pedagogical potential of these technologies has not yet been completely realised, according to anecdotal data and a small number of empirical research. Learners' attitudes and perceptions more especially, their acceptance, usability, and interaction with web-based platforms have a significant impact on this disparity. The success of web-based learning environments depends on students' preparedness, technological proficiency, and cognitive openness to digitally mediated instruction, despite the fact that they provide flexibility, immediacy, and personalisation (Levicky-Townley, 2021).

There is a discernible trend in biology education at the Federal College of Education, Zaria, towards web-based teaching methods. On the other hand, a lack of data regarding the perceptions of Nigeria Certificate in Education biology students regarding these advances in instruction. Do students think that web-based technologies are useful resources for learning? Do socioeconomic, instructional, or infrastructure difficulties influence their experiences? Effective implementation tactics are hampered by the conceptual confusion caused by the majority of sub-Saharan Africa's research to far, which has concentrated on generalised "technology-enhanced learning" without distinguishing between web-based and non-web-based platforms.

Additionally, the study has mostly ignored how views towards web-based biology teaching are shaped by the complex interactions of institutional infrastructure, digital culture, and learner motivation. The creation of responsive instructional approaches and policy initiatives suited to local conditions is hampered by the lack of knowledge about students' viewpoints. Efforts to include web-based technology may not be in line with learner demands without empirical understanding of students' perspectives, which could compromise academic results and instructional quality.

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Therefore, by methodically examining how Nigeria Certificate in Education students at the Federal College of Education, Zaria, perceive web-based technology in biology instruction, this study fills a crucial research need. In addition to providing policy-relevant suggestions for teacher preparation programs in Nigeria and other similar contexts, the findings will support evidence-based initiatives for improving the efficacy of digital pedagogies in biology instruction.

Research Objectives

The aim of this work is to examine student's perception on web-based technology in teaching Biology among Nigeria Certificate in Education Students in Federal University of Education, Zaria. However, the specific objectives are to:

1. Examine the perceptions of Nigeria Certificate in Education students on the use of web-based technology in teaching biology in FUE, Zaria.
2. Identify the factors that influence of Nigeria Certificate in Education students' perceptions of web-based technology in teaching biology in FUE, Zaria.
3. Determine the relationship between Nigeria Certificate in Education students' perceptions and their academic performance in biology in FUE, Zaria.
4. Discuss the relationship between Nigeria Certificate in Education students' perceptions and their gender in FUE, Zaria.

Research Questions

The following research questions guided the research process:

1. What are the perceptions of Nigeria Certificate in Education students on the use of web-based technology in teaching biology in FUE, Zaria?
2. What factors influence Nigeria Certificate in Education students'

perceptions of web-based technology in teaching biology in FUE, Zaria?

3. Is there a clear difference between Nigeria Certificate in Education students' perceptions and their academic performance in biology in FUE, Zaria?
4. Is there a compelling link between Nigeria Certificate in Education students' perceptions and their gender in FUE, Zaria?

Research Hypotheses

The following research hypotheses served as framework for the study:

1. There is no significant difference in the perceptions of male and female Nigeria Certificate in Education students on the use of web-based technology in teaching biology in FUE, Zaria.
2. There is a notable correlation between Nigeria Certificate in Education students' prior experience with web-based technology and their perceptions of its use in teaching biology in FUE, Zaria.
3. There is a significant positive correlation between Nigeria Certificate in Education students' perceptions of web-based technology in teaching biology and their academic performance in biology in FUE, Zaria.
4. There is no significant relationship between Nigeria Certificate in Education students' perceptions and their gender in FUE, Zaria.

METHODOLOGY

The study methodology used for this research work is descriptive survey design. The target population consist of all the Nigeria Certificate in Education students of Biology Department, Federal University of Education, Zaria. The population of comprises of 1568 (with 867 females and 701 males) respondents from the two selected combinations in Biology Department, Federal University of Education, Zaria. Simple

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random sampling technique was used to choose the sample for the study. Names of the levels in the three different combinations was written on paper, and the two combinations were randomly picked as sample. The sample was drawn from Nigeria Certificate in Education students from Biology Department. Krejcie and Morgan (1970) came up with a table for determining sample size for a given population for easy reference. Krejcie and Morgan Table of Determining Sample Size suggest that a population of 1568, then the sample will be 306.

