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Impact of Multimedia Instructional Strategies on Academic Performance of Chemistry Students in Senior Secondary Schools in Lokoja Metropolis

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Abstract
This research examined the Impact of multimedia instructional learning strategy on academic performance of chemistry students in senior secondary schools in Lokoja metropolis. A quasi-experimental pre-test, post-test control design was used for the research with a population of 122 Senior Secondary School two chemistry students from four (4) Schools in Lokoja metropolis of Kogi state were acquired via random sampling method. The instrument designed to steer the research was hydrocarbon chemistry performance test (HCPT), which includes a 20-item multiple objectives questions used to collect data for both pre-test-post-test in the control and experimental groups. The instruments received validation by experts in department of Educational technology and science education. Kudar-Richardson 20 method which give rise to a reliability coefficient of 0.75. To guide the investigation two research questions and two null hypotheses were formulated. Mean were calculated to answer the research questions while Analysis of Covariance (ANCOVA) tested the hypotheses at 0.05 level of significance. The findings from the research indicated a substantial advantage between chemistry students taught hydrocarbon using multimedia instructional strategy when compared with those taught traditional instructional strategy. It was further indicated that gender did not produce a significant difference when taught chemistry using multimedia instructional. Accordingly the study recommend that to boost students' academic performance, educators should employ the application of multimedia instructional strategy in teaching chemistry and opportunities must be distributed equally, free from any gender disparity.

Keywords: Academic Performance, Chemistry, Multimedia, Schools, Strategy

Introduction

Science plays a vital function in the community by transforming the way and manner we live, work and interact with the world around us (Aniodoh, 2012). Science has led to numerous technological advancements, improving health care, economic growth and development, environmental sustainability as well as insightful analysis and problem-resolution abilities (WHO, 2019). However, as we confront the demands of the 21st century, science will continue to play a vital function in shaping our future. This accounts for why science is seen as the bed-rock of human development in our society (Akpoghol et al., 2025). Ode and Eriba (2019) opined that the developed nations have tremendously achieved their status of development through science and technology application and education. Wokocha (2014) view science as both a knowledge base and an investigative activity that targets the collection, classification, and expansion of facts to discover innovative approaches and thoughts. In that context, the science-education curriculum acts like a lifeline, in equipping learners with the required skills to drive scientific and technological progress and achieve the development and change we seek (Agbidye, 2019). Science education can therefore be beneficial in making life useful, meaningful and easy for humanity (Akpoghol et al. 2025). Sylvanus (2018) defined science education as the study of how scientific disciplines, i.e., science subjects interrelates and the applying of educational pedagogical principles in instruction and learning process. Hence, science educators must possess deep expertise in at least one area of science. The body of knowledge in science education is been implemented in senior secondary schools through subject such as Biology, Chemistry, Physics and Mathematics. Chemistry is described as the scientific examination of the makeup, characteristics, and

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interactions of matter (Khazuangbe, 2015). It also involves the analysis of the structure, properties and transformation of substance at the atomic and molecular levels.

Chemistry plays a vital role in medical application such as medicine, treatments and diagnostic tools. Omokaadejo (2015) reveal that chemistry is equally obligatory for synthesis of new materials, such as plastics, fibers and metals which have transformed our daily lives. Atkins and De-Paula (2010) further affirmed that chemistry helps us to understand and address environmental related issues such as pollution and climate change. The study of chemistry is categorized into these branches- organic and inorganic chemistry. Miessler and Tar (2019) stated that inorganic chemistry is concerned with the study of in-organic compounds which are typically derived from mineral sources. Acid, base, salts and metals are examples of inorganic substance. Conversely, organic chemistry focuses on carbon-based compounds which are found in living organisms (Carey, 2020). It also involves the structure, properties and reactions of organic compounds which are typically composed of carbon and hydrogen atoms often with other elements such as oxygen (O), Nitrogen (N) and Sulphur (S).

Hydrocarbon chemistry is a fundamental aspect of organic chemistry that deals with carbon and hydrogen atoms alone. These compounds are classified into alkane, alkene and alkyne and aromatic hydrocarbons each with distinct structural and chemical properties. Hydrocarbons serve as a primary constituents of fossil fuels such as petroleum and natural gas, making them crucial to various industrial applications including energy production petrochemicals and materials science (Okeke & Adeoye, 2020). Understanding hydrocarbons is essential for student's studying chemistry as these compounds form the basis of numerous industrial processes including fuel combustion, polymer production and pharmaceutical synthesis. Akinyemi (2019) revealed that the abstract nature of hydrocarbon structures and reaction mechanism often poses challenges for learners, necessitating innovative instructional strategies to enhance comprehension and its application. One of the major challenges in teaching hydrocarbons is the abstract nature of the topic which makes it difficult for students to visualize molecular structures and reaction mechanism. Adeoye and Usman (2020) reported that many Nigerian secondary schools lack adequate laboratory facilities, thereby limiting students' exposure to hands-on experiments and practical applications of hydrocarbons. Yusuf and Oyetunde (2022) stated that students perform better when instructional material such as molecular models multimedia tools and laboratory experiments are integrated into hydrocarbon chemistry lessons. The shortage of qualified chemistry teachers poses a significant problem. Akinwumi (2020), highlighted that several secondary school teachers in Nigeria lack specialized training in organic chemistry which affects their ability to effectively teach chemistry of hydrocarbons. Consequently, lessons are often delivered using rote learning methods, making it complex for learners to comprehend the underlying principles of hydrocarbon in chemistry. Another factor affecting the teaching of hydrocarbons is the reliance on traditional teaching methods with minimal students' engagement.

