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**TEACHERS USE OF AI TOOLS AND ACADEMIC ACHIEVEMENT OF  
CHEMISTRY STUDENTS IN SECONDARY SCHOOL IN OBU DU LOCAL  
GOVERNMENT AREA OF CROSS RIVER STATE**

**BY**

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**Abstract**

*This study sought to investigate the influence of teachers' use of AI and the academic achievement of chemistry students in secondary schools in Obudu Local Government Area of Cross River State. To achieve the purpose of the study, two research questions were raised and two hypotheses were formulated. Survey research design was adopted for the study. The sample of 200 SS II chemistry students was drawn from the entire population of SSII chemistry students in public secondary schools in the study area using proportionate random sampling and simple random sampling techniques. Data collection was carried out with the use of research instruments titled Chemistry Teachers Use of AI Questionnaire (CTUAIQ) and Chemistry Achievement Test (CAT). The instruments were subjected to face validity by experts in Measurement and Evaluation and Chemistry Department respectively. The reliability was computed using the Cronbach alpha reliability coefficient. The reliability coefficient of 0.82*

*was obtained from the instrument. Mean and standard deviation were used to answer the research questions and independent t-test was used for research hypotheses. Based on the result of the study, it was revealed that teachers' use of AI significantly influenced the academic achievement of chemistry students in secondary schools. In conclusion the use of AI tools in Chemistry teaching enhances personalized learning and make students learn at their own pace and receive instant feedback. Based on the findings of the study, it was recommended amongst others that: government should formulate and implement policies that encourage the adoption of artificial intelligence tools in secondary school chemistry education and also organize regular training workshops, seminars, and certification programmes to equip teachers with the necessary skills to effectively use intelligent tutoring systems*

**Keywords:** Teachers' Use of Artificial Intelligence Tools, Virtual Laboratories and Adaptive Learning Technologies.

## Introduction

In recent years, the integration of Artificial Intelligence (AI) tools into education has become an innovative approach to improving teaching and learning processes. Academic achievement in secondary schools has continued to be a major focus of education stakeholders, as it is a key measure of the effectiveness of teaching and learning. Secondary education serves as the transitional stage between primary education and tertiary institutions, and the level of achievement at this stage often determines students' future academic and career opportunities. Good academic performance in secondary school lays the foundation for further learning, while poor performance can limit access to higher education and reduce students' chances of contributing meaningfully to national development (Ajayi, 2018).

A teacher is a trained professional who facilitates learning by imparting knowledge, developing skills, and fostering attitudes and values in learners through planned instruction and guidance (Hattie, 2009). In modern education, a teacher is also seen as a facilitator and mentor who supports students in constructing knowledge and achieving their full potential (Darling-Hammond, 2017). In the 21st century, the role of teachers has expanded to include collaboration, innovation, and lifelong learning. Teachers are expected to engage in reflective practice, collaborate with colleagues, and participate in professional learning communities to improve instructional effectiveness. The integration of digital tools and online learning platforms has further transformed teaching practices, requiring teachers to develop technological competencies alongside pedagogical skills (Koehler, Mishra, & Cain, 2013). As education systems continue to evolve, supporting teachers through policy, training, and resources remains crucial to ensuring quality education and sustainable development.

Academic achievement in secondary schools is influenced by multiple factors, including the availability of educational resources, teacher competence, students' attitudes and motivation, parental support, school environment, and government policies. High levels of academic achievement not only demonstrate mastery of subject matter but also play a critical role in

shaping students future opportunities, such as progression to higher education, career prospects, and active participation in national development (Atakora, 2021). Secondary education occupies a crucial stage in a learners' academic journey, as it bridges the foundation laid in primary education and the advanced knowledge gained in tertiary institutions.

Chemistry is often perceived as a challenging subject due to its abstract concepts, mathematical applications, and practical components. These challenges have sometimes contributed to low student achievement and interest in the subject. To address this, teachers are increasingly adopting AI-driven tools such as intelligent tutoring systems, virtual laboratories, simulation software, adaptive learning platforms, and automated assessment applications. Devi (2020) added that Chemistry is one of the core science subjects in secondary schools, and widely recognized as challenging due to its abstract concepts, practical experiments, and mathematical applications. Artificial Intelligence (AI) refers to the ability of machines and computer systems to perform tasks that normally require human intelligence, such as reasoning, learning, problem-solving, decision-making, and understanding natural language. Unlike traditional computer programs that operate strictly on predefined instructions, AI systems are designed to analyze data, recognize patterns, and adapt their behavior based on experience.

