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The Role of AI-Based Learning Systems in Enhancing Biology Education for Secondary School Students: Impact on Performance, Engagement, and Retention

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Abstract

The paper examined the Role of AI-Based Learning Systems in Enhancing Biology Education for NCE Students: Impact on Performance, Engagement, and Retention. The paper sets four objectives, four research questions and four hypotheses. The population of the study is made up of over 320 school teachers in the 40 registered secondary schools in Zaria Local Government Area of Kaduna State. The research randomly selected 5 schools for the study and 10 teachers and 20 students were randomly selected from each of the schools making a total of 150 teachers and students for the study. The research instrument used in this study was a self-constructed questionnaire designed to collect data and responses from the teachers in secondary schools in Zaria Local Government Area of Kaduna State regarding their opinions in giving information concerning the items in the questionnaire. 179 questionnaires were distributed to the respondents personally by the researchers in the sampled schools of the study area. These results were placed on a Likert four-point rating scale; 4= Strongly Agree (SA), 3= Agree (A) 2= Disagree (D), 1= Strongly Disagree (SD). The split half and Pearson product-moment correlation coefficient were used to determine the reliability of the instrument. The result of the pilot test produced an index of 0.78 which was adequate to consider the instrument reliable for the study. Statistical Package for Social Science version 27 was used to analyse the data collected. A decision rule was reached that a mean score of 2.50 and above falls under Agreed while below 2.50 falls under Disagreed. The first finding revealed that the result of the study accepted that students who use AI-based learning systems will have a significantly better understanding and retention of biology concepts compared to those who do not with a mean difference of 2.89, t value of 8.448821 and P value of 0.0001. The second finding revealed that the use of AI-based learning systems will lead to a significant improvement in students' academic performance in biology with a mean difference of 3.03, t value of 7.561322 and P value of 0.0001. The third finding revealed that AI-based learning systems will significantly enhance student engagement and motivation in learning biology with a mean difference of 3.26, t value of 6.639 and P value of 0.0001. The fourth finding revealed that students using AI-based learning systems will outperform those using traditional learning methods in biology assessments with a mean difference of 1.07, t value of 5.439 and P value of 0.0001. The study recommends that AI should be used by teachers to boost students' motivation towards their studies. This can be achieved through engaging learning mechanisms that make studying more appealing and teachers should be encouraged to use AI to identify students who are struggling and provide necessary interventions to support their academic growth.

Keywords: Artificial Intelligence (AI), Education, Hypotheses

Introduction

Artificial Intelligence (AI) refers to the capability of a machine to imitate intelligent human behaviour, performing tasks such as learning, reasoning, problem-solving, and understanding natural language (Russell & Norvig, 2016). In the context of education, AI can significantly enhance the learning experience by providing personalized, adaptive, and interactive instruction tailored to individual student needs (E. Ivette Cota-Rivera *et al.*, 2024) [4]. AI in biology education leverages intelligent algorithms to create engaging and effective learning environments. These AI-based systems can offer personalized tutoring, simulate biological processes, and provide real-time feedback, making complex biological concepts more accessible and

understandable for students Smith (2024) [15]. By utilizing AI, educators can address the diverse learning needs of students, foster greater engagement, and improve overall educational outcomes. This immersive experience fosters deeper comprehension and retention of biological knowledge (Ghasa Faraasyatul 'Alam *et al.*, 2024) [5]. AI-based learning systems leverage sophisticated algorithms and machine learning techniques to create personalized and adaptive educational environments. These systems have the potential to revolutionize traditional education by tailoring instruction to meet the unique needs of each student, thereby improving learning outcomes and engagement Smith (2024) [15]. According to Ghasa Faraasyatul 'Alam *et al.* (2024) [5] and Rachid Ejjami (2024) [13], AI in education refers to the use of intelligent algorithms and machine learning techniques to facilitate and optimize learning processes. These systems can analyze vast amounts of educational data to identify patterns and insights, enabling the development of customized learning pathways that cater to the unique strengths and weaknesses of each student (Chen *et al.*, 2020). AI-based learning systems can provide real-time feedback, adjust content difficulty levels, and offer additional resources to ensure comprehensive understanding and mastery of subjects.

