

Assessment of AI Driven Virtual Laboratories on Academic Achievement and Interest in Agricultural Science Among Senior Secondary Schools in Oye-Ekiti L.G.A, Ekiti State, Nigeria.

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ABSTRACT

The integration of Artificial Intelligence (AI) into education has created new opportunities for improving teaching and learning, especially in science subjects. This study investigated the assessment of AI-driven virtual laboratories on academic performance and interest in Agricultural Science among senior secondary school students in Oye Local Government Area, Ekiti State, Nigeria. It addressed challenges such as limited laboratory resources, declining interest, and poor academic outcomes in the subject. A descriptive survey design was used. Simple random sampling selected nine public secondary schools, while purposive sampling chose 224 willing students. Data were collected using the AI-Driven Virtual Laboratories and Students' Academic Performance Questionnaire (AVLSAPQ), capturing both quantitative and qualitative responses. Findings showed that AI-driven virtual laboratories significantly improved students' academic performance, understanding of complex concepts, and interest in Agricultural Science. Challenges identified included poor digital infrastructure, limited teacher expertise, unstable internet, and unequal access to AI resources. The study concluded that AI-driven virtual labs can transform Agricultural Science education by enhancing performance and engagement. The study recommended among others, Partnering with ISPs for school Wi-Fi and explore offline AI lab solutions (e.g., local servers), installing solar backups or generators to ensure uninterrupted sessions, aiming for a 1:3 computer-student ratio and leveraging ICT grants for educational institutions

INTRODUCTION

The global educational community has witnessed a substantial shift toward integrating AI technologies into various disciplines, with particular emphasis on STEM subjects such as agricultural science. Agricultural science education is of significant importance to the socioeconomic development of nations, as it equips students with critical knowledge and skills to address food security challenges, environmental sustainability, and rural development (Hossain & Islam, 2020). In Nigeria, a country where agriculture remains a major source of livelihood, fostering interest in agricultural science among students is of paramount importance. Interest in agricultural science has waned in recent decades among young people, particularly in developing countries like Nigeria, where urbanization and modernization have led to a preference for nonagricultural careers (Olowu, 2021). A decline in student interest in the field poses a significant challenge to the development of agricultural education and the agricultural sector at large. Research suggests that students' attitudes toward a subject are strongly correlated with their academic performance and eventual career choice (Isabirye, 2017).

In the case of agricultural science, this issue is compounded by the lack of practical exposure, which remains one of the major barriers to student engagement and interest (Adeyemo, 2018). To counter this, educational stakeholders have increasingly turned to virtual learning tools, including AI driven laboratories, as a potential solution for bridging the gap between theoretical knowledge and practical application in subjects such as agricultural science (Akpan & Usoro, 2020). Academic performance, defined as the measurable extent of a student's learning achievements, is a critical indicator of educational success. In the context of agricultural

science education in senior secondary schools in Oye-Ekiti LGA, Ekiti State, enhancing academic performance is essential for developing skilled individuals capable of contributing to the local agricultural sector. The integration of AI-driven virtual laboratories has been explored as a means to improve academic outcomes. Möller (2024) found that AI-powered teaching assistants reduced study time by 27%, suggesting that AI-driven tools can enhance learning efficiency. Similarly, Boateng, Budu, & Kumbol. (2023), developed "Kwame for Science," an AI teaching assistant that achieved 87.2% top-3 accuracy in answering student questions, highlighting its potential to support science education in West Africa.

In cybersecurity education, Kebande (2024) reported that virtual laboratories improved active learning and engagement, implying that similar tools could enhance agricultural science education. In cybersecurity education, Kebande (2024) reported that virtual laboratories improved active learning and engagement, implying that similar tools could enhance agricultural science education. However, successful implementation in Oye-Ekiti depends on infrastructural factors, as Aralu (2014) found that inadequate information support systems hinder ICT use in Nigerian universities. Therefore, while AI-driven virtual laboratories offer promising academic benefits, addressing infrastructural challenges is crucial for their effective deployment in agricultural science education. Artificial intelligence has become a crucial tool in creating immersive learning environments across various fields, including agricultural education, where it has shown promise, in enhancing students' academic performance and interest in the subject (Cao, 2021).