The use of AI tools in Chemistry teaching enhances personalized learning by allowing students to learn at their own pace and receive instant feedback. Through simulations and virtual experiments, learners can visualize molecular structures, chemical reactions, and complex processes that are otherwise difficult to grasp in a traditional classroom. AI also assists teachers in identifying students learning gaps, predicting performance, and designing appropriate interventions to improve outcomes (Akpen, 2022). Virtual laboratories, intelligent tutoring systems, adaptive learning technologies, and predictive analytics are innovative tools that have significantly transformed teaching and learning in the 21st century. Virtual laboratories provide students with simulated environments where they can conduct scientific experiments without being physically present in a traditional lab.

In addition, adaptive learning technologies go a step further by using data-driven algorithms to modify instructional content in real time according to students learning progress. For example, if a learner struggles with a mathematics concept, the system automatically provides additional practice and alternative explanations until mastery is achieved. This flexibility accommodates diverse learning styles and promotes inclusivity in education. Thus, the integration of AI into the teaching and learning of Chemistry in secondary schools has the potential to reduce barriers to understanding, increase student engagement, and enhance overall academic performance. It represents a significant step toward modernizing science education and aligning it with the digital age (Iriilo, 2018). AI tools are designed to mimic human intelligence in areas such as problem-solving, adaptation, and decision-making (Russell & Norvig, 2016).

In the context of Chemistry, these tools assist teachers in simplifying abstract concepts, engaging learners through simulations, and personalizing the learning experience to improve students' academic achievement. Teachers' use of AI tools emphasizes the shift from teacher-centered to student-centered learning. As noted by Zawacki-Richter (2019), AI supports

personalization, automation of administrative tasks, and intelligent assessment systems that free teachers' time for more meaningful instructional roles. Despite the recognized importance of Chemistry in secondary school curricula as a gateway to science, technology, and innovation. Students' academic achievement in the subject has continued to be a source of concern for educators, parents, and policymakers. National and international examination results often reveal low performance in Chemistry, with many students struggling to understand abstract concepts, apply mathematical reasoning, and carry out practical experiments effectively.

These challenges have raised questions about the adequacy of traditional teaching methods in promoting deep understanding and improved learning outcomes. The introduction of Artificial Intelligence (AI) tools into education has been proposed as a means of addressing these challenges by enhancing teaching and learning processes. AI-powered platforms, such as virtual laboratories, and adaptive learning technologies, offer opportunities for personalized learning, real-time feedback, and improved visualization of chemical processes. However, the actual use of these tools by teachers in secondary schools remains limited and inconsistent, particularly in developing countries where resources, technical expertise, and infrastructure are inadequate. It is on this basis that the study asks: to what extent does teachers use of AI influence academic achievement of chemistry students in secondary schools in Obudu Local Government Area of Cross River State.

The purpose of this study was to examine the influence of teachers' use of AI and the academic achievement of chemistry students in secondary schools in Obudu Local Government Area of Cross River State. Specifically, the study sought to:

1. Ascertain the extent to which virtual laboratories influence academic achievement of chemistry students in secondary schools
2. Examine the extent to which adaptive learning technologies influence academic achievement of chemistry students in secondary schools.

The following research questions were formulated to guide the study:

1. To what extent do virtual laboratories influence academic achievement of chemistry students in secondary schools?
2. To what extent do adaptive learning technologies influence academic achievement of chemistry students in secondary schools.

The following hypotheses were formulated and tested at 0.05 level of significant:

- vi. Virtual laboratories do not significantly influence academic achievement of chemistry students in secondary schools.
- vii. Adaptive learning technologies do not significantly influence academic achievement of chemistry students in secondary schools

## Literature Review

This paper contains a review of literature relevant to this study. The review is presented under the following subheadings;

Virtual laboratories and academic achievement of chemistry students in secondary schools

Adaptive learning technologies and academic achievement of chemistry students in secondary schools.

