IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

"Effects of AI-Generated Personalized Pathways on Students' Academic Achievement in Biology in Secondary Schools in Ikere Local Government Area, Ekiti State, Nigeria"

Effects of AI-Generated Personalized Pathways on Students' Academic Achievement in Biology in Secondary Schools in Ikere Local Government Area, Ekiti State, Nigeria

Oludare Jethro OLOJO[1] (Ph.D.) & Abiodun Emmanuel OKEYA[2](Ph.D.)

[1,2]Department of Science Education, Bamidele Olumilua University of Education, Science and Technology Ikere – Ekiti, Ekiti State.

Abstract

The study examined the effects of AI-generated personalized pathways on students' academic achievement in Biology in secondary schools in Ikere Local Government Area, Ekiti State. The study used a quasi-experimental design, with pre-test and post-test control groups. The study targeted all Senior Secondary School II (SS II) students offering Biology in public secondary schools in Ikere Local Government Area, Ekiti State. Ninety SS II students from four intact classes in four secondary schools in the study area who were purposefully chosen made up the sample. The Biology Achievement Test (BAT) was the instrument used for the study. The Biology Achievement Test (BAT) was validated by three experts: two in Science Education (Biology) and one in Measurement and Evaluation. The Biology Achievement Test's (BAT) reliability was established through a pilot test on 30 students in a school that was not part of the main sample. The data collection process was divided into three sections: pretest, treatment and posttest. Descriptive and inferential statistics were used to analyze the data. The study revealed a substantial difference between the mean performance scores of biology students taught using the conventional method and the AI-generated Personalized pathways. The study also showed that male and female students who were taught Biology concepts via AI-generated personalized pathways performed differently, favoring female students. It was recommended among others that the AI-generated Personalized Pathways Strategy should be implemented into secondary school biology instruction since it encourages active learning.

Key Words: AI-Generated, Personalized Pathways, Students' Academic Achievement, Biology, Secondary Schools,

Introduction

Biology is a scientific discipline that plays essential roles in secondary and tertiary education. It equips learners with knowledge of living systems, environmental interactions, and human health, while also developing skills of observation, experimentation, and critical thinking. In many curricula, Biology is considered foundational for careers in medicine, agriculture, biotechnology, and environmental sciences. Despite its importance, evidence consistently shows that students often struggle to achieve satisfactory outcomes in Biology. Common difficulties include the abstractness of biological concepts (e.g., cellular processes, genetics), the technical vocabulary, and the need to integrate theoretical knowledge with practical applications (Jegede & Okebukola, 2022). These challenges often lead to misconceptions, shallow understanding, and poor retention of knowledge over time.

IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

"Effects of AI-Generated Personalized Pathways on Students' Academic Achievement in Biology in Secondary Schools in Ikere Local Government Area, Ekiti State, Nigeria"

Artificial intelligence (AI) is changing several sectors as well as education, healthcare, business, agriculture, transportation, and security. AI is the creation of computer systems that can do human-like functions like thinking, problem-solving, learning, perception, and decision-making. Artificial intelligence can be traced back to early computational theories in the mid-20th century, particularly the pioneering work of Turing, who proposed that machines could simulate human reasoning. Over the years, researchers such as Russell and Norvig (2021) have provided comprehensive frameworks for understanding AI, describing it as the science and engineering of creating intelligent agents that can sense their surroundings and take action to accomplish particular objectives.

The growth of AI has been fueled by advances in computational power, machine learning algorithms, and access to big data. These developments have led to practical applications in areas such as computer vision, robotics, expert systems, and natural language processing. Today, AI is increasingly applied in real-life situations, including speech recognition, medical diagnosis, logistics, financial forecasting, and self-driving vehicles.

In the education sector, one of the most encouraging applications of AI is the development of personalized learning pathways. Personalized pathways refer to instructional approaches that adapt the pace, content, and style of teaching to suit the distinctive desires, strengths, and learning preferences of individual learners. Traditional classroom models often follow a uniform curriculum that overlooks learner diversity, thereby creating disparities in achievement and retention. Pane, Steiner, Baird, Hamilton, and Pane (2017) emphasized that personalized learning enables flexibility by tailoring educational content to individual learners, thereby improving engagement and mastery.

AI-driven personalized pathways enhance this concept by leveraging data analytics and adaptive technologies to monitor students' performance and provide real-time feedback. These systems allow students to progress at their own pace, revisit difficult concepts, and receive targeted instruction. According to Holmes, Bialik, and Fadel (2019), AI in education is not only transforming teaching and learning methods but also providing opportunities for more equitable and inclusive education, as it supports students with varying abilities and learning backgrounds.