By integrating AI, virtual laboratories can adapt in real-time to individual students' needs and responses, providing personalized feedback and recommendations based on their performance (Wang & Lee, 2019). This personalized approach not only enhances students' understanding of agricultural science but also fosters a deeper sense of engagement and motivation (Zhang, 2020). However, while the potential benefits of AI driven virtual laboratories are vast, there is still limited research on the specific impact of these technologies on students' academic performance and interest in agricultural science, particularly in developing regions such as Ekiti State, Nigeria (Ololube, Ubogu, & Egbezor, 2019). Most of the existing studies have focused on developed countries, where access to technology and infrastructure is more readily available (Hassan, 2021). Thus, there is a need for empirical studies that assess how AI-driven virtual laboratories can be implemented in the context of senior secondary schools in rural and semiurban settings like Oye Ekiti LGA. Such studies would provide valuable insights into the feasibility and effectiveness of integrating these technologies into the local educational system.

The introduction of AI-driven virtual laboratories in schools within Oye Ekiti Local Government Area presents a unique opportunity to enhance the quality of agricultural science education in the region. Oye Ekiti, like many other rural areas in Nigeria, faces challenges related to limited access to educational resources, including laboratories, textbooks, and experienced teachers. In this context, virtual laboratories offer a cost-effective solution to bridge the resource gap and provide students with opportunities to explore agricultural science in a more engaging and practical manner (Akinboboye, Oladipo, & Adekanbi, 2020). Moreover, the use of AI in these laboratories could help overcome logistical challenges associated with conducting practical agricultural experiments, such as the need for large tracts of land or specific weather conditions (Obi, Adeyemi, & Eze, 2021).

Interest in agricultural science is also influenced by students' perceptions of the subject as being relevant to their future career prospects. Research has shown that when students perceive a subject to be directly linked to their personal aspirations or societal needs, they are more likely to engage with the content and perform better academically (Baba & Adebayo, 2018). AI driven virtual laboratories can play a crucial role in shifting students' perceptions of agricultural science by demonstrating the real-world applications of the subject in innovative and interactive ways. By showcasing the latest advancements in agricultural technology and sustainable farming practices, these virtual platforms can help students see the relevance of agricultural science in addressing global challenges such as climate change, food insecurity, and rural development (Chavez & Johnson, 2020).

The integration of AI driven virtual laboratories in agricultural science education represents a promising approach to enhancing both academic performance and student interest in the subject. By providing students with access to realistic, interactive simulations and personalized learning experiences, these platforms can bridge the gap between theoretical knowledge and practical application. As this study aims to explore, the impact of these technologies on senior secondary school students in Oye Ekiti LGA, it could offer valuable insights into

the potential benefits of AI in agricultural Science as a subject in Nigerian school curriculum. Hence, the need for this study is to examine the effect of AI-driven virtual laboratories on the academic performance and interest in agricultural science among senior secondary school students in Oye Ekiti Local Government Area, Ekiti State.

In recent years, AI virtual laboratories have been explored as a means to enhance students' academic performance in Agricultural Science. Some literature review established this. Adebayo (2024) examined the effect of virtual laboratories on the academic performance of secondary school students in Ogun State, Nigeria. The study found that students who engaged with AI-powered simulations demonstrated better performance in their Agricultural Science practical exams. This improvement was attributed to the hands-on nature of virtual laboratories, which allowed students to interact with agricultural processes that were otherwise difficult to observe in a traditional classroom. They recommended that schools adopt AI virtual laboratories to provide more practical experience, which would, in turn, lead to improved academic results.

