EFFECTS OF THE USE OF ARTIFICIAL INTELLIGENCE ON STUDENTS ACADEMIC ACHIEVEMENT IN BIOLOGY IN SECONDARY SCHOOLS IN IMO STATE.

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Abstract

This paper investigated the effects of the use of artificial intelligence on students' academic achievement in biology in secondary schools in Imo State. The study specifically found out the effect of the use of artificial intelligence on students achievement in respiratory and digestive system in secondary schools in Imo State. The study adopted the quasi-experimental research design. A sample of 233 secondary school biology students from SS2 was selected by stratified random and purposive sampling technique from the three educational zones of Imo State for the study. Biology Achievement Test (BAT) was used to collect data through research assistants. Experts from Science Education, Measurement and Evaluation validated the instrument. A trial testing of the instrument on SS2 Biology students in Mbaitoli Local Government area was conducted and the reliability of the instrument was found to be 0.72. Data collected was analyzed using mean and standard deviation to answer the research questions and analysis of covariance to test the hypotheses at a 0.05 level of significance. The findings of the study shows that students taught respiratory system and digestive system with the aid of artificial intelligence performed better than those taught with convectional lecture method. The study further discovered significant statistical difference in the mean achievement scores of students taught with respiratory system and digestive system with the aid of artificial intelligence. The study recommended that Biology teachers should make use of artificial intelligence when teaching these topics, seminars and symposia on the use of artificial intelligence in teaching. seminars should be organized for in-service Biology teachers.

Key Words: Academic Achievement, Artificial intelligence, Biology students.

Introduction

In the relentless march of time, technology has become an integral part of our existence, reshaping how we live, work, and communicate. Among the recent developments, artificial intelligence (AI) has made significant progress in the field of education. AI-driven systems offer support to learners through educational assistants like bots, fostering a tailored learning experience that encourages autonomy, self-assessment, and self-explanation (Ipin, Aden & Mohammed, 2024*)*. Arthavans (2024) pointed out that in recent years; AI has emerged as a game-changer in various fields, including science education, leading to a growing interest among researchers in exploring its impact on Physics, Chemistry and Biology education. AI was employed in science education to enhance students' comprehension of concepts through customized learning experiences, instantaneous feedback, and targeted interventions. AI was also capable of analyzing students' learning patterns, detecting gaps in their understanding, and adapting to their learning requirements. These systems adapt to the individual's learning speed and deliver content that is best suited to the learner's needs, along with timely advice, feedback, and clarifications.

The advent of AI has brought about substantial improvements in the quality of teaching services and the efficiency of instructional time. Science educators who adopt AI into their 21st-century teaching methodologies can significantly enhance student engagement and participation leading to improved achievement. This shift aligns with the pedagogical evolution from a teacher-centric to a learner-centric approach, as highlighted by Onoja and Ugwuoti in 2021. Reflecting on these developments, the current study aims to investigate the effects of the use of artificial intelligence on students' academic achievement in biology in secondary schools in Imo State, examining its impact on educational delivery and outcomes. This investigation is crucial in understanding how AI can enrich the teaching and learning experience of students and consequently their achievement, ensuring that educators are equipped to meet the demands of modern education and that students are prepared to thrive in an increasingly digital world.

AI is already being used in Universities. For instance, Deakin University in Australia already applied IBM's supercomputer Watson as an emerging form of artificial intelligence and a solution to provide students with advice (Fahimirad & Kotamijani, 2018). This innovation significantly made efficient modifications to the quality of services rendered and time spent teaching students within a university, most Nigerian universities also make use of artificial intelligence to detect plagiarism in students' work (Fernafez et al, 2019).

Artificial intelligence (AI), defined by National Science Board (2016) as the capability of a machine to perform tasks that typically require human intelligence. Artificial intelligence is the simulation of human intelligence processes by machines, especially computer system. Specific applications of AI include machine version. It refers to computer systems performing complex tasks that historically only human can do, such as reasoning, making decisions of solving problems. It has revolutionized many fields, and education is no exception. The application of AI tools to biology education has the potential to enhance the learning experience for students and improve their understanding of complex biological concepts. According to a report from the National Science Board (2016), the use of technology in education can increase student engagement, improve learning outcomes, and reduce the academic achievement gap between students. AI tools, such as machine learning algorithms and natural language processing techniques, can help educators create personalized learning experiences that cater to the needs of individual students. For instance, AI systems can analyze students' learning patterns and performance, then tailor educational content to fit their unique needs. Furthermore, AI-powered Virtual Reality (VR) or Augmented Reality (AR) tools are being used to create interactive simulations or visualizations of complex biological systems, offering a more immersive and intuitive understanding of the subject matter.