The research instrument used for data collection was a structured questionnaire design by the researcher, the questionnaire has five sections, section A, which is the bio-data of the respondents which comprises of 5 items which include; gender, age, marital status and educational qualification of the respondents while section B, C, D & E which is design questions based on the research questions of the study comprises of 20 items. The instrument was titled: "Questionnaire on the Students Perception on Web-Based Technology in Technology in Teaching Biology among NCE Students in Federal

University of Education, Zaria", tagged (QSPWBTTTBANCESFUEZ).

The questionnaire was given to three expert in computer department for validation and other two different expert from Biology Department, Federal University of Education, Zaria, to establish the validity of the questionnaire before it was administered for the data collection. The researcher used direct contact method to administer the questionnaire to the students in the selected levels. The data was analysed using simple percentage, SPSS (Statistical Package for Social Sciences "SPSS version 23") to analyse the bio-data and research question in a tabular form.

RESULTS

Research Question One: What is the level of awareness of AI-integrated educational tools among Biology teachers in Zaria Local Government?

This question was answered by the descriptive statistics presented in table 4.5 and 4.8 below

Table 1: Descriptive Statistics Showing perception of respondents on level of awareness of AI-integrated educational tools among Biology teachers in Zaria Local Government?

Item Statement	Response				Total	Mean
	SA	A	D	SD		
Teachers are informed about the various AI-integrated tools for teaching Biology.	45	51	12	14	122	3.04
Teachers frequently engage in discussions or seminars related to AI-based educational tools.	51	49	17	5	122	3.20
Teachers feel confident in explaining the concept of AI-integrated educational tools to their colleagues.	71	31	16	4	122	3.39
Most Teachers use AI tools in their teaching practices	46	48	21	7	122	3.09
Zaria schools have introduced AI tool in teaching Biology	56	52	9	5	122	3.30
Average Mean Respondents						3.20

Table 1 shows respondents' view on level of awareness of AI-integrated educational tools among Biology teachers in Zaria Local

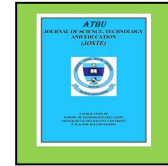
Government. The result revealed that teachers are informed about the various AI-integrated tools for teaching Biology with mean response of 3.04.

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Teachers frequently engage in discussions or seminars related to AI-based educational tools with a mean response of 3.20. Teachers feel confident in explaining the concept of AI-integrated educational tools to their colleagues with mean response of 3.39. Most Teachers use AI tools in their teaching practices with a mean response of 3.90. Zaria schools have introduced AI tool in teaching Biology with mean response of 3.30.

The study shows that most of the respondents were of the view that the level of awareness of AI-integrated educational tools among Biology teachers in Zaria Local Government is very poor with average mean respondent of 3.2.

Research Question One: How do Biology teachers perceive the benefits of AI tools in teaching the subject?

Table 2: Descriptive Statistics Showing perception of respondents on perceive the benefits of AI tools in teaching the Biology

Item Statement	Responses					Mean
	SA	A	D	SD	Total	
AI-integrated tools can significantly improve students' understanding of complex Biology concepts.	43	49	23	7	122	3.05
AI-based educational tools reduce teachers' workload and make lesson planning more efficient.	57	44	11	10	122	3.21
AI enhances individualized learning by catering to students' different learning paces.	65	34	19	4	122	3.31
AI integrated tools aids teachers in tracking student performances and identify learning gaps.	71	34	13	4	122	3.41
AI integrated tools create an atmosphere that encourages creativity in teaching biology	45	54	15	8	122	3.11
AI tools aid teachers in creating a more functional grading and assessment framework for students	56	43	20	3	122	3.25
Average Mean Respondents						3.22

Table 2 revealed that AI-integrated tools can significantly improve students' understanding of complex Biology concepts with mean response 3.05. AI-based educational tools reduce teachers' workload and make lesson planning more efficient with mean response of 3.21. AI enhances individualized learning by catering to students' different learning paces with mean response of 3.31. AI integrated tools aids teachers in tracking student performances and identify learning gaps with mean response 3.41. AI integrated tools create atmosphere that encourages creativity in

teaching biology with mean response 3.11. AI tools aid teachers in creating a more functional grading and assessment framework for students with mean response 3.225.