Similarly, Bello and Olayinka (2023) conducted a study across various schools in Oyo State to assess the impact of AI virtual laboratories on students' understanding of complex Agricultural Science topics. The study revealed that students who participated in AI-enhanced lessons showed greater comprehension of topics such as crop management and soil science. They argued that AI virtual laboratories offer students the opportunity to practice agricultural techniques in a controlled environment, leading to enhanced academic performance. They concluded that the integration of such technology would help in bridging the gap between theoretical knowledge and practical skills.

AI virtual laboratories have also been shown to significantly enhance student interest in Agricultural Science. Omotosho (2024) explored the impact of AI virtual laboratories on student engagement and interest in Agricultural Science in Lagos State. The study found that students were more excited about the subject when they had the opportunity to engage in AI-driven simulations of agricultural practices. Omotosho concluded that the interactive and immersive nature of AI virtual laboratories helps students develop a deeper interest in Agricultural Science, making learning more enjoyable and stimulating.

In a study by Ajayi and Oladele (2023), the influence of AI virtual laboratories on student interest in Agricultural Science was examined in Ondo State. The results indicated that students who participated in AI-driven lessons expressed greater enthusiasm for the subject, particularly when they could virtually engage in activities like crop planting and livestock management.

Statement of the Problem

Agricultural science education in Nigeria, particularly in rural areas like Oye Ekiti Local Government Area (LGA) in Ekiti State, faces numerous challenges that hinder student engagement and academic performance. Senior secondary schools in these regions often struggle with inadequate resources, including insufficient laboratory facilities, limited access to modern teaching materials, and a shortage of qualified agricultural science teachers. As a result, students are primarily exposed to theoretical content, with minimal opportunities for hands-on learning, which diminishes their interest in the subject and reduces their understanding of real-world agricultural practices. This lack of practical engagement has contributed to a general disinterest in agricultural science, despite its significance to Nigeria's economy and food security.

With the advent of Artificial Intelligence (AI) technologies, there is a growing opportunity to address these challenges through AI-driven virtual laboratories, which offer interactive, immersive learning experiences. These virtual laboratories have the potential to bridge the gap between theoretical learning and practical application by allowing students to simulate agricultural processes, such as crop cultivation, pest management, and soil health, in a virtual setting. AI virtual laboratories have also been shown to significantly enhance student interest in Agricultural Science. Omotosho (2024) explored the impact of AI virtual laboratories on student engagement and interest in Agricultural Science in Lagos State. The study found that students were more excited about the subject when they had the opportunity to engage in AI-driven simulations of agricultural practices. Omotosho concluded that the interactive and immersive nature of AI virtual laboratories helps students develop a deeper interest in Agricultural Science, making learning more enjoyable and stimulating.

In a study by Ajayi and Oladele (2023), the influence of AI virtual laboratories on student interest in Agricultural Science was examined in Ondo State. The results indicated that students who participated in AI-driven lessons expressed greater enthusiasm for the subject, particularly when they could virtually engage in activities like crop planting and livestock management. The researchers highlighted that the practical experience offered by AI virtual laboratories made students more curious and motivated to explore the subject further. They recommended incorporating virtual laboratories into the curriculum to foster sustained student interest in agricultural education.

Similarly, Sulaimon (2025) researched the role of AI virtual laboratories in promoting interest in Agricultural Science among secondary school students in Ogun State. The findings suggested that students who were exposed to AI virtual laboratories showed higher levels of engagement, especially when compared to those taught using traditional methods. Sulaimon noted that the ability to simulate real-life agricultural activities using AI technology captured students' attention, which led to increased participation and interest in the subject. The study concluded that AI virtual laboratories offer an exciting and innovative way to engage students in Agricultural Science.

Ogunleye (2023) investigated the effect of AI virtual laboratories on students' interest in Agricultural Science at secondary schools in Edo State. The research revealed that students were more inclined to pursue further studies in the field of agriculture after interacting with virtual agricultural simulations. He argued that AI virtual laboratories provide a unique opportunity to make agricultural education more relatable and engaging for students, which is crucial for stimulating long-term interest in the subject. The study recommended expanding the use of AI virtual laboratories to inspire more students to consider careers in agriculture.

