

## IMPACT OF TECHNOLOGY-ASSISTED INSTRUCTION ON SECONDARY SCHOOL STUDENTS ACHIEVEMENT IN CHEMISTRY

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### Abstract

*This study focused on secondary school chemistry students' achievement in chemistry. The study was carried out in Ovia North East Local Government Area of Edo State, , Nigeria. A quasi-experimental design was employed in the study involving 200 secondary school students from four schools were selected. In selecting the sample for the study, stratified simple random sampling technique was used. Data were collected using chemistry achievement test (CAT) and a questionnaire involving Challenges in the Use of Technology in Chemistry (CUTC). The instruments were validated and reliability determined the strength of the instrument and reliability index of .82 and .70 respectively were obtained before it was used. Independent samples t-tests statistics was use to analyze the data. Results indicated a significant difference in the academic achievement of the treatment group compared to the control group; a non-significant difference in the academic achievement of male and female students achievement in the treatment group. Qualitative findings highlighted several challenges, including technical issues, lack of resources, and insufficient training for teachers as challenges impacting the use of technology-assisted instruction in teaching.*

**Keywords:** *Technology-Assisted Instruction, Chemistry Education, Academic Achievement*

### Introduction

Technology Assisted instruction is relevant in the teachings of science in general and Chemistry in particular because it enhance the visualization of concept to be taught through the technological visual aids and this gives the students opportunities to have a concrete idea of what they are learning. The usage of technology in the teaching of chemistry also provides interactive simulation that help students visualize complex chemical concepts (molecular structures and chemical reactions). With the use of 3Dmodels developed through technology, illustrations of chemical structures and process are possible and this makes them easier to understand. The advent of technology in education has brought transformative changes on how subjects are

taught and learned, with significant implications for science education. One of the important science subjects that is taught at the senior secondary school level is Chemistry.

Chemistry defined as the scientific study of the composition of matter, its properties and the reactions that they undergo. The study of Chemistry, involves the analysis of the structure and the properties of matter in terms of their reactions and how they transform into other substances. Chemistry plays an important role in the development of a nation. It contributes significantly to various sectors of a nations' economy in the aspect of economic growth, it

provides opportunities for industrial development through creation of textiles, plastics, pharmaceuticals and agrochemical industries which in-turn job opportunities. The knowledge of Chemistry also helps in achieving environmental sustainability through production of clean energy, environmental monitoring and waste management techniques. Also, in food security and Agriculture, the knowledge of Chemistry has helped in the manufacturing of fertilizers, pesticides, food processing and preservation, improved animal health. Going further, in infrastructure development the knowledge of chemistry has helped in the production of construction materials and transportation. In scientific research and innovation, chemistry drives basic research by advancing humans understanding of the natural world leading to new discoveries.

Chemistry, a subject that requires both theoretical understanding and practical application, stands to benefit greatly from technology-assisted learning tools. These tools provide dynamic simulations, virtual experiments, and interactive content that make abstract concepts more tangible and experiments more accessible. The adoption of technology in educational settings aimed to address several pedagogical challenges, including the need for interactive and engaging learning experiences, the ability to visualize abstract concepts, and the facilitation of individualized learning process. In the context of chemistry education, technology can offer simulations, virtual labs, and interactive tutorials that augment traditional laboratory experiments, potentially leading to a deeper understanding of the subject matter. Previous studies have demonstrated that technology-enhanced learning environments can improve student engagement, understanding, and retention of complex scientific concepts (Barak, 2017; Hegedus & Roschelle, 2013).

In situations where educational resources are often limited, the potential benefits of integrating

technology in classrooms are particularly pertinent. According to Iyoha (2023), teachers in Ovia North East Local Government Area face significant challenges due to inadequate facilities and resources, which hamper the effective teaching of technology-related subjects. This limitation extends to the teaching of chemistry, where practical, hands-on experience is crucial. The lack of adequate laboratory facilities in many Nigerian schools restricts students' opportunities for practical learning, leading to a reliance on theoretical instruction (Yusuf & Afolabi, 2010).