Biology is a complex subject that requires students to understand a great deal of information about the interactions between living organisms and their environment. AI tools can help students gain a deeper understanding of these concepts by providing interactive visualizations, simulations, and other multimedia content. For example, Virtual Reality (VR) simulations can provide students with the opportunity to explore complex biological systems in a three-dimensional environment, allowing them to better understand the spatial relationships between different structures and organisms (Chang et al., 2018). Similarly, interactive visualizations can help students grasp difficult concepts such as protein folding and molecular interactions (Marx, 2013). Ugwuoti et al (2023) investigated the use of Artificial Intelligence (AI) based tools for biology education in Alvan Ikoku Federal College of Education, Owerri. Two research questions guided the study. The study adopted a descriptive cross-sectional survey design. A stratified random sampling technique was used to select 168 biology students whose experiences and perceptions were sought. Questionnaire was used for data collection. The internal consistency of the instrument was 0.81 using Cronbach Alpha formula. The research questions were analyzed using arithmetic mean and standard deviation.

The results showed limited experience and comfort level in using AI tools, and a potential need for more education and resources. While students found AI tools helpful in understanding complex biology concepts, there was variability in their perceptions and a preference for traditional teaching methods. The study highlighted the importance of providing training and support to enhance students' experience with AI tools and the potential of these tools to enhance understanding of complex biology concepts.

The theoretical framework for this research is based on constructivist learning theory. Constructivist theory of learning was proposed by Jean Piaget in 1950. This theory emphasizes how human beings adapts to the environment and how previous mental knowledge contribute to new behaviours.

The constructivist theory of learning emphasizes the active involvement of learners in constructing their understanding. This theory is apt for this study as it will consider how artificial intelligence tools can be used to improve students' academic achievement in biology in secondary schools in Imo State. In this regard, the students' will construct knowledge with the help of artificial intelligence tools.

Despite the increasing importance of Artificial Intelligence in instructional delivery, there are no or limited studies in Imo state to determine the effects of the use of artificial intelligence on students' achievement in biology in secondary schools in Imo State (Onoja & Ugwuoti, 2021). This has resulted in a gap between the potential benefits of AI in education (learners) and its actual utilization leading to a lack of improvement in students' learning outcomes. This is why the researchers investigated the effects of the use of artificial intelligence on students' academic achievement in biology in secondary schools in Imo State.

The specific objectives of the study are:

1. Find out the effect of the use of artificial intelligence on students' academic achievement in respiratory system in secondary schools in Imo State
2. To find out the effect of the use of artificial intelligence on students' academic achievement in digestive system in secondary schools in Imo State.

Research Questions

The following research questions guided the conduct of the study:

1. What is the effect of the use of artificial intelligence on students' achievement in respiratory system in secondary schools in Imo State?
2. What is the effect of the use of artificial intelligence on students' achievement in digestive system in secondary schools in Imo State?

Hypothesis

Ho: There is no significant difference in academic achievement of students' in digestive system and respiratory system when taught with artificial intelligence.

Methodology

The study adopted the quasi-experimental research design. A sample of 233 secondary school biology students from SS2 was selected by stratified random and purposive sampling technique from the three educational zones of Imo State for the study. Biology Achievement Test (BAT) was used to collect data through research assistants from the respondents. Experts from Science Education, Psychology, Measurement and Evaluation validated the instrument. A trial testing of the instrument on SS2 Biology students in Mbaitoli Local Government area which were not part of the study was conducted and the reliability of the instrument was found to be 0.72. Data collected was analyzed using mean and standard deviation to answer the research questions and analysis of covariance to test the hypothesis at a 0.05 level of significance.

Results

Research Question One

What is the effect of the use of artificial intelligence on students' academic achievement in respiratory system in secondary schools in Imo State?

Table 1: Mean and standard deviation of students' academic achievement in BAT for conventional and artificial intelligence aided instructions in respiratory system.

Group		Pretest	Posttest	Mean gain
Conventional	Mean	18.49	21.33	2.84
	N	117	117	
	SD	4.49	5.43	
A I Instruction	Mean	18.43	21.34	2.91
	N	116	116	
	SD	4.40	5.43	

Results of data analysis in Table 1 reveal that the pretest and post test mean for conventional and artificial intelligence aided instruction are 18.49 and 21.33, 18.43 and 21.34 respectively. The mean gain is 2.84 for convectional lecture method and 2.91 for artificial intelligence aided instruction. Thus, artificial intelligence aided instruction has high mean gain of 2.91 than conventional lecture method with the mean gain of 2.84. This means that students taught respiratory system with the aid of artificial intelligence achieved higher compared to those taught with conventional lecture method.

Research Question Two

What is the effect of the use of artificial intelligence on students' academic achievement in digestive system in secondary schools in Imo State?

Table 2: Mean and standard deviation of students' academic achievement in BAT for conventional and artificial intelligence aided instructions in digestive system.