While AI-driven learning tools have shown promise globally in improving educational outcomes, their impact on agricultural science education in rural Nigerian secondary schools remains underexplored. The lack of empirical studies on the effectiveness of AI technologies in this context makes it difficult to assess whether such innovations can effectively enhance student interest, understanding, and performance in agricultural science.

Therefore, this study seeks to investigate the effect of AI-driven virtual laboratories on students' academic performance and interest in agricultural science in senior secondary schools within Oye Ekiti LGA. It aims to assess whether AI can provide a viable solution to the resource limitations of these schools, engage students in the subject, and ultimately improve their learning outcomes in agricultural science.

Purpose of the Study

The main purpose of the study is to investigate the Assessment of AI-driven virtual laboratories on the academic performance and interest in agricultural science among senior secondary school students in Oye Ekiti LGA, Ekiti State. Specifically, the objectives aim to:

1. Explore the assessment of AI-driven virtual laboratories on the academic performance of senior secondary school students in agricultural science.
2. Examine the influence of AI-driven virtual laboratories on students' interest in agricultural science.

Research Questions

The following research questions were be raised for this study:

1. What is the perceived influence of AI-driven virtual laboratory on students' academic achievement in agricultural science?
2. What is the perceived students' interest in agricultural science when using AI driven virtual laboratory compared to traditional teaching methods

Research Hypotheses

The following hypotheses were formulated for this study

1. There is no significant gender difference in the perceived influence of AI-driven virtual laboratory on students' academic achievement in agricultural science.
2. There is no significant gender difference in the perceived students' interest in agricultural science when using AI driven virtual laboratory compared to traditional teaching methods.

METHODOLOGY

The study employed descriptive survey research design. Since this study sought to obtain information and to describe situation as they occur from the respondents on the impacts of AI-driven virtual laboratories on students' academic performance and interest in Agricultural Science, then this research design is considered to be appropriate for this study. The targeted population of this study are all the public secondary schools in Oye Local Government Area of Ekiti. Simple random sampling technique was used to select nine (9) out of the sixteen (16) public secondary schools in Oye Local Government Area of Ekiti (ekitistate.gov.ng) Purposive sampling technique was used to select students that are willing and enthusiastic to participate in the study. This resulted in a total of two hundred and twenty- four (224) respondents that participated in the study.

A research instrument titled 'AI-Driven Virtual Laboratories and Students' Academic Performance Questionnaire (AVLSAPQ)' was used for the study. The AVLSAPQ was structured to comprehensively assess the impacts of AI-driven virtual laboratories on students' academic performance and interest in Agricultural Science education, it was answered by the students. It was a primary data, because the data was collected directly by the researcher for the study. The questionnaire consisted of six sections, each targeting specific elements relevant to the study. To analyze the responses, a rating scale of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD) were employed, with numerical values assigned for statistical analysis.

The validity of the instrument was ascertained by given copies of the instrument to research experts in the field of agricultural education at Federal University Oye-Ekiti. Based on their feedback and evaluations, the instrument was refined and confirmed to meet both face and content validity requirements.

The instrument was pilot tested at a school outside the sampled schools. The reliability coefficient of the instrument was calculated using Cronbach Alpha's measure and the instrument yielded a reliability index of 0.90. The data obtained were analyzed using descriptive and inferential statistics. Descriptive statistics, such as frequency counts and percentage scores were used to analyzed the research questions, while inferential statistics, such as t-test analysis was used to test the formulated hypotheses at 0.05 level of significance. The justification for using t-test is that t-test is used to determine significant difference between the means of two groups. The means of the male and the female students are being compared on perceived impacts and interest on AI-Diven Virtual laboratory

RESULTS

The findings of this study are presented in table of frequency counts, percentages, mean, standard deviation, skewness and kurtosis according to the order in which the questions and hypotheses were addressed.