### Virtual Laboratories and Academy Academic Achievement

Chemistry as a science subject is deeply rooted in experimentation and observation. It requires students to understand invisible molecular processes and to relate theoretical knowledge to observable chemical reactions. However, many secondary schools face limitations such as inadequate laboratory facilities, insufficient reagents, safety hazards, and limited instructional time. These challenges have often hindered students' ability to engage meaningfully with the experimental aspects of chemistry. The emergence of virtual laboratories has been a major innovation in addressing these challenges, offering students an alternative environment for experimentation through digital means (Ross, 2020). The concept of virtual laboratories is rooted in the idea of technological mediation in education. As the world becomes increasingly digital, learning environments are evolving to integrate technology not as a supplementary tool but as a central component of the educational experience (Smith, 2018).

In chemistry, where visualizing molecular behavior and reaction mechanisms is essential, virtual laboratories enable students to visualize and interact with abstract phenomena that cannot be easily demonstrated in physical settings (Eric, 2019). For instance, students can observe molecular collisions, visualize atomic orbitals, and simulate chemical reactions that involve hazardous substances. In terms of pedagogy, virtual laboratories transform the role of the teacher from a transmitter of knowledge to a facilitator of learning. The teacher guides students in navigating the virtual environment, designing experiments, and interpreting outcomes (Ade, 2021). Through the use of virtual laboratories, teachers can create lessons that are interactive, dynamic, and tailored to students' needs. They can integrate simulations into lessons to demonstrate complex chemical phenomena that would otherwise be invisible or inaccessible (Jones, 2017). Additionally, virtual laboratories promote continuous assessment and feedback. Many virtual lab platforms include built-in features that provide instant responses to students' actions, helping them identify mistakes and improve their understanding in real time. This immediate feedback is crucial for reinforcing correct concepts and preventing the persistence of misconceptions (Wilson, 2021).

Despite these numerous advantages, the successful implementation of virtual laboratories requires several supporting conditions. There must be adequate technological infrastructure such as computers, software, stable electricity, and internet connectivity. Teachers also need proper training and orientation to effectively use and manage virtual laboratory platforms.

Without competent teachers, even the most advanced technology may fail to achieve its intended purpose (Hust, 2016).

Peterson (2021) carried out a research on virtual laboratories and academic achievement of chemistry students in secondary schools in Aboh Mbaize Local Government Area of Imo State. To achieve the objectives of the study, five researcher questions were raised and five hypotheses were formulated to guide the study. The population of the study was 492 students. A sample of 120 students were drawn from the population using stratified random sampling. The instrument used in gathering data for the study was a Test on Projectile (TOP). The result also showed that virtual laboratories significantly influence academic achievement of chemistry students in secondary schools. It was then recommended that government should equips the laboratories with enough facilities to enable teachers teach chemistry to the students for easy understanding.

Gabiro, (2018), investigated virtual laboratories and academic achievement of chemistry students in secondary schools in Owerri municipal in Imo State. To ascertain the objectives of the study, three research questions were raised and three hypotheses were formulated to guide the study. The research design adopted for the research was descriptive research design. The study had a population of 834 students. A sample of two hundred and fifty (250) students was selected from ten (10) secondary schools in the study area. A questionnaire titled Virtual Laboratories and Academic Achievement of Chemistry Questionnaire (VLAACA) was administered to students to gather data on their academic achievement in secondary schools. The data collected was analyzed using descriptive statistics and inferential statistics. The findings showed that there is a significant influence of virtual laboratories on academic achievement of chemistry students in secondary schools. Based on the findings of the study, recommendation were made that government should employ professional teachers in virtual laboratories in order to use it in the teaching of chemistry.

### **Adaptive learning technologies and academic achievement of chemistry students in secondary schools.**

Adaptive learning technologies also enhance formative assessment and feedback mechanisms, which are crucial for academic success. In traditional classrooms, feedback is often delayed and generalized, making it less effective in helping students' correct mistakes or misunderstandings (Prensky, 2021). Adaptive learning systems, however, provide immediate and specific feedback that guides learners toward the correct understanding. When a student answers a question incorrectly, the system not only indicates the error but also explains why it is wrong and offers hints or supplementary materials for further clarification (Fisher, 2017). This instant corrective feedback prevents misconceptions from becoming entrenched and encourages a growth mindset. Students learn that mistakes are part of the learning process and use feedback constructively to improve their performance.