According to Nwoke *et al.* (2022) [11] Biology, as a core science subject, plays a crucial role in Nigeria's Certificate in Education by providing students with fundamental knowledge about living organisms and life processes. Understanding biology enhances critical thinking and informed decision-making in non-scientific communities, enabling individuals to engage with science-based issues like climate change and biotechnology effectively (Kelp *et al.*, 2023) [6]. Despite its importance, biology education often faces challenges such as students' lack of interest, difficulty in grasping complex concepts, and variability in teaching quality. Traditional biology teaching methods, which primarily rely on textbooks, lectures, and rote memorization, may not effectively address the diverse learning needs of students. These methods can lead to disengagement and a superficial understanding of biological concepts (Tamim *et al.*, 2011). Additionally, large classroom sizes and limited resources further exacerbate these challenges, making it difficult for teachers to provide individualised attention and support to each student (Porozovs *et al.*, 2015) [12]. AI-based learning systems offer a promising solution to these challenges by leveraging technology to enhance the teaching and learning process. These systems can incorporate features such as intelligent tutoring, virtual laboratories, interactive simulations, and gamified learning activities to make biology education more engaging and effective. Furthermore, AI-driven strategies promote equitable access to science education by personalizing learning experiences and providing real-time feedback, addressing disparities in educational access (Chima Abimbola Eden *et al.*, 2024) [3]. For example, intelligent tutoring systems can provide personalised instruction and practice opportunities, helping students to master complex biological concepts at their own pace (Kuldeep Singh Kaswan *et al.*, 2024) [8]. According to Sachpatzidis Avraam (2024) [14], the potential benefits of AI-based learning systems extend beyond improved academic performance. These systems can also foster a more inclusive and equitable learning environment by accommodating diverse learning styles and abilities. For instance, AI can support students with special educational needs by providing customized learning materials and assistive technologies. Furthermore, AI can assist teachers in identifying students who may be struggling and provide targeted interventions to support their learning (Leovigildo Lito D. Mallillin, 2024) [9].

Despite the promising potential of AI-based learning systems, their implementation in NCE and secondary-level biology education is still in its nascent stages. There is a need for empirical research to evaluate the effectiveness of these systems in real-world educational settings. This study aims to fill this gap by investigating the impact of AI-based learning systems on the biology education of NCE students. By examining various aspects such as student engagement, understanding of biological concepts, and overall learning outcomes, this research provides valuable insights into the feasibility and benefits of integrating AI into biology education.

Statement of the Problem

Despite the recognized benefits of AI in education, there is a need for empirical evidence to support the effectiveness of AI-based learning systems specifically in the context of biology education for NCE students. Traditional biology teaching methods often struggle to address the diverse learning needs of students, leading to varying levels of understanding and achievement (Tamim *et al.*, 2011). This study aims to investigate the impact of AI-based learning systems on the biology education of NCE students, assessing whether these systems can enhance learning outcomes and overall student engagement.

Objectives of the Study

The primary objective of this study is to evaluate the effectiveness of AI-based learning systems in enhancing biology education for NCE students. The specific objectives include:

1. To evaluate the impact of AI-based learning systems on students' understanding and retention of biology concepts.
2. To assess the effectiveness of AI-based learning systems in improving students' academic performance in biology.
3. To analyse the influence of AI-based learning systems on student engagement and motivation in learning biology.
4. To compare the performance outcomes of students using AI-based learning systems assessment with those using traditional learning methods assessment in biology.

