

ENHANCING SECONDARY SCHOOL STUDENTS' INTEREST AND PERFORMANCE IN BIOLOGY THROUGH FUNCTIONAL PEDAGOGICAL APPROACHES IN JALINGO METROPOLIS

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ABSTRACT

Recognizing on going struggles with students' interest and performance in Biology, this study explored whether AI-supported teaching methods could offer a meaningful solution in Jalingo Metropolis, Taraba State. The research was guided by two research questions and respective null hypotheses, using a quasi-experimental pre-test post-test control group approach. From a population of 3,469 Senior Secondary School Two (SSS2) students, a sample size of 184 was drawn from five randomly selected schools through simple random sampling technique. Data came from a Biology Performance Test (BPT) and a specially developed Biology Interest Inventory (BII). Descriptive statistics of Mean and Standard Deviation addressed the research questions, while inferential statistics of ANCOVA tested the hypotheses. Findings revealed that students who experienced AI-enhanced lessons showed stronger interest and performed better than those taught through conventional methods. The study recommends that teachers receive proper training in AI tools and that the curriculum be updated to reflect this shift toward more dynamic, technology-enhanced learning.

Keywords: *Artificial Intelligence, Pedagogy, Biology Education, Students' Interest, Academic Performance*

INTRODUCTION

In a bid to meet global digitalization standards in the 21st century, nations are making significant efforts to embrace it through effective teaching and learning science. This is because; knowledge of science and technology is pivotal to sustainable development in any national economy. Developed nations such as United State of America boast of so many scientific feats, hence, it is among the nations rated as super powers. America has achieved this because of its early recognition of the importance of Science and Technology. It is no longer a doubt that Science and technology is a vehicle which a nation can be used to accelerate economic growth, increased productivity, competitiveness, and job creation, development for self-reliance and overall development. Thus, it is the desire of every nation to achieve this feat in the world of Science and Technology. Every branch of science specifically Biology has important contribution to make in a nation's technological advancement. Nwankwo and Uche(2024).

Biology, the study of living organisms, plays a pivotal role in the Nigerian secondary school curriculum. Nwankwo and Uche (2024) posit that Biology seems to be the most vital and popular science subject among secondary school students. Biology is quite vital for natural development because it is the root subject for many careers in science and technology such as Medicine, Engineering, Forestry, Agriculture, Biotechnology, Nursing among others. The authors further mentions that the deduction here is that any student with the plan of pursuing the afore-mentioned courses of study must be well grounded in the knowledge of Biology. The benefits of Biology for the development of any nation are too numerous to mention, and this is because the subject plays a key role in industrialization and other sectors of the economy (Joda 2019).

Despite its relevance in scientific, technological and human development, students' interest and performance in Biology in the West African Senior Secondary School Certificate Examination (WASSSCE) has been abysmally poor over the years (Njoka, 2015).The persistent failure in Biology, especially in different public examinations is worrisome and has piqued the interest of significant players in education. Biology students' academic performance in external examinations has typically

been below average (Ado et al, 2019). The authors further buttresses that, data from “two public examination bodies in Nigeria, the West African Examinations Council (WAEC) and the National Examinations Council (NECO), show no significant improvement in the students’ performance in Biology at the senior secondary school level over the years. The low level of students’ interest and academic performance in Biology at the senior school certificate examinations could be attributed to many factors including “lack of qualified teachers, lack of interest and commitment on the part of students, abstract nature of some of the topics, teachers’ low level of knowledge of the subject, poor pedagogical approaches Ali et al, (2014). Among the aforementioned factors enumerated above, Umoru and Onoja (2018) posits that poor pedagogical approach is the fundamental cause of students’ poor interest and performance in Biology because of over dependent on the conventional method of teaching.

The conventional method of teaching, particularly the lecture method, remains one of the most commonly used instructions in Nigerian secondary schools, especially in the teaching of Biology. This method involves the teaching delivering content verbally while students listen, take note, and occasionally ask questions. It is largely teacher-centered, while minimal students’ engagement or hands-on activities. While this method allows for the coverage of a broad curriculum within limited time, it often fails to meet the diverse learning needs of students, particularly in science subject (Biology inclusive) that require practical understanding and application (Ibe & Nwosu, 2022). Research has shown that the conventional lecture method promotes rote memorization rather than meaningful understanding, making it difficult for student to apply what they learned to real life situation (Onasanya & Adebija, 2020). In Biology, where observation, experimentation, and visualization are important in the learning process, the limitation of the conventional method becomes even more pronounced. Students taught through lectures often struggle with abstract concept and exhibit reduced interest and performance. Furthermore, this method does not encourage critical thinking, creativity, or collaboration, all of which are essential 21st–century learning skills