The study shows that most of the respondents were of the view that AI would have strong benefits as a tool in teaching Biology subjects with average mean respondent of 3.22.

Research Questions Three: To what extent are AI-integrated educational tools currently being used in Biology instruction?



Table 3: Descriptive Statistics Showing perception of respondents on extent to which AI-integrated educational tools currently being used in Biology instruction?

Item Statement	Response				Total	Mean
	SA	A	D	SD		
Most teachers are encouraged to use AI integrated educational tools by their schools	52	43	21	6	122	3.16
Teachers regularly use AI-integrated tools in my biology lessons.	45	44	23	10	122	3.02
Secondary schools in Zaria provide adequate AI-based resources for effective Biology instruction.	51	54	10	7	122	3.22
AI tools have become an essential part of my teaching methodology.	44	43	19	16	122	2.94
I have faced challenges integrating AI tools into my teaching.	47	34	23	18	122	2.90
Average Mean Respondents						3.048

Table 3 revealed that most teachers are encouraged to use AI integrated educational tools by their schools with mean response 3.16. Teachers regularly use AI-integrated tools in my biology lessons with mean response 3.02. Teachers' school provides adequate AI-based resources for effective Biology instruction with mean response 3.22. AI tools have become an

essential part of my teaching methodology with mean response 2.94. I have faced challenges integrating AI tools into my teaching with mean response 2.90

Research Questions Four: What are the approaches to be adopted to maximize AI benefits in teaching Biology?

Table 4: Descriptive Statistics Showing perception of respondents on approaches to maximize AI benefits in teaching Biology

Item Statement	Response				Total	Mean
	SA	A	D	SD		
Schools should organize regular training workshops on AI-integrated educational tools for teachers.	54	33	23	12	122	3.06
The government should provide more funding and resources to support AI adoption in Biology teaching.	43	53	13	13	122	3.03
Collaboration with technology experts and educators will help in the effective integration of AI tools in Biology instruction.	43	44	23	12	122	2.97
Schools should encourage teachers to use AI-based tools through incentives and support.	46	55	11	10	122	3.12
Average Mean Respondent						3.05

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Table 4 revealed that schools should organize regular training workshops on AI-integrated educational tools for teachers with mean response 3.06. The government should provide more funding and resources to support AI adoption in Biology teaching with mean response 3.03. Collaboration with technology experts and educators will help in the effective integration of AI tools in Biology instruction with mean response 2.97. Schools should encourage teachers to use

AI-based tools through incentives and support with mean response 3.12

Test of Null Hypotheses

Four null hypotheses were tested using analysis of T-test (one sample T-test) as statistical tools at 0.05 levels of significance as follows:

Null Hypothesis One: H_{01} : There is no significant relationship between the level of awareness of AI-integrated educational tools and Biology teachers' perception in Zaria Local Government.

Table 5: Analysis of significant relationship between the level of awareness of AI-integrated educational tools and Biology teachers' perception in Zaria Local Government.

Variables	N	X	S.D	Mean diff.	df	T	P value	Remark
Agree	100	3.20	0.320					
				1.66	121	4.889	0.0001	Significant
Disagree	22	1.54	0.320					

Table 5 shows that the agreed respondents have a mean rate of 3.20 exhibiting variability with a SD of 0.320 while disagreed respondents have a mean rate of 1.54 with a variability of 0.320. The average difference between the variables is 1.67. Given that the computed value of the t- test 4.063 the is greater than the table value (2.571); the findings of the study rejects the null hypotheses which say that there is no significant relationship between the level of awareness of AI-integrated educational

tools and Biology teachers' perception in Zaria Local Government. Therefore, this study accepts that there is a significant relationship between the level of awareness of AI-integrated educational tools and Biology teachers' perception in Zaria Local Government.