Socio-Demographic Attributes of the Respondents

Table 1 Respondents Distribution by Gender and Age

		Frequency	Percent
Students' Gender	Male	120	53.6
	Female	104	46.4

	Total	224	100.0
Students' Age	10-12 Years	40	17.9
	13-15 Years	104	46.4
	16-18 Years	48	21.4
	Above 18 Years	32	14.3
	Total	224	100.0

Table 1 shows that 120 (53.60%) of the respondents were males while 104 (46.40%) were females. 40 (17.90%) of the respondents were between the ages of 10-12 Years, 104 (46.40%) of the respondents were between the ages of 13-15 Years, 48 (21.40%) of the respondents were between the ages of 16-18 Years, while the remaining 32 (14.30%) were above 18 years.

Research Question One: What is the perceived influence of AI-driven virtual laboratory on students' academic achievement in agricultural science?

Table 2 Descriptive statistics of the perceived influence of AI-driven virtual laboratory on students' academic achievement in agricultural science

		Freq.	%	Mean	S.D	Skewness	Kurtosis	Decision
The AI-driven virtual laboratory made it easier for me to understand Agricultural Science topics.	Strongly Disagree	16	7.1	3.29	0.84	-1.31	1.44	Agree
	Disagree	8	3.6					
	Agree	96	42.9					
	Strongly Agree	104	46.4					
	Total	224	100.0					
Using the virtual laboratory improved my academic performance in Agricultural Science.	Strongly Disagree	8	3.6					Agree
	Disagree	8	3.6	3.39	0.73	-1.33	2.11	
	Agree	96	42.9					
	Strongly Agree	112	50.0					
	Total	224	100.0					
There is better performance in practical sessions after	Strongly Disagree	8	3.6	3.43	0.73	-1.42	2.27	Agree
	Disagree	8	3.6					

using the AI virtual laboratory	Agree	88	39.3					
	Strongly Agree	120	53.6					
	Total	224	100.0					
The AI virtual laboratory made it easier to visualize complex agricultural concepts.	Strongly Disagree	8	3.6	3.46	0.73	-1.53	2.49	Strongly Agree
	Disagree	8	3.6					
	Agree	80	35.7					
	Strongly Agree	128	57.1					
	Total	224	100.0					
The lessons from the AI virtual laboratory helped me answer test and exam questions better.	Strongly Disagree	16	7.1	3.29	0.84	-1.31	1.44	Agree
	Disagree	8	3.6					
	Agree	96	42.9					
	Strongly Agree	104	46.4					
	Total	224	100.0					

Table 2 shows that 200 (89.300%) students agreed with the statement that the AI-driven virtual laboratory made it easier for them to understand Agricultural Science topics with mean and standard deviation of 3.29 and 0.84 respectively. 208 (92.90%) students agreed with the statement that using the virtual laboratory improved their academic performance in Agricultural Science with mean and standard deviation of 3.39 and 0.73 respectively. 208 (92.90%) students agreed with the statement that they were able to perform better in practical sessions after using the AI virtual laboratory with mean and standard deviation of 3.43 and 0.73 respectively. 208 (92.90%) students strongly agreed with the statement that the AI virtual laboratory made it easier to visualize complex agricultural concepts with mean and standard deviation of 3.46 and 0.73 respectively. 200 (89.30%) students agreed with the statement that the lessons from the AI virtual laboratory helped them answer test and exam questions better with mean and standard deviation of 3.29 and 0.84 respectively.

Research Question Two: What is the perceived students' interest in agricultural science when using AI driven virtual laboratory compared to traditional teaching methods?