Adoption of AI-generated personalized pathways is not without technical hitches, in spite of the benefits. To guarantee the appropriate use of AI in education, issues including unequal access to digital resources, teacher readiness, ethical concerns, and data protection must be addressed. However, the integration of AI with personalized learning pathways holds immense potential for improving academic achievement, particularly in science-related subjects where students often struggle with abstract concepts.

With the rise of digital learning technologies, educators have increasingly turned to Artificial Intelligence (AI) as a tool for enhancing science education. AI-driven systems can analyze learner performance in real time and generate personalized pathways that adapt content, difficulty, pacing, and feedback to each student's needs. These adaptive systems promise to address variation in learner abilities, strengthen mastery of difficult concepts, and provide spaced review that supports long-term retention. Recent meta-analyses suggest that AI-personalized systems can improve academic achievement across various subjects (Aljohani, 2023; Ndukwe, Adeoye, & Yusuf, 2024), but evidence specific to Biology is still limited. Even fewer studies have rigorously compared not only immediate achievement but also retention outcomes.

IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

"Effects of AI-Generated Personalized Pathways on Students' Academic Achievement in Biology in Secondary Schools in Ikere Local Government Area, Ekiti State, Nigeria"

Furthermore, while conventional instruction tends to deliver the same content uniformly to all learners, AI-generated personalized pathways allow learners study at their own pace, address misconceptions, and receive personalized feedback. Theoretically, this alignment with cognitive ideologies such as recovery drill and spaced repetition could enhance long-term knowledge retention (Roediger & Butler, 2011). However, the effectiveness of such AI-based personalization in actual Biology classrooms, especially in resource-constrained contexts remains an open question requiring empirical evidence.

Achievement is the result of education when a student, instructor, or organization meets its learning goals. According to Ezeudu (2019), achievement is the result of education that allows a student, teacher, or institution to fulfill their learning objectives. An accomplishment is something that a person has successfully completed, especially by using their own abilities and efforts (Okeke, 2018). The act of obtaining a result through efforts in both the quantity and quality of students' work is known as achievement. In contrast, Bitrus (2014) described academic achievement as a measurement of knowledge acquired during the educational process, as demonstrated by test results, grade point averages, and degrees. For this reason, some schools define it as a certain class ranking or grade point average (GPA). Nwagbo (2017) defined it as students' academic attainment. It can entail getting great grades and a high GPA. By using innovative teaching techniques, such as two metacognitive teaching strategies (problem-solving and collaborative), this high GPA level can be attained. According to Jonassen, Peck, and Wilson (2019), using innovative teaching strategies could help students gain a deeper understanding of a subject like Physics and Biology enhanced achievement. Biology achievement refers to measurable learning outcomes, which are frequently assessed by class quizzes, assignments, continuous evaluations, and standardized examinations such as the West African Senior School Certificate Examination (WASSCE). Reports from the West African Examinations Council (WAEC) have consistently highlighted poor grades in Biology, with examiners attributing this to poor understanding of abstract concepts, rote memorization, and shallow comprehension of key biological principles (WAEC, 2020). In addition, poor retention—the capability of students to store, ability to remember, and apply educated information over time—has been identified as a major factor contributing to weak performance. When learners fail to retain essential concepts, they often struggle with advanced topics, which lead to declining academic performance and lack of interest in the subject (Eze & Aroh, 2020).

Gender is a cultural construct that defines suitable behaviors, attitudes, and values for each sex (Kalusi, 2019). According to Lee (2011), gender is an assigned feature that distinguishes masculine and feminine individuals from masculine social conduct. According to Offorma (2014), gender is a social construct that applies to both men and women. According to Offorma, gender is imposed by cultural practices, as gender identity is shaped by cultural learning. This means that male and female expectations are influenced by their settings. Gender refers to the classification of substance into sexes. Some authors, like Kalusi (2010), confounded gender and sex, while others, like Robert (2017), differentiated between them. The author claims that sex is an innate physiological condition that determines a person's gender. Oraifo (2010) asserts that gender is a cultural understanding of what defines masculinity and femininity in a culture, while sex is based on biological and physical variations between males and females.

IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

"Effects of AI-Generated Personalized Pathways on Students' Academic Achievement in Biology in Secondary Schools in Ikere Local Government Area, Ekiti State, Nigeria"

Several factors contribute to the challenges of low achievement in Biology. These include teacher-centered instructional strategies, overcrowded classrooms, limited access to instructional resources, and lack of individualized attention to students' learning needs (Adeyemo, 2019). Traditional approaches often emphasize uniform instruction, where all learners are taught in the same way, regardless of their differences in learning styles, pace, and prior knowledge. Consequently, fast learners may become disengaged due to lack of challenge, while slow learners struggle to cope, leading to gaps in understanding.

To address these issues, scholars and education stakeholders have pushed for learner-centered and technology-driven instructional approaches that can better support diverse learning needs. One promising innovation is the use of Artificial Intelligence (AI)-generated personalized pathways. AI-based personalized learning systems adapt instructional content, sequence and provide feedback based on the learner's pace, skills, and deficiencies. Real-time data analysis identifies student struggles and provides targeted activities or resources to improve comprehension and memory (Holmes, Bialik, &Fadel, 2022; Zawacki-Richter, Marín, Bond, & Gouverneur, 2019).

Studies have shown that personalized learning pathways not only enhance students' understanding of difficult concepts but also foster active engagement, self-paced learning, and deeper cognitive processing—all of which are critical for retention (Siemens & Long, 2021). In Biology, where many topics are abstract and require visualizations, simulations, and repeated practice, AI-powered personalized learning can provide interactive models and adaptive revision strategies that strengthen memory retention and application of knowledge.

Given the persistent underachievement in Biology and the need for sustainable solutions, it becomes imperative to explore the impact of AI-generated personalized pathways on the achievement and retention of students in Biology. This research work is anchored on conviction that integrating adaptive learning technologies into Biology instruction can provide individualized support to learners, improve performance outcomes, and address the long-standing challenges of poor achievement.

Despite Biology's importance in science education, achievement and retention rates of students remain poor. Research has attributed these challenges to abstract concepts, teacher-centered methods, and limited opportunities for individualized learning and feedback. Many students perform well on immediate post-instruction tests but fail to retain knowledge when assessed after a delay, highlighting weaknesses in conventional teaching strategies.

Therefore, this study explored the effects of AI-generated personalized pathways on students' academic achievement and retention in Biology in secondary schools in Ikere Local Government Area, Ekiti State. The study aims to examine:

i. the difference in pre-test and post-test mean scores of Biology students taught utilizing AI-generated personalized pathways.
ii. the difference in mean achievement scores of students taught Biology utilizing AI-generated personalized pathways and Conventional method.

Research Questions

The following research questions were raised to guide the study:

1. Is there difference between the academic achievement of students taught Biology concepts using AI-generated personalized pathways strategy and those taught using conventional teaching method?

IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

"Effects of AI-Generated Personalized Pathways on Students' Academic Achievement in Biology in Secondary Schools in Ikere Local Government Area, Ekiti State, Nigeria"

2. Is there difference between the achievement of male and female students taught Biology concepts using AI-generated personalized pathways?

Research Hypotheses

The following null hypotheses were formulated for the study.

1. There is no significant difference in the mean academic achievement scores of students taught Biology concepts using AI-generated personalized pathways in pre-test and posttest.
2. There is no significant difference in the mean academic achievement scores of male and female students taught Biology concepts using AI-generated personalized pathways.

Methodology

The study used a quasi-experimental design, with pre-test and post-test control groups. This design examines the impact of AI-generated individualized learning pathways on students' academic achievement in Biology, with intact classes serving as both experimental and control groups. This technique preserves the natural classroom setting while minimizing disturbances to typical educational activities.

The study targeted all Senior Secondary School II (SS II) students offering Biology in public secondary schools in Ikere Local Government Area, Ekiti State. SS II students were chosen because they occupy an intermediate level in the secondary school program and are actively engaged in essential Biology concepts that align with the focus of this study. Ninety SS II students from four intact classes in four secondary schools in the study area that were purposefully chosen made up the sample. Schools with basic ICT infrastructure and a willingness to participate in the study were chosen through the use of purposive sampling techniques. After that, the intact classes in the chosen schools were divided into the experimental and control groups at random. AI-generated tailored learning pathways were used to train the experimental group, whereas conventional method was used to teach the control group. By using intact classes, possible disruptions to school routines were minimized and regular classroom interactions were preserved. The Biology Achievement Test (BAT) is a 20-item multiple-choice test based on SS II Biology curriculum topic such as cell. This instrument measured students' academic achievement in Biology.