Null Hypothesis Two H_{02} : There is no significant relationship between teachers' perceptions of the benefits of AI tools and teaching Biology.

Table 6: Analysis of significant relationship between teachers' perceptions of the benefits of AI tools and teaching Biology

Variables	N	x	S.D	Mean diff.	df	T	P value	Remark
Agree	99	3.22	0.803					
				2.80	121	3.112	0.0001	Significant
Disagree	23	0.42	0.173					

Total = 3.112 > $t_{tab} (0.05, 5) = 2.571$

Table 6 shows that the agreed respondents have a mean rate of 3.22 with a displaying dispersion of 0.803 while disagreed respondents have a mean rate of 0.42 displaying a dispersion value of 0.0.173. The mean variation between the variables is 2.80. In light of the

calculated value of the t- test 3.112 is greater than the table value (2.571); the product of the study rejects the null hypotheses which say that there is no significant relationship between teachers' perceptions of the benefits of AI tools and teaching Biology. Therefore, this study accepts that there is

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a significant relationship between teachers' perceptions of the benefits of AI tools and teaching Biology.

Null Hypothesis three Ho₃: There is no significant relationship between the extent to which AI-integrated educational tools are currently being used and Biology instructional material.

Table 7: Analysis of There is no significant relationship between the extent to which AI-integrated educational tools are currently being used and Biology instructional material

Variables	N	x	S.D	Mean diff.	df	T	P value	Remark
Agree	91	3.048	0.343					
				1.618	121	2.987	0.0001	Significant
Disagree	31	1.43	0.343					

Table 7 shows that the agreed respondents have a mean rate of 3.048 with a variability of 0.343 while disagreed respondents have a mean rate of 1.43 with a variability of 0.343. The mean contrast between the variables is 1.618. Considering the computed result of the t- test 2.987 and is greater than the table value (2.571); the product of the study rejects the null hypotheses which say that there is no significant relationship between the extent to which AI-

integrated educational tools are currently being used and Biology instructional material. Therefore, this study accepts that there is a significant relationship between the extent to which AI-integrated educational tools are currently being used and Biology instructional material.

Null Hypothesis Four Ho₄: There is no significant relationship between possible approaches to maximize AI benefits in Biology education.

Table 8: Analysis of there is no significant relationship between approaches to maximize AI benefits in Biology education

Variables	N	x	S.D	Mean diff.	df	T	P value	Remark
Agree	92	3.05	0.531					
				1.27	121	2.59	0.0001	Significant
Disagree	30	1.78	0.532					

Table 8 shows that the agreed respondents have a mean rate of 3.05 with a variability of 0.531 while disagreed respondents have a mean rate of 1.78 with a variability of .532. The average difference between the variables is 1.27. Because the determined value e of the t- test 2.59 and is greater than the table value (2.571); the outcome of the study rejects the null hypotheses which say that there is no significant relationship between approaches to maximize AI benefits in Biology education. Therefore, this study accepts that there is significant relationship between possible strategies to enhance the

adoption and effective utilization of AI tools in Biology education.

SUMMARY OF FINDINGS

- The present investigation accepts that there is a significant relationship between the level of awareness of AI-integrated educational tools and Biology teachers' perception in Zaria Local Government with a mean disparity of 1.66 and t-value and p value 0.00001
- The inquiry accepts that there is a significant relationship between teachers' perceptions of the benefits of AI tools and

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- teaching Biology with an average difference of and t-value 4.889 and p value 0.00001.
- iii. The research accepts that there is a strong association between the extent to which AI-integrated educational tools are currently being used and Biology instructional material with a average difference of 1.618 and t-value 2.987 and p value 0.00001.
- iv. Therefore, our analysis accepts that there is an important association between possible methods to boost AI adoption in Biology education with an average gap of 1.27 and t-value 1.27 and p value 0.00001