Teachers can then use this data to provide targeted interventions, plan remedial lessons, and adjust instructional strategies to maximize student achievement (Rutilo, 2021). Moreover,

adaptive learning technologies enhance teacher effectiveness. Rather than replacing teachers, these systems serve as intelligent assistants that support instruction. Teachers gain access to real-time data and insights about each students' progress, enabling them to make informed decisions about classroom activities, group work, and individualized instruction. They can identify students who are struggling and provide additional support, while allowing advanced learners to move ahead. Despite their numerous advantages, the successful implementation of adaptive learning technologies in chemistry education requires careful planning and adequate support. Access to reliable internet, electricity, and computing devices is essential to sustain their use. Teachers must also receive professional training to effectively integrate these systems into their teaching methods. Without proper orientation, the technology may not be used to its full potential. Additionally, developers must design adaptive systems that align with the national curriculum and local educational contexts to ensure relevance and cultural appropriateness (Rossy, 2021). When thoughtfully implemented, adaptive learning technologies hold great promise for transforming chemistry education in secondary schools and improving students' academic achievement.

Adu (2017) studied the adaptive learning technologies and academic achievement of chemistry students in secondary schools in Rivers State, Nigeria. Five research questions were raised and five hypotheses were formulated to guide the study. The survey research design was adopted for the study. The study sample consists of 220 public secondary students drawn from a population of 768 public secondary school students using simple random sampling technique. The instrument used for data collection was questionnaire. Pearson product moment correlation coefficient analysis was used to analyze the data obtained. The findings of the study revealed that adaptive learning technologies significantly influence academic achievement of chemistry students in secondary schools, Nigeria. Based on the findings of the study it was recommended that government should introduce adaptive learning technologies in all public secondary schools in order to make learning easy for the learners.

## Methodology

This study adopted the descriptive survey research design. It involves the collection of data to accurately and objectively describe existing phenomena (Kayode & Ayodele, 2015). The research area for this study was Obudu Local Government Area of Cross River State, Nigeria. The local government headquarter is Obudu. The total population for the study is 1953 SSII Chemistry students in public secondary schools. Nine hundred and fifty (950) were males while one thousand and three were girls (Source: Obudu Local Government Education Authority, 2025).

Proportionate random sampling and simple random sampling techniques are used to select sample of 1, 953 SS II chemistry students, which involved obtaining the population of students from each of the selected secondary schools in Obudu Local Government Area. Simple random sampling technique was also used to select SS II chemistry students in order to ensure that all categories of students were given equal chance of being selected. Ten (10) schools were selected from each political ward. At the end, 20 students each were selected, making a total

of 200 SS II Chemistry students. The study sample consisted of two hundred (200) senior secondary (SS 2) Chemistry students randomly selected from the ten (10) public secondary schools in Obudu Local Government Area of Cross River State.

The data for the study were collected using researcher developed questionnaire titled Chemistry Teachers Use of AI Questionnaire (CTUAIQ) and Chemistry Achievement Test (CAT). The first instrument was in two sections: Section A contained personal information of students, while section B elicited information concerning teachers use of AI. There were 20 questions in section B which were arranged in four clusters. Each of the clusters asked questions about each variable of the study and contained a total of five questions. The responses of the questionnaire were on four-point Likert scale type as follows: Strongly Agree, Agree, Disagree, and Strongly Disagree. The second instrument was designed to elicit information from the students on their academic achievement in Chemistry. This was got from WAEC past questions of 2023. The second questionnaire contained 20 item questions.