The researchers developed the instrument in accordance with the table of specification to guarantee that the curriculum was well covered. The Biology Achievement Test (BAT) was validated by three experts: two in Science Education (Biology) and one in Measurement and Evaluation. Their suggestions were used to improve the instruments. The Biology Achievement Test (BAT) reliability was established through a pilot test on 30 students in a school that was not part of the main sample. The Kuder-Richardson Formula 20 (KR-20) was used to assess the internal consistency of the instrument. A reliability coefficient of 0.70 was judged satisfactory and acceptable. The Biology Achievement Test (BAT) was given to both experimental and control groups to create a knowledge baseline before the treatment. The experimental group was subjected to AI-generated personalized learning pathways for six weeks. Lessons were adapted to individual learning needs, pace, and preferences through the AI system. The control group received the same Biology instruction using the conventional

IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

method. After the treatment, the BAT was re-administered to measure academic achievement. Descriptive and inferential statistics were used to analyze the data.

Descriptive statistic of mean and standard deviation were used to answer the research questions raised; research hypotheses were tested using the independent sample t-test and linear regression model. All hypotheses were tested at the 0.05 level of significance.

Results

Descriptive Analysis

Research Question 1:

Is there difference between the academic achievements of students taught Biology concepts using AI-generated personalized pathways strategy and those taught using conventional teaching method?

Table 1: Responses to the difference between the academic achievements of students taught Biology concepts using AI-generated personalized pathways strategy and those taught using conventional teaching method

Method	No (%)	Mean	SD
AI-generated Personalized pathways strategy	45 (50.0)	19.31	3.479
Conventional Method	45 (50.0)	19.06	3.148

The mean and standard deviation of the mean achievement scores of students taught biology concepts using both conventional method and the AI-generated Personalized Pathways strategy were shown in Table 1. Students that were taught using the AI-generated Personalized Pathways technique had a mean score of 19.31 and a standard deviation of 3.479. Additionally, students who were taught using the conventional method had a mean score of 19.06 and a standard deviation of 3.148. This demonstrated unequivocally that the two groups' mean difference was 0.25. This suggests that the average mean achievement of students in the experimental group was higher than that of students in the conventional group. Hence, there was difference between the academic achievement of students taught Biology concepts using AI-generated Personalized pathways strategy and those taught using conventional teaching method in favour of those taught with AI-generated Personalized pathways strategy.

Research Question 2

Is there difference between the achievement of male and female students taught Biology using AI-generated personalized pathways?

IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

"Effects of AI-Generated Personalized Pathways on Students' Academic Achievement in Biology in Secondary Schools in Ikere Local Government Area, Ekiti State, Nigeria"

Table 2: Responses to the difference between the achievement of male and female students taught Biology using AI-generated personalized pathways

Gender	No (%)	Mean	SD
Male	25 (55.6)	18.10	5.315
Female	20 (44.4)	18.74	6.789

Table 2 shows the mean and standard deviation of achievement scores for male and female Biology students taught by AI-generated personalized pathways. It was discovered that the mean score of male students taught using AI-generated Personalized pathways is (18.10), with a standard deviation of 5.315. Also, the mean achievement score of female students taught utilizing AI-generated Personalized pathways is (18.74) with a standard deviation of (6.789). This clearly demonstrated that the mean difference between the two groups was 0.64. This means that the average achievement of male students in the experimental group was slightly lower than the average mean achievement of female students in the same group. Hence, male and female students who were taught Biology concepts via AI-generated personalized pathways performed differently, favoring female students.

Testing of Hypotheses

Hypothesis 1
There is no significant difference in the mean academic achievement scores of students taught Biology concepts using AI-generated Personalized pathways in pre-test and posttest.

Table 3: t-test analysis of difference in the mean academic achievement scores of students taught Biology concepts using AI-generated Personalized pathways and conventional methods in the pre-test

Method	N (%)	Mean	SD	Df	$t_{(cal)}$	$t_{(tab)}$	Decision
AI-generated personalized pathway	45 (50.0)	10.31	3.769	88	0.274	1.96	NS
Conventional	45 (50.0)	11.06	3.888				

P<0.05 level of significance **NS = Not Significant**

Table 3 showed the mean score of respondents who were taught Biology concepts using AI-generated personalized pathways is (10.31) is lower than the mean score of the respondents taught Biology using conventional method. There was a mean difference of 0.75 between respondents who were taught Biology concepts using the conventional method (11.06). The standard deviation shows a difference of 0.129. The t-test analysis reveals that the computed value (0.274) is less than the table value (1.96), at the 0.05 level of significance. There is no

IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

significant difference in the mean pre-test scores. Biology students are taught using AI-generated personalized pathways and conventional method.
Hence, the null hypothesis is upheld. This implies that there was no difference in the previous knowledge of the respondents taught using AI-generated Personalized pathways and conventional method on the areas of Biology where they were tested.