DISCUSSION OF THE FINDINGS

The study revealed that there is an important association between the level of awareness of AI-integrated educational tools and Biology teachers' perception in Zaria Local Government. This is in line with the study of Omolara et al. (2025) findings which revealed that most of the students were aware of AI, their understanding was often superficial, limited to popular applications like AI-powered chatbots and recommendation systems. There is a need for more comprehensive AI education that addresses both technical skills and ethical considerations. This would ensure that senior secondary school students are better equipped to engage with AI technologies responsibly in their future careers. Cao et al. (2024) opined that AI tools are influenced by students' attitudes, concerns and expectations regarding AI integration as well as direct experiences with AI teaching of biology related subjects.

The study also found that there is a strong correlation between teachers' perceptions of the benefits of AI tools and teaching Biology. This is similar to the studies of Lindelani et al. (2024), Telaumbanua (2025) and Adewuyi et al. (2023) findings which indicated a significant awareness of AI's potential benefits and risks. However, the study also highlighted a gap between students' theoretical knowledge of AI ethics and their practical application of these principles. The conclusion emphasized the need for integrating ethics more deeply into AI curricula,

suggesting that practical case studies and ethics workshops could bridge this gap.

Kadunabadejo and Adekunle (2021) findings revealed that while students were generally positive about the potential of AI to enhance learning and research, they were also wary of the ethical challenges it poses. Issues such as the lack of transparency in AI decision-making processes, the potential for exacerbating social inequalities, and the risks of AI being used in ways that violate human rights were commonly mentioned.

Furthermore, this study accepts that there is a substantial link between the potential approaches for AI integration in Biology education. In conjunction with study by Bamidele and Fashola (2024) corroborates these findings, noting that although there has been a significant increase in AI awareness among senior secondary school students over the past two years, the depth of knowledge remains inadequate. The researchers observed that most students are familiar with AI terminology and can identify common AI applications, but lack a in-depth knowledge of the underlying principles and challenges posed by these technologies.

CONCLUSION

This study provides compelling empirical evidence on the pivotal role of artificial intelligence (AI)-integrated educational tools in shaping Biology instruction within Zaria Local Government Area. The findings reveal a statistically marked correlations between Biology teachers' level of awareness and their perceptions of AI tools, suggesting that greater awareness positively influences acceptance and readiness for implementation. Furthermore, teachers' favorable perceptions of AI's pedagogical benefits are significantly associated with their willingness to integrate these tools into instructional practice.

The data also indicate that the current use of AI-integrated tools in Biology teaching albeit still emergent is meaningfully related to the quality and relevance of instructional materials being employed. This underlines a crucial link between technology adoption and the enrichment

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of teaching content. Additionally, the study underscores that strategic interventions, such as professional development, infrastructure enhancement, and institutional support mechanisms, are significantly correlated with the increased adoption and effective utilization of AI tools.

The research accepts that there is a strong association between the extent to which AI-integrated educational tools are currently being used and Biology instructional material with an average difference of 1.618 and t-value 2.987 and p value 0.00001. This is in consistent with the findings of Al Darayseh (2023) who found the use of AI in the classroom by science teachers with positive correlation to self-efficacy, ease of use, expected benefits, attitudes and behavioural intentions.

Finally, the research accepts that there is an important association between possible methods to boost AI adoption in Biology education with an average gap of 1.27 and t-value 1.27 and p value 0.00001. This findings is compatible with that of Mafara and Shehu (2024) who revealed the possible methods of AI adoption to include collaborations, provision of real data and algorithm, internet connectivity, electricity and devices.

RECOMMENDATIONS

Based on the above findings, the following recommendations are made:

1. Faculty members and teachers should be trained on the best use of AI web-based instructions in teaching biology and other science subjects.
2. There should be a national AI integration frame work for all science subjects. The framework should be made to align with curriculum standard.
3. Government and school authorities should prioritize the provision of reliable internet connectivity, uninterrupted electricity supply, digital tools and expert technologist in our biology laboratories'.
4. Faculty members in the universities and colleges of education should be empowered to

conduct action research and pilot projects that explore innovative uses of AI in science education.

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