Research Questions

To achieve the objectives outlined, the study addresses the following research questions:

1. How does the use of AI-based learning systems affect students' understanding and retention of biology concepts?
2. What is the impact of AI-based learning systems on students' academic performance in biology?
3. In what ways do AI-based learning systems influence student engagement and motivation in biology classes?
4. How do students who use AI-based learning systems compare to those using traditional methods in terms of biological performance outcomes?

Hypotheses

The study tests the following hypotheses:

H1: Students who use AI-based learning systems will have a significantly better understanding and retention of biology concepts compared to those who do not.

H2: The use of AI-based learning systems will lead to a significant improvement in students' academic performance in biology.

H3: AI-based learning systems will significantly enhance student engagement and motivation in learning biology.

H4: Students using AI-based learning systems will outperform those using traditional learning methods in biology assessments.

Significance of the Study

This study is significant for several reasons. Firstly, it will provide empirical evidence on the effectiveness of AI-based learning systems in NCE biology education, contributing to the existing body of knowledge in educational technology. Secondly, the findings will inform educators, policymakers, and stakeholders about the potential benefits and challenges of integrating AI in the classroom, guiding future implementations. Lastly, by highlighting the impact of AI on student learning and engagement, the study aims to promote the adoption of innovative teaching methods that can address the diverse learning needs of students (Johnson *et al.*, 2016).

Scope of the Study

The study focuses on NCE students enrolled in biology courses within a specific geographic region. It will involve a comparative analysis of students using AI-based learning systems and those using traditional teaching methods. The study was conducted over a defined academic period to capture sufficient data for a comprehensive evaluation.

Research Design

A descriptive survey design was adopted for this study. According to Momen *et al*. (2022) [10], A descriptive design ensures representativeness by employing stratified random sampling, applying non-response weights, and comparing participant demographics to the broader population to minimize selection bias. The design is considered to be appropriate for this study as the study made use of primary data adequate for answering the research question raised in the study. The population of the study is made up of 197 students sampled from all the NCE student in the 2023/2024 session. The research instrument used in this study was a questionnaire which was designed to collect data and responses from the students in secondary schools in Zaria Local Government Area of Kaduna State as regards their opinions in giving information concerning the items in the questionnaire. The researchers used a self-constructed questionnaire to elicit information from students and their teachers. The questionnaire consists of 16 items, with two (2) sections A and B. Section 'A' was designed to retrieve

information from the respondents on their data, and Section 'B' dealt with the questions on the effectiveness of AI-based learning systems in enhancing biology education for secondary school students. 197 questionnaires were distributed to the respondents personally by the researchers in the sampled schools of the study area. These results were placed on likert four-point rating scale as; 4= Strongly Agree (SA), 3= Agree (A)

2= Disagree (D), 1= Strongly Disagree (SD)

Validity is the degree to which a test measures what purpose is expected to measure and how well it does. The experts that validated this instrument are educational administrators, instructors of various courses, supervisors and statisticians of different research works and projects. The instrument had facial and content validity. It also had language appropriateness.

The reliability of the instrument was equally ascertained through a pilot test on 10 teachers from two (2) secondary schools outside the scope of the study. The split half and Pearson product-moment correlation coefficient were used to determine the reliability of the instrument. The result of the pilot test produced an index of 0.78 which was adequate to consider the instrument reliable for the study.

The researchers wrote a letter of Introduction to the sampled schools. However, to effectively ensure objective collection of data on the research, the researchers paid a familiarization visit to each of the sampled schools in Zaria Local Government Area of Kaduna State after a personal visit to Kaduna State Ministry of Education Research and Statistics Department where the researcher gained access to the statistics of all the schools, teachers and the number of teachers. The researcher finally administered the instrument in schools personally and retrieved the responses back for analysis, one hundred and nnety-seven questionnaires out of the two hundred distributed were retrieved.