Alamina and Otuturu (2019) revealed that students learn better when interactive teaching strategies such as multimedia instructional strategy (MIS) are adopted as compared to when a traditional instructional strategy (TIS) is used. The use of animations simulations and virtual laboratory exercises has been shown to enhance students understanding of hydrocarbons concepts in chemistry by providing dynamic visual representations of molecular interactions (Ogunleye, 2022). To mitigate these barriers, stakeholders in Nigeria education system have advocated for curriculum reforms and improve teacher training programs. The federal ministry of education (FME 2022) recommended that modern teaching approaches including inquiry-based learning and the use of technology enhanced instruction to improve students' comprehension of hydrocarbon. In contemporary teaching and learning, students learning of scientific concepts could be simplified by using technologies and media that boost knowledge construction and give students concrete mastery.

Multimedia learning strategies involves the utilization of digital machineries to facilitate instruction and learning, attitude, critical-thinking abilities and long-term knowledge retention. They encompass electronic media such as television slide projectors, compact disks (CD) display, Radio and other interactive media such as cell phones and the internet. Nwanekezi and kalu (2012) reveals that text, video, sounds, graphics and animation are primary types of multimedia. These tools provide visual representations of abstract chemical concept thereby making it easier for students to grasp complex topics. According to Mayer's cognitive theory, suggest that learners benefit most from a combination of verbal and visual content of learning materials instead of text alone. The theory underpins the effectiveness of multimedia tools in chemistry education as they cater to different learning styles and promote active engagement (Mayer, 2021). Adekunle and Olurunfemi, (2022) highlighted the benefits of multimedia based instruction in improving students' academic performance in chemistry, specifically in topics related to hydrocarbon. Multimedia, a tech-driven constructivist settings, lets students tackle problems actively

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by discovering on their own, working together, and getting hands-on. By simulating multiples senses, such as visual and auditory, multimedia learning is considered an effective educational approach (Malik & Agarwal, 2012). It also fosters peer-to-peer learning, individual creativity and innovative thinking. Despite its advantages, multimedia learning strategy encounter challenges such as lack of access to technological resources, insufficient teacher training program and resistance to change from traditional teaching method.

The continual low performance in science subjects has been credited to the use of the traditional instructional strategy of teaching and learning that only appeals to learner's auditory senses. Therefore, learners who are visual and kinesthetic in learning are at a great advantages when conventional chalk and talk strategy of teaching is used where the teacher imparted knowledge through direct instruction. In conventional classroom setting, the teacher acts as the transmitter of educational materials as information or messages while the students are passive receivers of the information and are compelled to practice rote learning which can affect chemistry performance amongst students regardless of gender.

Aim and Objectives of the Study

The aim of the study is to examine the impact of multimedia instructional learning strategy on academic performance of chemistry students in senior secondary schools in Lokoja Metropolis.

1. Determine the mean performance scores of students taught hydrocarbon using MIS and students taught using TIS.
2. Ascertain the variation in average performance scores of male and female students' taught hydrocarbon using MIS.

Research Questions

The study was driven by the research questions below:

1. What is the variation in average performance scores between students taught hydrocarbons through a multimedia instructional approach and those taught using conventional teaching methods?
2. What is the variation in average performance scores between male and female students taught hydrocarbon using MIS?

Hypotheses

The outlined null hypothesis were established and evaluated at 0.05 significance level to steer the research:

H_{01}: There is no significance difference in average performance scores between students taught hydrocarbons through a multimedia instructional approach and those taught using traditional instructional strategy.

H_{02}: There is no significance difference in average performance scores between male and female students taught hydrocarbon using MIS.

Methods and Materials

A quasi-experimental approach was applied using pre-test, post-test non-randomized, non-equivalent control group design to ascertain the impact of MIS on academic performance of chemistry students in senior secondary schools in Lokoja metropolis. The research was carried out in Lokoja Metropolis in Kogi State comprising of all Public senior secondary school II chemistry students. The population was chosen owing to the fact that senior secondary II chemistry students are typically introduced to organic chemistry which includes hydrocarbon and one of its topic as stated in the Nigerian chemistry curriculum (NERDC, 2020). Lokoja, is the capital city of Kogi state as it lies about 7.802^0 N (North of the equator) and 6.7333^0E (East of the meridian). The city has various suburbs such as Ganaja, Adankolo, Otokiti and Felele. Owing to the many ethnic groups, there are various festivals, events and socio-cultural activities which are tied to a particular community. The Religious landscape of Lokoja metropolis includes Christianity, Islam and traditional religion faith. The metropolis has three (3) major markets- New, old and Kpata markets.