International studies provide a robust foundation for understanding the impact of technology in education. For instance, Schmid et al. (2014) conducted a meta-analysis showing that the use of technology in post-secondary education significantly enhances learning outcomes. Similarly, Sung, Chang, and Liu (2016) found that integrating mobile devices with teaching and learning improves students' learning performance. In the context of virtual laboratories, Tatli and Ayas (2013) demonstrated that such tools positively affect students' achievement in chemistry from the findings of Gambari, et al. (2017), who reported improved achievement levels and attitudes toward chemistry among secondary school students using virtual labs.

In Nigeria, research specific to secondary schools, particularly in rural or less urbanized areas, remains sparse. The few existing studies, such as those by Eya and Ezeh (2020), highlight gender disparities in academic achievement in chemistry, emphasizing the need for inclusive and effective teaching methods. Additionally, Kapici, et al. (2020) explored how different laboratory environments influence students' attitudes towards science courses and laboratories, providing valuable insights into the potential benefits and challenges of implementing technology-assisted learning in diverse educational contexts.

This study aims to address the gap in the literature by investigating the impact of technology-assisted learning in chemistry in secondary schools in Ovia North East Local Government Area, Edo State, Nigeria. It seeks to evaluate the impact of these tools on students' academic achievement in chemistry, and to identify the challenges and limitations associated with its implementation.

### **Statement of the Problem**

Despite the global push towards incorporating technology into education, many Nigerian secondary schools still rely on lecture methods. In subjects like chemistry, this often translates to limited hands-on experience due to inadequate laboratory facilities. The lack of resources not only hampers students' practical understanding but also diminishes their engagement and interest in the subject. Additionally, there is a disparity in the distribution of technological resources, with rural and less urbanized areas often being left behind. This digital divide exacerbates educational inequalities, limiting students' access to the benefits of technology-enhanced learning. The challenges are further compounded by insufficient training for teachers on how to effectively integrate technology into their teaching practices. Many educators lack the necessary skills and confidence to utilize these tools, which can lead to suboptimal implementation and reduced educational outcomes. As noted by Iyoha (2023), teachers in Ovia North East Local Government Area, Edo State face significant difficulties due to inadequate professional development opportunities, which impacts their ability to adopt innovative teaching methods.

Moreover, the introduction of technology in classrooms may encounter resistance from both educators and students who are accustomed to traditional methods of teaching and learning. This resistance can stem from a variety of factors, including fear of the unknown, discomfort with new technologies, and concerns about the

reliability and effectiveness of these tools.

There is a critical need to evaluate whether integrating technology can mitigate these challenges and enhance the educational experience for students in these settings. Specifically, this study seeks to investigate the impact of technology-assisted learning in improving students' academic performance, engagement, in chemistry. By addressing these issues, the study aims to provide evidence-based recommendations for the successful implementation of technology in Nigerian secondary schools.

### **Purpose of the Study**

The main purpose of this study was to investigate the impact of technology-assisted learning on student performance and engagement in chemistry labs within secondary schools in Ovia North East LGA, Edo State. Specifically, the study sought to:

- 1 Investigate the difference in the academic achievement of secondary school student taught chemistry using technology-assisted instruction and those exposed to the traditional method
- 2 Evaluate the difference in the academic achievement of male and female secondary school students exposed to technology-assisted instruction
- 3 Identify the challenges and limitations associated in the use of technology – assisted instruction in chemistry.

### **Research Questions**

- 1 What is the difference in the academic achievement of secondary school students taught chemistry using technology-assisted instruction and those to the traditional method

- 2 What is the in the academic achievement of male and female secondary school students exposed to technology-assisted instruction?
- 3 What are challenges faced in implementation of technology assisted instruction in chemistry ?
- 4 What are the challenges associated in the use of technology-assisted instruction in chemistry?

### Hypotheses Testing

To address the research objectives, the following hypotheses were tested:

H<sub>01</sub>: There is no significant difference in the academic achievement of secondary school students taught chemistry using technology-assisted instruction and those exposed to traditional method.