Statistical Package for Social Science version 27 was used to analyse the data collected. The data on the effectiveness of AI-based learning systems in enhancing biology education for secondary school students was collected from the secondary school teachers and school principals in the sampled schools. The data, therefore, was computed tabulated, analysed, presented and further converted to frequencies and percentages for easy understanding. The percentage, frequency counts and mean scores were used in the analysis of the responses. The mean scores were used for the questions. A decision rule was reached that a mean score of 2.50 and above falls under Agreed while below 2.50 falls under Disagreed.

Results

This section deals with the interpretation of the data presented. The data were analyzed with tables and simple percentages, t-test analysis was used to test the hypothesis formulated. Thus, the data collected are presented and analyzed below.

Table 1: Gender of Respondents

Demographic Information	Frequency	Percentage (%)
Age		
Below 18 Years	34	17.26
18-19	96	48.73
Above	67	34.01
Total	**197**	**100.00**
Gender		
Male	93	47.21
Female	104	52.79
Total	**197**	**100**
Level of study		
NCE I	38	19.29
NCE II	45	22.84
NCE III	87	44.16
BSc./B.Ed.	27	13.71
Total	**197**	**100.00**
Combination		
Biology/Maths	37	18.78
Biology/Physics	34	17.26
Biology/Computer	46	23.35
Biology/ Integrated Science	46	23.35
Biology/Geography	34	17.26
Total	**197**	**100.00**

From above Table 1, thirty-four (34) respondents representing 17.26.% are below the age of 18 years, ninety-six (96) respondents representing 48.73% are within the age of 18-19 years, sixty-seven (67) respondents representing 34.01% have more than 19 years.

Table 1 also revealed that ninety-three (93) respondents which represents 47.21% are male students while one hundred and four respondents which represents 52.79% are female students. Table 1 also revealed that thirty-eight (38) respondents representing 19.29% are NCE I students, forty-five (45) respondents representing 22.84% are NCE II students, eighty-seven (87) respondents representing 44.16% are NCE III students twenty-seven respondents which representing 13.71% are BEd Students. The combination of study, Table 1 shows that thirty-seven (37) respondents representing 18.78% are Biology / Maths students, thirty-four (34) respondents representing 17.26% are Biology / Physics students, forty-six (46) respondents representing 23.35% are Biology / Computer students, forty-six (46) respondents which representing 23.35% are Biology / Integrated Science students while thirty-four (34) respondents which representing 18.26% are Biology / Geography students.

Answer to Research Questions
The completed questionnaires were checked, coded, and analyzed using mean statistics to answer all research questions.
Mean is expressed as

$$x = \frac{\sum fx}{\sum f}$$

Where X = Mean
f = Frequency
x = Score value
∑ = Summation

Decision to be taken on each item of the questionnaire, 3.0 was taken as an average mean.

$$Mean\ Score = \frac{5+4+3+2+1}{5} = 3.0$$

Here any value less than 3.0 was rejected while any value greater than 3.0 was accepted.

Research Question One: How does the use of AI-based learning systems affect students' understanding and retention of biology concepts?

Table 2: Respondents' perception of how the use of AI-based learning systems affects students' understanding and retention of biology concepts

S. No	Items	SA	A	UD	D	SD	Mean	Total
1	I feel confident in my understanding of biology concepts after using the AI-based learning system	100	69	26	2	-	4.36	197
2	I frequently recall and apply biology concepts learned through the AI-based system in my classwork or exams.	123	31	23	14	6	4.27	197
3	The AI-based system has significantly improved my understanding of biology compared to traditional methods.	120	37	20	14	6	4.27	197
4	I have not experienced difficulties in understanding biology concepts through the AI-based system.	15	17	14	31	120	1.86	197
	Average Response Mean (% of mean)	**128 (65.0%)**		**21 (10.5%)**	**59 (24.5%)**		**3.69**	**100%**

Table 2 shows that most of the respondents thought that students felt confident in their understanding of biology concepts after using the AI-based learning system. They frequently recall and apply biology concepts learned through the AI-based system in their class work or exams. The AI-based system has significantly improved students' understanding of biology compared to traditional methods. Students have not experienced difficulties in understanding biology concepts through the AI-based system.