Interest refers to someone’s feeling for something for which they expend time and energy. Danjuma (2015) defines interest as what someone’s development of passion for and their consequent commitment of time in doing it. The indication here is that a student develops interest in a stimulus which they consider stimulating to them. Michelsen (2013) sees interest as a relational construct between a person and an object. The author added that students’ interest varies depending how deeply or permanently they are situated within students. This is because students’ interest in a subject has been found to correlate with academic performance. Notably Kpolovie, et al (2014), in a study discovered that students’ interest correlates positively with their academic performance and the strategy employed in teaching. However, in a more recent study by Dewulf et al, (2020) found students’ interest in a particular topic had little or no impact their test scores or grade. Similarly, Vallerand et al, (2021) found students’ interest in a subject not a reliable indicator of their actual performance in a subject but could be due to the strategy employed. To Mori et al, (2018) in an earlier study emphasized that relationship between students’ interest and their academic performance could be weak and inconsistent across different subjects if a learner centered approach is not employed by the teacher.

The academic performance of students which is the product of school work is a major concern for science educators considering Biology as bedrock of scientific and technological development of any nation. Research reports have pointed at the poor performance in Biology by students in largely attributed to instructional strategy and ways to improve on it. According to Arokoyu and Chukwu (2017), there is no doubt that the conventional method of teaching which is predominantly used in secondary schools in Nigeria contributes greatly to the poor academic performance of students in Biology. Hence, the need to explore or use modern and innovative strategies such as Artificial Intelligence and others to enhance students’ interest and performance in subjects,

The rapid advancement of artificial intelligence (AI) has significantly transformed the landscape of education particularly through the development of AI adaptive learning systems. These systems enhance students' interest and performance by delivering personalized learning experiences tailored to individual needs, preferences and learning styles. According to Akthar and Malob (2024) AI is already causing changes across various aspects of the educational system including instruction delivery, students' evaluation or assessment and management. In teaching Biology, AI plays a significant role in developing functional literacy through the use of personalized interactive tools and data analysis.

The rapid advancement of artificial intelligence (AI) has significantly transformed the landscape of education particularly through the development of AI adaptive learning systems. These systems enhance students' interest and performance by delivering personalized learning experiences tailored to individual needs, preferences and learning styles. According to Russell and Norvig (2020), AI is the study of agents that receive precepts from the environment and perform actions to maximize the chances of achieving goals. To Okonkwo and Chukwendo (2021), AI has the capacity to individualize instruction through tutoring systems that can assess students' strength and weakness in real-time, thereby tailoring lessons to suit students' learning style. This is particularly beneficial in large classrooms where individualized attention is often lacking. Commenting on the significance of Artificial Intelligence, Askarova and Altynsarin (2024) emphasized that in teaching Biology, AI technologies play a significant role in developing functional literacy through the use of personalized interactive tools and data analysis. Also, the primary advantage of AI is its fairness in treating all individuals' abilities equally. In the words of Ajayi and Salami (2023), AI can also support teachers by automating routine tasks such as grading, generating lesson plans, and tracking students' progress. Thereby allowing students to interact and participate actively thereby overcoming the antecedent problems of conventional methods of teaching. Ivette Cota-Rivera et al (2024) opines that AI in biology education leverages intelligent algorithms to create engaging and effective learning environments thereby increasing and sustaining the students' interest in the subject. In a related study, Olamide and Udo (2021) found out that students exposed to AI-based instruction in Biology scored significantly higher in achievement tests compared to their counterparts taught using conventional methods. Contrarily, Basha (2024) in a related study emphasized that the effortless works and activities by students using AI tools makes them useless in the academic journey and also negatively impacts on the students' academic performance as they are unable to do their work or activities independently without using AI tools getting discouraged in their studies instead of being encouraged, motivated and curious in education.