Table 3 Descriptive statistics of the perceived students' interest in agricultural science when using AI driven virtual laboratory compared to traditional teaching methods

		Freq.	%	Mean	S.D	Skewness	Kurtosis	Decision
The AI-driven virtual laboratory makes learning	Strongly Disagree	8	3.6	3.46	0.78	-1.48	1.72	Strongly Agree
	Disagree	16	7.1					

Agricultural Science more interesting	Agree	64	28.6					
	Strongly Agree	136	60.7					
	Total	224	100.0					
Agricultural Science lessons are enjoyed more, when we use virtual laboratories	Strongly Disagree	8	3.6	3.46	0.73	-1.53	2.49	Strongly Agree
	Disagree	8	3.6					
	Agree	80	35.7					
	Strongly Agree	128	57.1					
	Total	224	100.0					
The virtual laboratory increases my curiosity to explore more about agriculture.	Strongly Disagree	8	3.6	3.46	0.78	-1.48	1.72	Strongly Agree
	Disagree	16	7.1					
	Agree	64	28.6					
	Strongly Agree	136	60.7					
	Total	224	100.0					
There is eagerness to attend Agricultural Science classes because of AI virtual laboratory sessions.	Strongly Disagree	8	3.6	3.43	0.78	-1.38	1.51	Agree
	Disagree	16	7.1					
	Agree	72	32.1					
	Strongly Agree	128	57.1					
	Total	224	100.0					
AI virtual laboratories is preferred to be used for other science subjects too.	Strongly Disagree	8	3.6	3.25	0.74	-0.97	1.15	Agree
	Disagree	16	7.1					
	Agree	112	50.0					
	Strongly Agree	88	39.3					
	Total	224	100.0					

Table 3 shows that 200 (89.30%) students strongly agreed with the statement that the AI-driven virtual laboratory makes learning Agricultural Science more interesting with mean and standard deviation of 3.46 and 0.78 respectively. 208 (92.80%) students strongly agreed with the statement that they enjoy Agricultural Science lessons more when they use virtual laboratories with mean and standard deviation of 3.46 and 0.73 respectively. 200 (89.30%) students strongly agreed with the statement that the virtual laboratory increases their curiosity to explore more about agriculture with mean and standard deviation of 3.46 and 0.78 respectively. 200 (89.30%) students agreed with the statement that they look forward to Agricultural Science classes because of AI virtual laboratory sessions with mean and standard deviation of 3.43 and 0.78 respectively. 200 (89.30%) students agreed with the statement that they would like to use AI virtual laboratories for other science subjects too with mean and standard deviation of 3.25 and 0.74 respectively.

Research Question Three: What is the perceived students' engagement and academic performance of agricultural science concepts while using AI driven virtual laboratory?

Table 4 Descriptive statistics of the perceived students' engagement and academic performance of agricultural science concepts while using AI driven virtual laboratory

		Freq.	%	Mean	S.D	Skewness	Kurtosis	Decision
There is frequent participation in AI-driven virtual laboratory sessions.	Strongly Disagree	8	3.6	3.29	0.70	-1.09	1.98	Agree
	Disagree	8	3.6					
	Agree	120	53.6					
	Strongly Agree	88	39.3					
	Total	224	100.0					
The more I engage with AI virtual laboratories, the better my understanding of Agricultural Science.	Strongly Disagree	8	3.6	3.32	0.71	-1.16	1.96	Agree
	Disagree	8	3.6					
	Agree	112	50.0					
	Strongly Agree	96	42.9					
	Total	224	100.0					
My academic performance in Agricultural Science improves after using virtual laboratory activities.	Strongly Disagree	8	3.6	3.21	0.68	-0.99	2.22	Agree
	Disagree	8	3.6					
	Agree	136	60.7					
	Strongly Agree	72	32.1					
	Total	224	100.0					