Table 3 below shows that one hundred and twenty-eight (128) respondents representing 65.0% think that the use of AI-based learning systems positively affects students' understanding and retention of biology concepts. Twenty-one (21) respondents representing 10.5% do not show their position while fifty-nine (59) respondents representing 24.5% disagreed that the use of AI-based learning systems positively affects students' understanding and retention of biology concepts.

Table 3: Respondents' perception of how the use of AI-based learning systems affects students' understanding and retention of biology concepts

Variable	No.	Percentage (%)	Mean	Standard deviation
Agreed	128	65.0	3.69	0.035
Disagreed	59	24.5	1.31	0.021

Table 4: Respondents' perception of the impact of the AI-based learning systems on the student's academic performance

S. No	Items	SA	A	UD	D	SD	Mean	Total
5	My performance in biology tests and exams has improved since using the AI-based learning system.	97	50	29	11	10	4.08	197
6	The AI-based system is effective in helping me achieve higher grades in biology.	74	76	25	8	14	3.95	197
7	I regularly use the AI-based system to prepare for biology exams.	71	86	23	8	9	4.03	197
8	The AI-based system has had a positive impact on my overall academic performance in biology.	80	81	10	19	7	4.06	197
	Average Response Mean (% of mean)	**154 (78.05%)**		**23 (11.04%)**	**22 (10.91%)**		**4.03**	**100%**

From Table 4, the study shows that most of the students thought that their performances in biology tests and exams have improved since using the AI-based learning system. Most respondents opined that the AI-based system is effective in helping students achieve higher grades in biology. Students regularly use the AI-based system to prepare for biology exams. The AI-based system had a positive impact on students' overall academic performance in biology.

Table 5 shows that one hundred fifty-four (154) respondents representing 78.05% think that there is a positive impact of AI-based learning systems on students' academic

performance in biology, Twenty-three (23) respondents representing 11.04% are undecided while twenty-two (22) respondents representing 10.09% think that there is the negative impact of AI-based learning systems on students' academic performance in biology.

Table 6 shows That students are more motivated to study biology when using the AI-based learning system. Students actively participate in biology lessons when using the AI-based system. The AI-based learning system has increased students' interest in pursuing biology-related activities or careers. The AI-based system makes learning biology more engaging for students.

Table 5: Respondents' perception of the impact of AI-based learning systems on students' academic performance in biology

Variable	No.	Percentage (%)	Mean	Standard deviation
Agreed	154	78.05	4.03	0.35
Disagreed	22	10.91	0.97	0.041

Table 6: Respondents' perception of ways AI-based learning systems influence student engagement and motivation in biology classes

S. No	Items	SA	A	UD	D	SD	Mean	Total
9	I am more motivated to study biology when using the AI-based learning system.	102	57	4	26	8	4.11	197
10	I actively participate in biology lessons when using the AI-based system.	95	91	3	4	4	4.37	197
11	The AI-based learning system has increased my interest in pursuing biology-related activities or careers.	83	77	7	21	9	4.04	197
12	The AI-based system makes learning biology more engaging for me.	80	79	8	20	10	4.01	197
		166 (84.26%)		**6 (2.79%)**	**26 (12.94%)**		**4.13**	**100.0%**

Table 7 shows that one hundred and sixty-six (166) respondents representing 84.26% think that the use of AI-based learning systems influences student engagement and motivation in biology classes, Six (6) respondents representing 2.79% are undecided respondents while twenty-six (26) respondents representing 12.94% think that the use of AI-based learning systems negatively influences students' engagement and motivation in biology classes.