There are several types of Artificial Intelligence namely; Narrow AI, General AI Super AI, ChatGPT. For the benefit of this study, the researchers used ChatGPT. This is because it helps students to gather ideas, assists with brainstorming for class projects and enhances creativity, enable students to build confidence, manages time effectively among others. However, according to Facione (2020) over-reliance of AI for assessment and feedback may reduce opportunities for meaningful dialogue and reflection, essential for higher thinking order. The author further maintained that ethical concerns such as data privacy, algorithmic bias and digital divide must be addressed. It is on this note that, the researchers in this study advocate for the use of Artificial Intelligence to ascertain if students' interest and performance could be improved in Biology to enable the students meet up with the 21st century styles of learning which is geared towards achieving scientific and technological breakthrough. More so, that currently there is a paradigm shift from the conventional method of teaching in the classrooms.

Statement of the Problem

Despite growing interest in AI-enhanced education, its implementation in secondary schools faces challenges such as limited awareness, teacher training, and infrastructure in Jalingo metropolis. Furthermore, empirical studies focusing on the effectiveness of AI in specific subjects like Biology

are scarce. More so, that researchers are constantly seeking ways to alleviate students' poor interest and academic performance. This study seeks to address this gap by exploring how AI can enhance teaching and learning in Biology classrooms. The integration of artificial intelligence (AI) in education has transformed the traditional learning environment, offering new opportunities for interactive and personalized instruction. In the context of biology education, AI tools can simulate complex biological processes, foster inquiry-based learning, and enhance students understanding. However, the extent of AI's effectiveness in improving learning outcomes at the secondary level remains underexplored. This study aims to bridge this gap by examining the role of AI in Biology teaching and its effect on students' interest and academic performance. Hence, the need for the study

Purpose of the study

The main purpose of the study is to investigate the effectiveness of Artificial Intelligence on students' interest and academic performance in Biology in Jalingo metropolis. Specifically, the study seeks to;

- i. Determine the effect of Artificial Intelligence applications on students' interest in Biology and those exposed to conventional method.
- ii. Examine the effect of Artificial Intelligence applications on students' academic performance in Biology and those exposed to conventional method.

Research Questions

The following questions are raised to guide the study

- i. What are the mean interest ratings of students taught using Artificial Intelligence applications and those exposed to conventional method?
- ii. What are the mean performance scores of students taught using Artificial Intelligence applications and those exposed to conventional method?

Research Hypotheses

The following hypotheses are formulated to be tested at .0.05 level of significance.

- i. There is no significant difference in the mean interest ratings of secondary school students' interest taught Biology using Artificial Intelligence applications and those exposed to conventional method.
- ii. There is no significant difference in the mean academic performance of secondary school students taught Biology using Artificial Intelligence applications and those exposed to conventional method.

Method

This study employed pre-test, post –test, non-equivalent control group of quasi experimental design. It is a quasi-experimental design because the two groups were randomly assigned into intact two classes. The study was conducted in Jalingo metropolis of Taraba State. The rationale for this choice was due to students' inability to obtain a credit pass in Biology that has prevented them to study science and science related courses of their choice in tertiary institutions.

The target population of the study comprised of 3,469 Senior Secondary 1of Biology students of the study area. A sample size of 184 students was randomly drawn from four secondary schools using simple random sampling technique. Two intact classes were assigned from each of the schools and treatment was given to one while the other one served as a control group using conventional method. The instrument for data collection was Biology Performance Test tagged (BPT).The questions were drawn from the topic Photosynthesis. The BPT was used for both pre-test and post-test. It consisted of 15 multiple choice items. The instructional delivery approach was the use of Artificial Intelligence. Two research assistants were used for both the teaching and administration of instrument using a well-developed lesson plan. The lesson comprised of three lessons per week on the topic which lasted for three weeks. In addition, there was a 10 item self-constructed questionnaire on interest titled Artificial Intelligence Interest Scale (AIIS) rated strongly agree =4, Agree 3, Disagree 2 and Strongly Disagree 1.

Before the commencement of the treatment, the test instruments PAT and AIIS were administered as pre-test to all the students in the sampled schools. After this, the experimental group was taught using Artificial Intelligence for a period of 9 lessons within three weeks. At the end of the lesson periods, the posttests were administered to the students. The researchers marked and recorded the scores which were used with the pretest scores for data analysis. The research questions were answered using mean and standard deviation while the hypotheses were tested at 0.05 level of significance with Analysis of Co-variance (ANCOVA).

Results

Research Question one

1. What are the mean interest ratings of students taught using Artificial Intelligence applications and those exposed to conventional method?