H<sub>02</sub>: There is no significant difference in the academic achievement of male and female secondary school students exposed to technology-assisted instruction.

### Method of the Study

The study employed a pre-test –post –test non-equivalent group quasi-experimental design. In this design, there is no randomization of subjects into groups but rather intact classes were used. This is to avoid the disruption of class activities. This design is considered appropriate because it will not be possible to randomly assign subjects into groups and as such, intact classes were used. According to Johnson and Christensen (2000), any design which randomization is a condition for true experimental design is omitted, such design is described as quasi-experimental design.

The sample consist of 200 secondary school students from all the secondary schools in Ovia North East Local Government Area Edo State. This consist of 75 students in the control group while 135 students were in the treatment

group. The sample technique employed was stratified random sampling method. The difference in the number of students allocated to the treatment and control group was because intact classes were used for the experiment.

Two instruments were used for data collection. Chemistry Achievement Test (CAT) and a questionnaire involving Challenges in the Use of Technology in Chemistry (CUTC). The chemistry achievement test (CAT) consists of two sections. Section A elicits information on students' bio-data and section B contains 50 items with one correct answer and four distracters raised on the concepts taught. The 50 items were picked from West Africa Examination Council past questionnaire from 2015 to 2024. While the challenges and limitations associated with the implementation of technology in chemistry laboratory instrument is a structured questionnaire with twenty items on a four scale of Strongly Agreed, Agreed, Disagree and strongly disagreed designed by the researcher to elicit information on the challenges and limitations associated with the implementation of technology Assisted instruction in teaching chemistry. Both instruments were administered on the students to respond to.

Two validity measures were conducted on the instrument CAT (face and content) and face validity was carried out on the CUTC. For the CAT, the face validity of the instrument was determined by three experts: one in science education, one expert in science Educator, one experienced Chemistry Teacher and one expert in measurement and evaluation. They specifically looked at the CAT questions, the research questions and the hypotheses with the aim of establishing if the instrument could give the needed data to answer the research questions and test the hypotheses. They suggested that two items should be reframed and this was effected after which it was approved for data collection. The content validity was done using a table of

specification based on Bloom taxonomy of educational objectives to ensure that content was properly represented.

The CUTC face validity was determined by a panel of three experts, made up of one science educator, one chemistry teacher and one expert in measurement and evaluation. The instrument was given to them with the research questions and hypotheses to enable them to determine the suitability of the questionnaire and they all suggested that the instrument will be able to generate data needed to answer the research questions.

In determining the reliability of the instrument (CAT), the instrument was administered to twenty SS II students in school who were not part of the sample used for the study. Data collected were analyzed using Kuder-Richardson Formula 21 to determine the reliability value. The formula was used because the instrument was an achievement test with one mark for correct answer and zero for wrong answer. From the analysis of the data collected, an r-value of .82 was obtained for the achievement test. With this value which is above .70, the instrument was considered reliable. This is because according to Ajaja (2013) any instrument with a reliability value of .70 and above is reliable. Also, in order to determine the reliability of the CUTC a set of questionnaires was administered to 20 students on the same student. The data collected were analyzed using Cronbach's Alpha Statistical Procedure. This procedure was adopted because the questionnaire options have varying values. In this case, the questionnaire administered was found to have a reliability value of .78. This shows that the instrument is reliable.

In order to collect data for analysis, the treatment group teachers that were used the

technological Assisted instruction were trained for two weeks how to use the methodology with a training manual developed by the researcher. In the training the teachers were exposed to the concept of technology Assisted Instruction, Types of technology assisted instruction, importance of Technology Assisted instruction, devices used in technology assisted instruction, theory backing the use of technology assisted instruction and steps to follow in using technology assisted instruction. The training came to an end with practice after the researcher was convinced that the teachers (research assistant) have mastered the usage of the technology assisted instruction in teaching

After the training of the teachers for the treatment group, both group students were pre-tested using the instruments for data collection and taught the concepts using the different teaching strategies respectively. The pre-test was used to establish a baseline of academic achievement. During the intervention phase, the treatment group was exposed to various technology-assisted learning tools, such as virtual lab simulations, educational software, interactive whiteboards, and online tutorials, over a period of one semester (approximately three months). At the end of the treatment, both groups were post-tested and data collected where analyze using mean, standard deviation, and independent sample t-test statistics.