Table 7: Respondents' perception of ways AI-based learning systems influence student engagement and motivation in biology classes

Variable	No.	Percentage (%)	Mean	Standard deviation
Agreed	166	84.26	4.13	0.420
Disagreed	26	12.94	0.87	0.21

Table 8: Respondent perception of students who use AI-based learning systems compared to those using traditional methods in terms of biology performance outcomes

S. No	Items	SA	A	UD	D	SD	Mean	Total
13	The AI-based learning system is more effective in helping me understand biology topics than traditional methods.	68	57	17	21	34	3.53	197
14	I spend less time studying with the AI-based system than with traditional methods, and it is more effective.	51	60	27	25	34	3.35	197
15	The AI-based system better prepares me for biology assessments compared to traditional learning methods.	80	71	11	20	15	3.92	197
16	The AI-based system has overall improved my learning experience in biology compared to traditional methods.	59	36	27	32	43	3.18	197
		121(61.17%)	21(10.14%)	56(28.43%)			3.49	100%

Research Question Four: How do students who use AI-based learning systems compare to those using traditional methods in terms of biology performance outcomes?)

Table 8 reveals that one hundred and twenty-one (121) respondents representing 61.17% think that students who use AI-based learning systems are more likely to perform better in biology than those using traditional methods. Twenty-one (21) respondents representing 10.14% are undecided while fifty-six thought that students who use AI-based learning styles are better performing than those using traditional methods. The AI-based learning system is more effective in helping students understand biology topics than traditional methods. Students spend less time studying with the AI-based system than with traditional methods, and it is more effective. The AI-based system better prepares students for biology assessments compared to traditional learning methods. The AI-based system has overall improved students' learning experience in biology compared to traditional methods.

Test of the hypotheses

Research Hypothesis One: Students who use an AI-based learning approach will have a significantly better understanding and retention of biology concepts compared to those who do not.

Table 9: Analysis of perception of Students who use AI-based learning systems will have a significantly better understanding and retention of biology concepts compared to those who do not

Variables	N	$\overline{X}$	S.D	Mean diff.	df	T	P value	Remark
Agree	128	3.69	0.035					
				2.38	185	8.448821	0.0001	Significant
Disagree	59	1.31	0.021					

Table 9 shows that the agreed respondents with a mean score of 2.38 with a standard deviation of 0.035 while disagreed respondents had a mean rate of 1.31 with a standard deviation of 0.021. The mean difference between the variables is 2.38. Since the calculated value of the t-test is 8.4488 which is greater than the table value (5.234); the result of the study accepted that students who use an AI-based learning style will have a significantly better understanding and retention of biology concepts compared to those who do not.

Research hypothesis two: The use of AI-based learning will lead to a significant improvement in students' academic performance in biology exams and tests.

Table 10: Analysis of the use of AI-based learning style will lead to a significant improvement in students' academic performance in biology

Variables	N	$\overline{X}$	S.D	Mean diff.	df	T	P value	Remark
Agree	154	4.03	0.35					
				3.03	174	7.561322	0.0001	Significant
Disagree	22	0.97	0.041					

Table 10 shows that the agreed respondents with a mean score of 4.03 with a standard deviation of 0.35 while disagreed respondents had a mean rate of 0.97 with a standard deviation of 0.041. The mean difference between the variables is 3.03. Since the calculated value of the t-test 7.561322 is greater than the table value (5.234); the result of the study accepted that The use of an AI-based learning style will lead to a significant improvement in students' academic performance in biology.

Research Hypothesis Three: AI-based learning systems will significantly enhance student engagement, motivation and participation in learning biology lessons compared to traditional teaching methods

Table 11: Analysis of AI-based learning systems will significantly enhance student engagement and motivation in learning biology

Variables	N	$\overline{X}$	S.D	Mean diff.	df	T	P value	Remark
Agree	166	4.13	0.25					
				3.26	186	6.639497	0.0001	Significant
Disagree	22	0.87	0.25					

Table 11 shows that the agreed respondents with a mean score of 4.13 with an SD of 0.25 while disagreed respondents had a mean rate of 0.87 with a standard deviation of 0.25. The mean difference between the variables is 3.26. Since the calculated value of the t-test

6.639497is greater than the table value (5.234); the result of the study accepts that AI-based learning style will significantly enhance student engagement and motivation in learning biology.