Group		Pretest	Posttest	Mean gain
Conventional	Mean	2.42	2.52	0.1
	N	117	117	
	SD	1.84	1.83	
Pictorial	Mean	2.46	2.74	0.28
	N	116	116	
	SD	2.67	2.16	

Results of data analysis in Table 2 reveal that the pretest and post test mean for conventional and artificial intelligence aided instruction are 2.47 and 2.52, 2.46 and 2.74 respectively. The mean gain is 0.1 for convectional lecture method and 0.28 for artificial intelligence aided instruction. Thus, artificial intelligence aided instruction has high mean gain of 0.28 than conventional lecture method with the mean gain of 0.1. This means that students taught digestive system with the aid of artificial intelligence achieved higher compared to those taught with conventional

lecture method.

Hypothesis

Ho: There is no significant difference in academic achievement score of students' in digestive system and respiratory system when taught with artificial intelligence

Table 3: Analysis of covariance of students' mean academic achievement scores in BAT for digestive and respiratory system.

Source	Sum of Squares	df	Mean square	F-cal	Sig.	Decision
Corrected	1.861[a]	2	.931	1204.328	.000	model
Intercept	0.01424	1	0.01424	0.18	.893	
Pretest	185	1	.185	239.035	.000	
Group	.024	1	.024	30.703	.000	S
Error	.029	37	.001			
Total	267.212	40				
Corrected	1.890	39				

R Squared = .985 (Adjusted R Squared =.984).

Table 3 indicates a significant difference in the mean academic achievement scores of students taught digestive and respiratory system with the aid of artificial intelligence at 0.00 with the calculated F value of 30.70 (F1, 39 =30.70, $P < 0.05$). The null hypothesis of no significant difference in the mean academic achievement scores of students taught digestive and respiratory system with the aid of artificial intelligence was therefore rejected. Thus, significant statistical difference exist in the mean academic achievement scores of students taught digestive and respiratory system with the aid of artificial intelligence.

Discussion of Results

Effect of the use of artificial intelligence on students' academic achievement in respiratory system in secondary schools in Imo State.

The analysis of data on research question 1 and hypothesis 1 showed that artificial intelligence aided instruction have significant effect on students' academic achievement in respiratory system in secondary schools in Imo State. It was found that students taught respiratory system with artificial intelligence aided instruction had a higher mean achievement scores compared with their control group counterparts, (F_1, 351=27.541, $P < 0.05$). The reason for the better performance by students in the experimental group may be that the students were able to get better insight into the different terms used in respiratory system with the aid of artificial intelligence and link the knowledge to the concepts they were taught. This could have also awakened their interest which increased their commitment to learning and subsequently increased their achievement. Thus, the result reveals that the adoption of appropriate teaching strategies, in this case, artificial intelligence aided instruction enhances better achievement in respiratory system. The result of this study agrees with the findings of Fernafez et al, (2019) that artificial intelligence promotes personalized productive learning behavior such as self-regulation, self-monitoring and self-explanation as it provides learning activities at the learners pace and with the most appropriate content, timely guidance, feedback and explanations. The

findings showed a significant difference in process of science scores between pretest and post test of students taught respiratory system with artificial intelligence aided instruction and those that were not.

Effect of the use of artificial intelligence on students' academic achievement in digestive system in secondary schools in Imo State.

Results of data analysis in Table 3 revealed that the pretest and posttest mean for conventional and artificial intelligence aided instruction are 2.47 and 2.52, 2.46 and 2.74 respectively. The mean gain is 0.1 for convectional lecture method and 0.28 for artificial intelligence aided instruction. Thus, artificial intelligence aided instruction had high mean gain of 0.28 than conventional lecture method with the mean gain of 0.1. This means that students taught digestive system with the aid of artificial intelligence achieved higher compared to those taught with conventional lecture method. The finding is supported by finding of Athavans, (2024) who embarked on a literature survey to explore how artificial intelligence and its technologies transform teaching and learning in basic science: Physics, Chemistry, and Biology. The researcher discovered that the integration of AI technology into science education not only offered personalized learning opportunities but also enhanced cognitive abilities, resulting in a more engaging and enjoyable educational experience that fostered self-motivation. AI-powered simulations, virtual laboratories, and interactive tools created learning environments that allowed students to gain hands-on experience with complex scientific problems, investigate data, and draw conclusions. These student-centered teaching techniques were personalized and engaging, influencing students' cognitive skills and enabling them to think critically and understand complex concepts in virtual science learning environments.

Conclusions and Recommendations.

The study discovered that students taught respiratory system and digestive system with the aid of artificial intelligence performed better than those taught with convectional lecture method. The study further discovered significant statistical difference exist in the mean academic achievement scores of students taught with digestive and respiratory system with the aid of artificial intelligence. The study recommended the use of artificial intelligence aided instruction in improving students' academic achievement in respiratory system and digestive system, Biology teachers should make use of this strategy when these topics, artificial intelligence aided instruction should be included in Biology curriculum as strategy for teaching respiratory system and digestive system. Workshops, seminars and symposia on the use of artificial intelligence in teaching should be organized for in-service Biology teachers.

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