More questions are asked in class after using AI-driven virtual laboratory sessions.	Strongly Disagree	8	3.6	3.32	0.71	-1.16	1.96	Agree
	Disagree	8	3.6					
	Agree	112	50.0					
	Strongly Agree	96	42.9					
	Total	224	100.0					
There is active participation during practical activities when AI-driven virtual laboratories are used.	Strongly Disagree	8	3.6	3.39	0.73	-1.33	2.11	Agree
	Disagree	8	3.6					
	Agree	96	42.9					
	Strongly Agree	112	50.0					
	Total	224	100.0					

Table 4 shows that 208 (92.90%) students agreed with the statement that they frequently participate in AI-driven virtual laboratory sessions with mean and standard deviation of 3.29 and 0.70 respectively. 208 (92.90%) students agreed with the statement that the more they engage with AI virtual laboratories, the better their understanding of Agricultural Science with mean and standard deviation of 3.32 and 0.71 respectively. 208 (92.80%) students agreed with the statement that their academic performance in Agricultural Science improves after using virtual laboratory activities with mean and standard deviation of 3.21 and 0.68 respectively. 208 (92.80%) students agreed with the statement that they ask more questions in class after using AI-driven virtual laboratory sessions with mean and standard deviation of 3.32 and 0.71 respectively. 208 (92.80%) students agreed with the statement that they actively take part in practical activities when AI-driven virtual laboratories are used with mean and standard deviation of 3.39 and 0.73 respectively.

Testing the Hypotheses

H₀₁: There is a significant gender difference in the perceived impact of AI-driven virtual laboratory on students' academic achievement in agricultural science.

Table 5 T-test analysis of gender difference in the perceived impact of AI-driven virtual laboratory on students' academic achievement in agricultural science

	Gender	N	Mean	SD		t	df	F	Sig.
	Male	120	17.3333	1.96325	Equal var. assumed	4.397	222	38.653	.000
	Female	104	16.3077	1.44193	Equal var. not assumed	4.493	216.386		

(Decision: Significant, $p < 0.05$)

Results in tables 5 shows that there was statistically significant difference ($t_{(1,222)} = 4.397$) in the perceived impact of AI-driven virtual laboratory on students' academic achievement in agricultural science based on gender ($p = 0.000$). The mean and standard deviation values also show statistically significant difference in the perceived impact of AI-driven virtual laboratory on students' academic achievement in agricultural science based on gender. Therefore, we do not accept the null hypothesis that there is no significant gender difference in the perceived impact of AI-driven virtual laboratory on students' academic achievement in agricultural science.

H₀₂: There is a significant gender difference in the perceived students' interest in agricultural science when using AI driven virtual laboratory compared to traditional teaching methods.

Table 6 T-test analysis of gender difference in the perceived students' interest in agricultural science when using AI driven virtual laboratory compared to traditional teaching methods

Gender	N	Mean	SD		t	df	F	Sig.
Male	120	17.0000	1.27021	Equal var. assumed	-.796	222	4.983	.027
Female	104	17.1538	1.61768	Equal var. not assumed	-.783	194.433		

(Decision: Significant, $p < 0.03$)

Results in Table 6 shows that there was statistically significant difference ($t_{(1,222)} = -0.796$) in the perceived students' interest in agricultural science when using AI driven virtual laboratory compared to traditional teaching methods based on gender ($p = 0.027$). The mean and standard deviation values also show statistically significant difference in the perceived students' interest in agricultural science when using AI driven virtual laboratory compared to traditional teaching methods based on gender. Therefore, we do not accept the null hypothesis that there is no significant gender difference in the perceived students' interest in agricultural science when using AI driven virtual laboratory compared to traditional teaching methods.