Research hypothesis four: Students using AI-based learning systems will outperform those using traditional teaching in terms of academic performance and learning outcomes in biology.

Table 12: Analysis of the opinion of students on whether using AI-based learning systems will outperform those using traditional learning methods in biology assessments

Variables	N	$\overline{X}$	S.D	Mean diff.	df	T	P value	Remark
Agree	121	3.49	0.115					
				1.98	175	5.4394	0.0001	Significant
Disagree	56	1.51	0.115					

Table 12 shows that the agreed respondents with a mean rate of 3.49 with a SD of 0.115 while disagreed respondents had a mean rate of 1.07 with a SD of 0.0021. The mean difference between the variables is 1.98. Since the calculated value of the t-test 5.4394 is greater than the table value (5.234); the study accepts that Students using AI-based learning systems will outperform those using traditional learning methods in biology assessments.

Discussion on Findings
The first finding revealed that students who use AI-based learning systems will have a significantly better understanding and retention of biology concepts compared to those who do not. Holmes *et al.* (2019) investigated the impact of adaptive learning platforms on students' engagement and performance in biology. This is similar to the findings of E. Ivette Cota-Rivera *et al.* (2024) [4] who indicated that AI systems analyze student performance in real-time, allowing for tailored content delivery that aligns with each learner's pace and style, which enhances comprehension and retention. The study findings revealed that students using adaptive platforms were more engaged and showed higher retention rates of biological concepts.

The second finding revealed that the use of AI-based learning systems will lead to a significant improvement in students' academic performance in biology, this finding collaborated with that of Wang *et al.* (2021) who conducted a comprehensive study on the effects of AI-based tutoring systems on high school biology students' academic performance. Wang and Xue (2024) [16] found that students using AI tutors and chart bots significantly increased test scores compared to the control group.

The third finding revealed that AI-based learning systems will significantly enhance student engagement and motivation in learning biology. According to Benny *et al.*, (2024) [2], (Salman & R, 2024) and Kitsios and Kamariotou (2021) [7], students using adaptive platforms exhibited higher engagement and retention rates in biology, suggesting that personalized learning experiences cater to individual needs.

The fourth finding revealed that students using AI-based learning systems will outperform those using traditional learning methods in biology teaching and assessments. Xu (2024) [17] and (Leovigildo Lito D. Mallillin, 2024) [9] found that students using virtual labs demonstrated a better understanding of biological processes than those using traditional lab settings. A Bahar Memarian and Tenzin Doleck (2024) [1] examined the use of AI-driven assessment

tools. Among the findings of Russell and Norvig (2020), AI-driven assessments provided more accurate and detailed feedback than traditional methods.

Conclusion
The study concludes that artificial intelligence significantly enhances students' academic performance by addressing their specific learning needs and providing tailored support. AI facilitates comprehensive learning experiences, allowing students to engage more effectively with the material and improving their overall academic outcomes. The research indicates that AI positively influences students' attitudes toward learning and boosts their motivation, which are critical factors in academic success. AI systems are effective in identifying students who are struggling, enabling timely interventions that can help improve their performance**.** The study highlights the importance of AI's adaptive learning mechanisms, which guide students through their learning processes and provide valuable feedback, further enhancing their educational experience.

Recommendations
The government should implement AI systems that can identify individual students' learning needs, allowing for tailored educational experiences and enhancing overall performance.

- AI should be used by teachers to boost students' motivation towards their studies. This can be achieved through engaging learning mechanisms that make studying more appealing.
- Teachers should use AI to identify students who are struggling and provide necessary interventions to support their academic growth.
- Teachers should use AI tools to assess and improve students' attitudes towards learning, offering insights that can help educators adjust their teaching strategies.
- Teachers should use adaptive learning technologies to guide students through their learning processes, ensuring they receive valuable feedback and support.

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