To ensure the validity of the items, they were subjected to face validity by the experts in Test and Measurements and Chemistry departments to criticize the items. They were selected to validate the instrument due to their wealth of experiences, professional background and expertise knowledge. All necessary corrections and modification made by the experts were affected and items were reconstructed based on the satisfactory comments of the experts. The reliability of the instruments was computed using the Cronbach alpha reliability coefficient. The reliability coefficient of 0.82 was obtained. Data for the study were collected using Chemistry Teachers Use of AI Questionnaire and Chemistry Achievement Test (CAT) respectively. Data were analyzed using mean and standard deviation to answer the research questions while independent t-test statistical tool was used to test the research hypotheses at 0.05 level of significant. This subsection presents the results of data analysis. Research questions are answered using mean and standard deviation while hypotheses were tested using independent t-test at .05 level. The decision rule was that any item mean from 2.5 and above is accepted while any item mean from 2.4 and below is rejected. The results are presented as follows:

### **Research question one**

To what extent do virtual laboratories influence academic achievement of chemistry students in secondary schools. Mean and standard deviation were used to answer the research question. The results is presented in table 1

**Table 1**

**Mean and standard deviation of responses on virtual laboratories influence academic achievement of chemistry students in secondary schools**

Items	N	Mean	SD	Decision
I have used virtual laboratory simulations in learning chemistry.	200	2.5	0.69	A
Virtual labs make chemistry experiments easier to understand	200	2.5	0.69	A
Virtual laboratory activities improve my practical skills in chemistry.	200	2.7	0.70	A
Virtual labs help me visualize experiments that are dangerous or difficult to perform in real labs.	200	2.6	0.68	A
Using virtual labs increases my interest in chemistry lessons	200	2.4	0.73	R
<b>Grand mean</b>		<b>2.54</b>		

From table 1 above, all the means were accepted except one. The grand mean for all the items was 2.54 showing that the respondents were in total agreement that virtual laboratories have a positive influence on academic achievement of chemistry students in secondary schools.

Research question two

To what extent does adaptive learning technologies influence academic achievement of chemistry students in secondary schools? Mean and standard deviation was used to answer the research question. The results is presented in table 2

**Table 2**

**Mean and standard deviation of responses on adaptive learning technologies influence academic achievement of chemistry students in secondary schools**

Items	N	Mean	SD	decision
The digital learning platforms I use adjust lessons based on my chemistry learning progress.	200	2.3	.62	A
Adaptive learning tools provide personalized exercises based on my weaknesses.	200	2.7	.40	A

These technologies help me understand difficult chemistry topics better.	200	2.6	.45	A
Adaptive lessons make chemistry learning more engaging and enjoyable.	200	2.7	.44	A
I learn chemistry concepts faster through adaptive learning tools.	200	3.0	.87	A
<b>Grand mean</b>		<b>2.66</b>		

From table 2 all the respondents were in agreement with the item above since the means were above 0.25 and also the average mean for all the items was 2.66 which show that adaptive learning technologies influence academic achievement of chemistry students in secondary schools.

### Test of Hypotheses

Hypothesis one

Virtual laboratories do not significantly influence academic achievement of chemistry students in secondary schools. Independent t-test was used to test the hypothesis. The result is presented in table 3

**Table 3**

**Summary table for t-test of virtual laboratories and academic achievement of chemistry students in secondary schools**

Sub-variable	N	X	S.D	df	t-cal	sig	Inf
Virtual laboratories	200	2.54	0.70				
198	3.5	.023	Rej H <sub>0</sub>				
academic achievement of chemistry students in secondary schools	200	5.77	0.42				

Table 3 shows that the probability associated with the calculated value of 3.5 for the virtual laboratories and academic achievement of chemistry students in secondary school is 0.23. Since the probability value of 0.23 is less than 0.05 level of significance, the null hypothesis was rejected meaning virtual laboratories significantly influence academic achievement of chemistry students in secondary schools

## Hypothesis Two

Adaptive learning technologies does not significantly influence academic achievement of chemistry students in secondary schools. Independent t-test was carried out to test the hypothesis. The result is presented in table 4

**Table 4**

**Summary table for t-test of adaptive learning technologies and academic achievement of chemistry students in secondary schools**

Sub-variable	N	X	S.D	df	t-cal	sig	Inf
adaptive learning technologies	200	2.840.81					
Academic achievement of chemistry students in secondary schools	200	5.77	0.42	198	0.940.00	Rej H <sub>0</sub>	