Table 1

Mean Interest rating scores of students in experimental and control group

GROUP	N	Pre-test	S.D	Post-test	S.D	Mean gain
		\bar{X}		\bar{X}		
EXP GRP	90	17.66	6.606	54.17	16.348	36.51
Ctrl GRP	94	21.98	8.998	43.22	12.255	21.24
Mean Difference		4.32		10.95		15.27

EXP GRP = Artificial Intelligence.

Control GRP = Conventional method .

Table 1 shows the experimental group taught using Artificial Intelligence approach had a pretest mean interest ratings of 17.66 with a standard deviation of 6.606, while the control group taught using the conventional lecture method had a pretest mean interest rating of 21.98 with a standard deviation of 8.998. The difference between the pretest scores of the experimental group and the control group is 4.32. Furthermore, the posttest mean interest rating of the student taught using the Artificial Intelligence is 54.17, while that of their counterparts taught using the conventional lecture method is 43.22. The standard deviation scores of the two groups show how the datasets in both groups have a reasonable degree of variability. The difference between the post-test mean interest ratings of the students in the two groups is 10.95 and in favour of the group taught using Artificial Intelligence.

The mean gain interest for students taught using the Artificial Intelligence is 36.51, while that of those taught using the conventional method is 21.24. The reasonable mean gain shows that the interest of those in the Artificial Intelligence group increased higher than those in the control group by 15.27. Therefore, it can be concluded that the Artificial Intelligence was highly effective in improving students' interest in Biology.

Research Question Two

What are the mean performance scores of students taught using Artificial Intelligence applications and those exposed to conventional method?

Table 2
Mean Performance scores of students in experimental and control group

GROUP	N	Pretest	S.D	Post-Test	S.D	Mean gain
		\bar{X}		\bar{X}		
EXP GRP	90	20.01	9.901	51.42	15.875	31.41
Ctrl GRP	94	26.00	10.789	34.47	15.978	8.47
Mean Difference		5.99		16.95		22.94

Exp Grp = Artificial Intelligence approach

Control Grp = conventional method

Table 2 shows that the experimental group taught using the Artificial Intelligence approach had a pretest mean score 20.01 with a standard deviation of 9.901, while the control group taught using the conventional lecture method had a pretest mean score of 26.00 with a standard deviation of 10.789. The difference between pretest scores of the experimental group and the control group is 5.99. after the effect of the pretest has been statistically removed, the posttest mean score of the students taught using the Artificial Intelligence approach stands at 51.42, while that of their counterparts taught using the conventional lecture method is 34.47. The standard deviation scores of two groups indicate that the datasets in the two group exhibit a reasonable degree of variability. The difference between the post-test mean score of the student in the two groups is 16.95 and in favour of the group taught using Artificial Intelligence approach. The mean gain (that is, the difference between the pretest and posttest scores) of student taught using the artificial Intelligence approach is 31. 41, while that of those taught using the conventional method is 8.47. The reasonable mean gain shows that the Artificial Intelligence group gained higher than the control group by 22.94. Therefore, it can be deduced that the Artificial Intelligence approach was highly effective in improving students' performance in Biology.

Hypotheses testing

Hypothesis one

There is no significant difference in the mean interest ratings of secondary school students' interest taught using Artificial Intelligence applications and those exposed to conventional method.

Table 3

One-way ANCOVA showing method of teaching on interest rating of students taught biology using Artificial Intelligence

Source	Type III Sum of Squares	df	Mean Square	Sig.	F	Squared Multiple Correlation
Corrected Total	5468.766	2	22734.383	12.938	.000	.125
Model						
Intercept	47948.307	1	47948.307	226.880	.000	.555
Pretest interest Rating	121.346	1	121.346	.574	.450	.003
GROUPS	5370.629	1	5370.62	25.413	.000	.123

ERROR	38252.169	181	211.338
Total	477894.000	181	
Corrected total	43720.935	183	
R squared = .125 (Adjusted R square = .115)			

Table 3 is a one- way between-groups analysis of covariance to test the mean interest ratings of students in Biology using Artificial Intelligence approach. The analysis reveals compelling evidence regarding the effect of Artificial Intelligence approach on students' interest in Biology. Firstly, a significant difference was observed between the two groups in terms of students' post-test scores, as evidenced by the obtained F-statistic of 25.413 with a p-value < 0.05 indicating statistical significance. Moreover, the substantial effect size, represented by a partial eta-squared value of 0.123, suggests that 12.3% of the variance in Artificial Intelligence scores can be attributed to Artificial Intelligence approach employed. Considering these evidences, the hypothesis suggesting that the Artificial Intelligence approach has no significant effect on students' interest in biology is hereby rejected. Instead, the results indicate a significant effect of the Artificial Intelligence approach on students' interest in Biology.