Table 4: t-test analysis of difference in the mean academic achievement scores of students taught Biology using AI-generated Personalized pathways and conventional methods in the post-test

Method	No (%)	Mean	SD	Df	$t_{(cal)}$	$t_{(tab)}$	Decision
AI-generated pathway	45 (50.0)	19.31	3.479	88	2.555	1.96	S
Conventional	45 (50.0)	19.06	3.148				

P<0.05 level of significance **S = Significant**

Table 4 showed that respondents taught using AI-generated Personalized pathways had a higher mean academic achievement score (19.31) when compared with those taught conventionally (19.06), with a mean difference of 0.25. The standard deviation shows a difference of (0.331). The t-test analysis indicates that the calculated value (2.555) exceeds the table value (1.96) at the 0.05 level of significance.

Hypothesis 2
There is no significant difference in the mean academic achievement scores of male and female students taught Biology concepts using AI-generated personalized pathways.

Table 5: t-test analysis of difference in the mean academic achievement scores of male and female students taught Biology concepts using AI-generated personalized pathways.

Gender	N	Mean	SD	df	$t_{(cal)}$	$t_{(tab)}$	Decision
Male	50 (55.6)	18.10	5.315	88	2.017	1.96	S
Female	40 (44.4)	18.74	6.789				

P<0.05 level of significance **S = Significant**

Table 5 showed that the mean academic success scores of male respondents (18.10) are lower than those of female respondents (18.74), with a mean difference of (0.64). The measure of variability (standard deviation) differs by (1.474). The t-test analysis indicates that the calculated value (2.017) exceeds the table value (1.96) at the 0.05 level of significance. There is a considerable difference in average academic accomplishment scores between male and

IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

female Biology students taught by AI-generated personalized pathways. Female students outperformed male students when exposed to AI-generated personalized pathways, as evidenced by their better average academic accomplishment. Hence, the null hypothesis is not upheld. This suggests a large variation in average academic achievement.

Discussion of Findings

The study's descriptive analysis revealed homogeneity across the student groups instructed utilizing both conventional method and AI-generated personalized pathways during the pre-test phase. It was discovered that in the post-test phase, students ' performance using AI-generated Personalized pathways outperformed those taught by traditional methods. Additionally, the study found that female students' performance when instructed utilizing AI-generated personalized pathways strategy. It was shown that students in the experimental group had more retentive ability than those in the conventional group in Biology, while those of the male students who were taught using AI-generated personalized pathways were higher.

The study's inferential analysis showed that the mean performance scores of Biology students taught using AI-generated personalized pathways with conventional method. Students in the AI-generated personalized pathways approach group outperformed their counterparts in the conventional group because they had a higher mean score rating than those exposed to the conventional method. This supported the findings of Holmes, Bialik, and Fadel (2019), who discovered that AI-generated Personalized pathways are useful strategy to employ when one wants to improve students' ideas, development, raise their understanding of a certain issue, and promote targeted students' participation and learning through group projects. Additionally, this result corroborated Roediger and Butler's (2011) findings when contrasting conventional education with the AI-generated. They discovered that there was a noticeable difference in the educational process in the personalized pathways classroom. Students in the AI-produced higher achievement scores in the designated areas were observed in the personalized pathways classroom. The AI-created Students in the classroom using the AI-generated personalized pathways had a more positive opinion of the educational process than those receiving traditional instruction. Students in the AI-produced stronger intrinsic motivation, increased interest in the subject, and increased cognitive engagement and involvement were reported in the personalized pathways classroom.

The study also showed that male and female biology students who were taught using AI-generated personalized pathways had significantly different mean performance scores. The fact that female students' mean performance was greater suggests that they fared better than their male counterparts when AI-generated personalized pathways are used. This was in contrast to Offorma's (2014) findings regarding gender imbalance in language, technology, and biology, which showed that men had higher mean scores than women worldwide for all attitudinal variables (anxiety, confidence, and motivation). This result supported the findings of Kalusi (2010), who suggested that some gender-based language researchers have reported that feminist empiricists and liberal feminist critics seem to agree that, in theory, women will produce exactly the same scientific knowledge as men as long as enough rigor is put into scientific inquiry.

IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

"Effects of AI-Generated Personalized Pathways on Students' Academic Achievement in Biology in Secondary Schools in Ikere Local Government Area, Ekiti State, Nigeria"

Conclusion

The results of this study clearly show that students who were exposed to AI-generated Personalized pathways when compared to their counterparts who were exposed to standard technique strategy, AI-generated Personalized pathways performed noticeably better.

Recommendations

The following recommendations were made based on the findings of the study.

1. The AI-generated Personalized Pathways Strategy should be implemented into secondary school Biology instruction since it encourages active learning.
2. To ensure effective delivery in secondary schools, teachers should create lessons that provide equal learning opportunities for both male and female students.
3. Teachers should make adequate use of teaching facilities in order to effectively transfer information when teaching biology.
4. Biology teachers should focus more on the usage of AI-generated personalized pathways strategy for teaching and studying Biology to improve student performance.

References

Adeyemo, S. A. (2019). Factors affecting students' learning outcomes in science subjects in Nigerian secondary schools. *Journal of Science Education, 15(2), 44–57.*

Aljohani, N. (2023). Effects of artificial intelligence–driven personalized learning systems on students 'academic achievement: A meta-analysis. Education and Information Technologies, 28(4), 5123–5145.

Bitrus, T. (2014). Foundations of educational assessment. Kaduna: ABU Press.

Eze, E., &Aroh, C. (2020). Causes of poor performance in Biology among secondary school students. *African Journal of Science Education, 8(2), 23–31.*

Ezeudu, S. A. (2019). Understanding student achievement in Nigerian secondary schools. *Journal of Educational Research, 19(1), 14–22.*

Holmes, W., Bialik, M., &Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign.

Holmes, W., Bialik, M., &Fadel, C. (2022). Artificial intelligence in education: Applications and future directions. Center for Curriculum Redesign.

Jegede, O. J., &Okebukola, P. A. (2022). Cognitive conflict and learning of biology concepts. *Science Education International, 33(2), 102–115.*

Jonassen, D. H., Peck, K. L., & Wilson, B. G. (2019). Learning with technology: A constructivist perspective. Merrill/Prentice Hall.

Kalusi, J. (2010). Gender roles and socio-cultural expectations: Implications for education. *Nigerian Journal of Gender Studies, 5(1), 88–101.*

Lee, S. (2011). Gender as a social construct: Understanding societal expectations. *Journal of Social Psychology, 147(2), 134–150.*

Ndukwe, I. G., Adeoye, F. A., & Yusuf, T. (2024). Artificial intelligence–

IJO - INTERNATIONAL JOURNAL OF EDUCATIONAL RESEARCH

(ISSN: 2805-413X) Oludare Jethro OLOJO1 (Ph.D.) *

https://ijojournals.com/ Volume 09 || Issue 05 || May, 2026 ||

personalized learning systems and student performance: A systematic review. *Journal of Digital Learning, 7(1), 16–29.*

Nwagbo, C. (2017). Student academic achievement and classroom instruction: A conceptual review. *Nigerian Journal of Curriculum Studies, 4(2), 55–63.*

Offorma, G. C. (2014). Gender and education: Re-examining stereotypes and classroom practices. *Journal of Curriculum and Instruction, 8(3), 120–132.*

Okeke, O. C. (2018). Understanding achievement in the Nigerian school system. Educational Insights Quarterly, 10(3), 45–54.

Pane, J. D., Steiner, E. D., Baird, M. D., Hamilton, L. S., & Pane, J. (2017). Informing progress: Insights on personalized learning implementation and effects. RAND Corporation.

Roediger, H. L., & Butler, A. C. (2011).The critical role of retrievalpractice in long-term retention. Trends in Cognitive Sciences, 15(1), 20–27.

Russell, S. J., &Norvig, P. (2021). Artificial intelligence: A modern approach (4th ed.). Pearson.

Siemens, G., & Long, P. (2021). Learning analytics and the future of personalized learning. *Educause Review, 56(2), 22–39.*

WAEC. (2020). Chief examiners' report on the West African Senior School Certificate Examination (WASSCE).West African Examinations Council.

Zawacki-Richter, O., Marín, V. I., Bond, M., &Gouverneur, F. (2019). Systematic review of research on artificial intelligence in education. International *Journal of Educational Technology in Higher Education, 16(1), 1–27.*