The result from data analysis are presented in the Tables along with the research questions and hypotheses:

**Research Question 1:** What is the difference in the academic achievement of secondary school students taught chemistry using technology-assisted instruction and those to the traditional method

**Table 1 : Post test Mean and Standard Deviation Scores of both Groups**

Groups	N	Mean	Mean Diff	SD
Technology Assisted Instruction	75	58.54	18.28	12.67
Lecture Group	135	40.28		5.17

The Table revealed that the students in the technology assisted Instruction had a mean of 58.54 with a standard deviation of 12.67 and the lecture group students had a mean of 40.28 with a standard deviation of 5.17. The students taught with Technology Assisted Instruction had a higher mean score, with a difference of 18.28. In order to determine if the difference is significant,

was tested using independent sample t-test statistics.

**Hypothesis 1:** There is no significant difference in the academic achievement of secondary school students taught chemistry using technology-assisted instruction and those exposed to traditional method

**Table 2 : Independent Sample t-test Statistics**

Groups	N	Mean	Mean Diff	SD	df	t.cal	Sig(2-tailed)
Technology Assisted Instruction	75	58.54	18.28	12.67	198	13.04	.00
Lecture Group	135	40.28		5.17			

The result in table 2 showed a significant difference in the post-test scores of the Technology Assisted instruction group and the lecture group since the calculated sig.value of .00 obtained is less than critical sig value of .05, indicating that students taught using technology-assisted learning tools performed better academically compared to those taught using lecture method. Thus, the null hypothesis which

states that there is no significant difference in the academic achievement of secondary school students taught chemistry using technology-assisted instruction and those exposed to traditional method .is rejected.

**Research Question 2:** What is the in the academic achievement of male and female secondary school students exposed to technology-assisted instruction?

**Table 3: Gender mean and standard deviation scores for students exposed to TAI**

Sex	N	Mean	Mean Dif	SD
Male	33	59.91	2.32	14.82
Female	42	57.59		10.90

The Table revealed that the male students in the technology assisted Instruction had a mean

of 59.91 with a standard deviation of 14.82 and the female students had a mean of 57.59 with a

standard deviation of 10.90. The male students taught with Technology Assisted Instruction had a higher mean score, with a difference of 2.32. In order to determine if the difference is significant,  $H_{02}$  was tested using independent sample t-test statistics.

**Table 4: Independent Sample t-test Statistics**

Sex	N	Mean	Mean Dif	SD	df	tcal	Sig (2-tailed)
Male	33	59.91	2.32	14.82	73	1.1	.205
Female	42	57.59		10.90			

The result in Table 4 revealed a non-significant difference in the post-test scores of the male and female students taught with Technology Assisted instruction since the calculated sig value of .205 which is greater than the critical sig value .05 was obtained, indicating that students taught using technology-assisted learning tools performed better academically compared to those taught using lecture method.

**Hypothesis Two:** There is no significant difference in the academic achievement of male and female secondary school students exposed to technology-assisted instruction.

Thus, the null hypothesis which states there is no significant difference in the academic achievement of male and female secondary school students exposed to technology-assisted instruction is not rejected

**Research Question 3:** What are the challenges associated in the use of technology-assisted instruction in chemistry?

**Table 5: Mean and standard deviation scores indicating the Challenges associated with Using Technology Assisted Instruction**

Theme	Mean	SD
Technical issues (e.g., software)	2.94	1.00
Lack of resources (e.g., devices)	3.15	.85
Insufficient training	2.86	.84
Distraction due to pop ups	2.88	1.01
Resistance to apply new innovation	2.74	.93