Hypothesis two

There is no significant difference in the mean academic performance of secondary school students taught using Artificial Intelligence applications and those exposed to conventional method.

Table 4

One way ANCOVA showing effects of teaching method on students' performance in biology

Source	Type III			Mean		Squared	Partial Eta
	Squares	df	Square	F	Sig.		
Corrected model	17899.457	2	8949.728	34.122	.000		.272
Intercept	57039.641	1	57039.641	217.472	.000		.546
Pretest	58.323	1	58.323		.222	.638	.001
GROUPS	17004.285	1	17004.285	64.831	.000		.264
Error	47473.581	181	262.285				
Total	4723271.000	184					
Corrected total	65373.038		183				

a. R squared = .274 (adjusted R squared = .266)

Table 4 is a one-way between-groups analysis of covariance to evaluate the mean performance Scores of students taught Biology using Artificial Intelligence approach. The analysis shows that the effect of the Artificial Intelligence approach on students' achieving in Biology is significant. This is seen in the evidence from the obtained F-statistic of 64.831 with p-value < 0.05, indicating statistical significance. Furthermore, the substantial effect size, represented by a partial eta-squared value of 0.264 suggests that a considerable portion (26.4%) of variance in performance scores can be attributed to the Artificial Intelligence approach employed. Considering these findings, the hypothesis suggested that the Artificial Intelligence approach has no significant effect on student performance in Biology is hereby rejected. Instead, the results indicate a significant positive effect of the Artificial Intelligence approach on students' performance in Biology.

Discussion of findings

Findings on the difference between the interest ratings of students taught Biology using the Artificial Intelligence approach was highly effective in enhancing students' interest in Biology. This is in line with Vallerand et al,(2021) who found students' interest in a subject not a reliable indicator of their actual performance in a subject but could be due to the strategy employed. However, the study is at variance

with Dewulf et al, (2020) which revealed that students' interest in a particular topic had little or no impact their test scores or grade.

Findings on the difference between the mean performance scores of student taught biology using the heuristic approach and those taught using the conventional method revealed that the Artificial Intelligence approach was highly effective in enhancing student' achievement in biology this agrees with Olamide and Udo (2021) found out that students exposed to AI-based instruction in Biology scored significantly higher in achievement tests compared to their counterparts taught using conventional methods. Contrarily, the findings did not align with Basha (2024) in a related study who emphasized that the effortless of works and activities by students using AI tools makes them useless in the academic journey and also negatively impacts on the students' academic performance as they are unable to do their work or activities independently without using AI tools getting discourage in their studies instead of being encouraged, motivated and curious in education.

CONCLUSION

The findings revealed that Artificial Intelligence is a highly effective instructional strategy compared to conventional teaching method. It significantly enhanced student's interest towards Biology and improved their academic performance. The study highlights the potential of Artificial Intelligence to make learning more interactive and student-centered, thereby addressing common challenges in science education, by improving students' learning outcome, artificial Intelligence offers a practical and inclusive approach to enhancing the quality of Biology education. Thus, it was concluded that integrating artificial Intelligence teaching strategies into Biology instruction can contribute to achieving better learning outcomes and fostering a more positive attitude among students.

RECOMMENDATIONS

Based on the findings and conclusions of this study, the following recommendations are made:

- *Biology teachers in senior secondary schools should adopt artificial Intelligence teaching strategies to enhance students' engagement, interest, and academic performance, workshops and training sessions should be organized to help teachers become proficient in implementing this strategy.
- * Curriculum developers should endeavor to update the current curriculum to reflect this shift towards a more dynamic and technology- enhanced learning
- *Regular in-service training and professional development programs should be organized to familiarize teachers with innovative instructional strategies like artificial Intelligence. These programs should emphasize the benefits of student-centered learning approaches.
- *Researchers are encouraged to conduct similar studies on other subjects and across different educational levels to explore the broader applicability of Artificial Intelligence strategies in enhancing teaching and learning.
- *Government and educational stakeholders should allocate resources to support the implementation of innovative teaching strategies like artificial Intelligence. This includes providing training materials, textbooks, electronic gadgets and other teaching aids.

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