The result in Table 4 shows that an f-ratio ( $p < .05$ ) was obtained. Given the fact that the associated probability ( $p$ ) value of 0.00 when compared with the 0.05 level of significance ( $\alpha = 0.05$ ) for testing the hypothesis was not significant because 0.00 is less than 0.05, is consequently rejected. Therefore the null hypothesis was rejected, this mean that adaptive learning technologies significantly influence academic achievement of chemistry students in secondary schools. The findings of the study were discussed in line with the research questions and hypotheses that guided the study. They are discussed under the following headings:

### Virtual laboratories and academic achievement of chemistry students in secondary schools

The findings of research question one and hypothesis one indicated that virtual laboratories significantly influence academic achievement of chemistry students in secondary schools. This finding is in line with the finding of Ade (2021) who posits that virtual laboratories supports the development of higher-order thinking skills. In a virtual environment, students engage in problem-solving, critical thinking, and analytical reasoning as they design experiments and interpret results. These skills are essential in chemistry, where understanding the relationship between cause and effect in reactions requires logical and analytical reasoning. Virtual laboratories encourage learners to hypothesize, test, and evaluate, thereby strengthening their scientific thinking. In addition, they foster autonomy and self-regulation in learning. Because virtual labs often allow learners to progress at their own pace, students can take responsibility for their learning, revisit experiments, and correct misconceptions independently

This is also in agreement with Wilson (2021) who supports that virtual laboratories promote continuous assessment and feedback. Many virtual lab platforms include built-in features that provide instant responses to students' actions, helping them identify mistakes and improve their understanding in real time. This immediate feedback is crucial for reinforcing correct concepts and preventing the persistence of misconceptions. The motivational impact of virtual laboratories on learners is another important factor influencing academic achievement. The interactive and game-like features of many virtual laboratories capture students' attention and sustain their interest in chemistry. As learners engage with colorful visuals, dynamic reactions, and interactive tasks, they develop the sense of curiosity and enjoyment that makes learning less stressful and more engaging.

Adaptive learning technologies and academic achievement of chemistry students in secondary schools

The findings of research question two and hypothesis two indicated that adaptive learning technologies significantly influence academic achievement of chemistry students in secondary school. This finding is consistent with Rutilo (2021) who posits that adaptive learning technologies enhance formative assessment and feedback mechanisms, which are crucial for academic success. In traditional classrooms, feedback is often delayed and generalized, making it less effective in helping students' correct mistakes or misunderstandings. Adaptive learning systems, however, provide immediate and specific feedback that guides learners toward the correct understanding. When a student answers a question incorrectly, the system not only indicates the error but also explains why it is wrong and offers hints or supplementary materials for further clarification. This instant corrective feedback prevents misconceptions from becoming entrenched and encourages a growth mindset. Students learn that mistakes are part of the learning process and use feedback constructively to improve their performance.

This is also in agreement with Fisher (2017) who opines that adaptive learning technologies encourage inclusivity and accessibility in education. They are particularly beneficial for students with learning difficulties or disabilities, as the systems can accommodate different learning needs without stigmatizing or isolating learners. For example, students with slower processing speeds can take more time to complete lessons, while those with auditory preferences can use text-to-speech features. This adaptability ensures that every learner, regardless of ability or background, can participate actively and benefit from chemistry education

## Conclusion

Based on the findings of the study; it was concluded that there exist significant influence on teachers use of AI and academic achievement of chemistry students in secondary schools. All the hypotheses formulated for the study, significantly influenced, meaning that teachers' use of AI is a key predictor of academic achievement of chemistry students in secondary schools. This informed the researcher to conclude that the failure of students in Chemistry will be curtailed if AI platforms will be utilized appropriately while teaching in secondary schools.

The use AI tools in Chemistry teaching enhances personalize learning by allowing students to learn at their pace and receive instant feedback. Through virtual experiments and adaptive learning technologies learners can visualize molecular structures, chemical reactions and complex process that are otherwise difficult to grasp in a traditional classroom.

### Recommendations

In line with the findings of the study, the following recommendations were made:

1. Government should formulate and implement policies that encourage the adoption of intelligent tutoring systems in secondary school chemistry education.
2. Regular training workshops, seminars, and certification programmes should be organized to equip teachers with the necessary skills to effectively use intelligent tutoring systems
3. Teachers should adopt adaptive learning technologies to address individual differences in students' current level of understanding, thereby promoting mastery learning.

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