Table 5 revealed that the mean and standard deviation scores on the challenges faced by students in using technology Assisted instruction strategy. For technical issues (e.g., software) the of 2.94 and standard deviation of 1.00 was obtained, for lack of resources (e.g., devices) a mean of 3.15 and a standard deviation of .85 was obtained, in the case of insufficient training a mean of 2.86 and a standard deviation of .84 was obtained, for the distraction due to pop ups a mean of 2.88 and a standard deviation of 1.01 and lastly for resistance to apply new innovation a

mean of 2.74 and a standard deviation of .93 was obtained. With the means higher than the criterion mean of 2.50, it can be concluded that technical issues (e.g., software), lack of resources (e.g., devices), insufficient training, distraction due to pop ups and resistance to apply new innovation are challenges associated in the use of technology-assisted instruction in chemistry.

**Discussion of Findings**

This study investigated the Impact of Technology-Assisted instruction on secondary

school students' achievement in Chemistry. This study is timely considering the importance of the use of Technology-Assisted instruction in teaching.

The first finding of the study revealed a significant difference in the academic achievement of students taught using technology-assisted instruction when compared with those taught using lecture method. This significant difference observed in favour of the treatment group is due to the fact that the technology-assisted Instruction gave the students in the treatment group opportunities to have concrete experience with the concepts taught and they were both involve with hands on and minds on activity during the teaching and learning process. This aligns with that of Adalikwu and Iorkpilgh, (2013) whose findings revealed that students who used interactive multimedia resources in learning chemistry performed significantly better than their peers taught with lecture method. Similarly, Yusuf and Afolabi (2010) study demonstrated the positive impact of computer-assisted instruction on students' achievement in biology. Also, a meta-analysis by Schmid et al. (2014) found that digital learning tools significantly enhance student achievement in science subjects across various educational levels. Furthermore, studies of Harris et al., (2016) and Ambusaidi et al., (2018) revealed that virtual labs and simulations effectively improved students' understanding and retention of complex scientific concepts.

The second finding showed a non-significant difference in the male and female chemistry students achievement taught using Computer Assisted Instruction. This finding is due to the fact that the male and female chemistry students were exposed to same activities irrespective of their sex and this would have influenced the achievement equally. This finding also confirmed the findings of Agboro-Eravwoke, (2022), Asuquo, and Anaekwe (2023), who found no significant difference between male and female students' achievement.

The third finding revealed that technical issues, lack of resources, insufficient training and Distraction due to pop ups facing the usage of Technology Assisted Instruction in teaching are challenges faced with the usage of Computer Assisted Instruction in the teaching of chemistry. These challenges are consistent with those reported by Adewoye and Akinde (2023); Iyoha (2023); Ndlovu and Lawrence (2012) and Ertmer and Ottenbreit-Leftwich (2010).

## Conclusion and Recommendations

In conclusion, this study demonstrated that technology-assisted instruction significantly enhanced academic achievement more than lecture method. It was also concluded that technology assisted instruction is not sex biased. Based on the one the third finding of the study, it was concluded that technical issues, lack of resources, insufficient training and distraction due to pop ups are challenges that affects the usage of Technology Assisted Instruction in the teaching of chemistry.

Based on the findings of the study, the following recommendation were drawn:

- To maximize the benefits of using Technology-Assisted Instruction in the teaching of chemistry, it is crucial to provide comprehensive training and ongoing support for teachers. This training should focus on the effective integration of technology into the curriculum, familiarizing educators with digital tools, and equipping them with strategies to overcome potential technical challenges.
- Ministry of Education should invest in robust technological infrastructure, including reliable internet access, up-to-date devices, and maintenance of equipment
- Also, it is recommended that digital learning resources tailored specifically to

the Nigerian secondary school chemistry curriculum should be developed and used for teaching. These resources should include interactive simulations, virtual labs, and multimedia content that align with the learning objectives to address the unique educational needs of Nigerian students.

- Lastly, surveys, focus groups, and academic achievement assessments should be used to gather feedback from both students and teachers, ensuring that the technology remains responsive to their needs and contributes to continuous improvement in educational outcomes.

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