DISCUSSION OF FINDINGS

The study surveyed **224** Agricultural Science students in Oye-Ekiti LGA. The gender split was nearly even, and ages ranged within the secondary school age. This balanced demographic ensures broad applicability of the findings across typical secondary-school cohorts. The overwhelmingly positive responses on the perceived impact of AI-driven virtual laboratory on students' academic achievement in agricultural science demonstrate that AI-driven virtual laboratories substantially enhance both theoretical comprehension and practical application in Agricultural Science. By simulating experiments-such as soil testing, pest control, and crop growth-students gain repeated, low-risk practice that translates directly into higher test scores and better laboratory proficiency. In the Hypotheses, the mean and standard deviation values also show statistically significant difference in the perceived students' interest in agricultural science when using AI driven virtual laboratory compared to traditional teaching methods based on gender and they also show statistically significant difference in the perceived students' engagement and academic performance of agricultural science concepts while using AI driven virtual laboratory based on gender. These implies rejection of the null Hypotheses.

Moreover, AI-driven virtual laboratories turned otherwise abstract Agricultural Science topics into interactive experiences, boosting intrinsic motivation and transforming students' attitudes from passive recipients to active explorers. The desire to extend these tools to other subjects suggests a generalized uplift in engagement, beyond agriculture. Findings of this study also attested to the transformative power of AI laboratories in fostering a participatory classroom culture-students become co-constructors of knowledge, ask insightful questions, and apply concepts hands-on, reflecting Kolb's experiential learning cycle. While pedagogically effective, AI-driven laboratories depend heavily on infrastructure-reliable internet, stable electricity, and sufficient devices. Technical support and training are necessary to mitigate operational hurdles.

The findings of this study echoes Adebayo (2024) and Bello & Olayinka (2023), who found AI laboratories raise examination scores and conceptual mastery. Aligns with Omotosho (2024) and Ajayi & Oladele (2023), reporting heightened student enthusiasm via AI simulations

Limitations to the Study

This study was limited by inadequate access to AI-driven virtual laboratory facilities, unstable internet connectivity, limited availability of compatible digital devices, and variations in students' digital literacy. The study was also constrained by financial limitations and technical challenges. Other factors such as students' prior knowledge, teacher competence, motivation, and socioeconomic background also influenced the outcomes despite efforts to control these variables.

Suggestions for Further Research

Other studies should:

- Conduct think-aloud protocols and in-depth interviews to explore why some students still struggle conceptually.
- Map digital divides across urban vs. rural and socio-economic strata; test low-bandwidth AI solutions.
- Experiment with blended virtual-fieldwork curricula, combining AI simulations with school farm projects.
- Examine how socioeconomic factors shape access to AI resources and investigate strategies to democratize AI tool use across diverse institutions.

CONCLUSION

The study robustly demonstrates that **AI-driven virtual laboratories** can revolutionize Agricultural Science education in Oye-Ekiti secondary schools, boosting performance, engagement, and motivation, provided that infrastructure and capacity-building challenges are addressed through strategic, collaborative action. The findings of this study will provide evidence on the educational value of AI-driven virtual laboratories in enhancing students' learning outcomes, engagement, and practical competencies. The study may encourage teachers to adopt AI-supported instructional strategies that promote active and personalized learning. It may also guide curriculum developers in integrating AI-based virtual laboratory experiences into science and agricultural science curricula. Furthermore, the findings could assist educational policymakers in making informed decisions regarding investments in digital infrastructure, teacher capacity building, and AI technologies to improve laboratory instruction. Finally, the study will contribute to the growing body of knowledge on artificial intelligence in education and provide a basis for future research on technology-enhanced learning in secondary and tertiary institutions.

RECOMMENDATIONS

With the result of the findings which emanated from the study, the following listed recommendations were made:

The stakeholders in the education industry should:

- i. Partner with Internet Service Providers (ISPs) for school Wi-Fi and explore offline AI lab solutions (e.g., local servers).
- ii. Install solar backups or generators to ensure uninterrupted sessions.
- iii. Aim for a 1:3 computer-student ratio; leverage ICT grants and public-private partnerships.
- iv. Embed AI laboratories into every major unit (e.g., crop science, soil management)..
- v. Establish an "AI in Agricultural Education" fund under Ekiti State's budget.
- vi. Develop regulatory guidelines covering data privacy, content standards, and teacher accreditation

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