The study's target population comprised 1,026 senior secondary school II students studying chemistry in government-owned schools within Lokoja Metropolis, Kogi State. The students were chosen based on the premise that they were not preparing for any external examination and are familiar to the topic of investigation. The selection of the schools hinged on gender make-up, which is a key variables in the research. The researcher used Simple random sampling techniques for selection of one hundred and twenty-two (122) chemistry students consisting of sixty-eight (68) males and fifty-four (54) females from four (4) schools situated in the study area. The schools were chosen because they have been presenting candidates for senior secondary schools certificate

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examination (SSCE) for more than a decade, again the chemistry tutors in these schools possess pre-requisite educational qualification such as National Certificate Examination (NCE), B.Ed., B.Sc. (Ed.) in chemistry of not less than six (6) years teaching experience and co-educational based on gender variable.

The students in the experimental group received instruction on hydrocarbons in chemistry through the use of a multimedia teaching strategy and those in the control-group received instruction in hydrocarbons in chemistry employing TIS. The apparatus used for collection of data was hydrocarbon chemistry performance test (HCPT) for both experimental and control groups consisting of twenty (20) objectives questions with four (4) response labeled A through D. Zero (0) and two (2) marks were allotted to wrong and right options respectively thereby making a total score of forty (40) marks. Both the pre-test, post-test of the instrument measured cognitive dimensions of Bloom's taxonomy as specified in the learning objectives. The study used two distinct lesson plan packages for the experimental and control group of chemistry students. The students' were requested to complete Part "1" comprising of background information such as class, time allowed, date and gender and Part "2" contains the hydrocarbon chemistry performance test questions. The pre-test, post-test administered were used to assess the students prior knowledge on the topics considered for the study and students level of performance after treatment of the experimental and control groups. To safeguard face and content validity the research questions were given to three experts. Two (2) educational technologist at Federal University Lokoja and Ignatius Ajuru University of Education, Rumuolumeni, and two (2) tutors in chemistry from the schools selected for the research. The study's questions were critically reviewed for clarity, relevance and correctness of the objectives of the study. Following their feedback all necessary corrections were made ensuring its suitability and validity before the final administration by the researcher. The trail testing was carried out with thirty (30) chemistry students' from a school which was not part of the research to ascertain the internal consistency of the instrument. The result obtained from Hydrocarbon chemistry performance test (HCPT) were examined via Kuder-Richardson 20 method. This yielded a coefficient reliability of 0.75 thereby guaranteeing its reliability. The researcher trained chemistry teachers in the selected schools, this is to maintain uniformity and standard in the instrument used for the study to reduce error due to variations among the selected teachers. The trained chemistry teachers administered the pre-test research questions to the both groups. The test scores obtained were recorded by the research assistant. Thereafter, the research assistants taught hydrocarbon topics using MIS to the experimental group and used traditional teaching strategy to the control-group. It took four (4) weeks only to complete the experiment thereafter the post-test was administered and their outcome were recorded accordingly. The performance test administered as pre-test-post-test was used to collect the required data. However, the data were summarized with mean and standard deviation to address the research questions while the hypotheses were evaluated using analysis of covariance at significance level of 0.05.

Results

Research Question 1: What is the variation in average performance scores between students taught hydrocarbons through a multimedia instructional approach and those taught using traditional instructional strategy?

Table 1: Mean scores and standard deviation of the variation in average performance scores between students taught hydrocarbons through a MIS and those taught using TIS

Groups	n	Pretest		Posttest		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
MIS	50	34.34	24.539	69.24	11.628	34.90
TIS	72	27.29	11.080	37.94	11.341	10.65

Table 1 reveals that the mean performance score for the experimental group (MIS) was 24.539 while the mean performance score for the control group was 11.080. This indicates that the difference in mean academic performance scores between the both groups was 24.25. This implies that the MIS has a better impact on students' academic performance on hydrocarbon in chemistry when compared with TIS.

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Research Question 2: What is the variation in average performance scores between male and female students taught hydrocarbon using Multimedia instructional strategy?

Table 2: Mean score and standard deviation of the variation in average performance scores between male and female students taught hydrocarbon using MIS

Groups	n	Pretest		Posttest		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
Male	54	36.52	24.87	69.83	9.44	33.31
Female	27	32.48	24.57	68.74	13.37	33.26

Result from table 2 indicate that difference in mean performance scores of male and female students before treatment to MIS was 36.52 and 32.48 respectively. However, after the treatment, the male students performed slightly higher than their female participants with a mean scores of 69.83 and 68.74 for male and female students respectively. This implies that the treatment has a greater impact on the male chemistry students than the female.

Testing of Hypotheses

$H0_1$: There is no significance difference in average performance scores between students taught hydrocarbons through a multimedia instructional approach and those taught using traditional instructional strategy.

Table 3: Summary of Analysis of covariance (ANCOVA) on the variation in average performance scores between students taught hydrocarbons through a multimedia instructional approach and those taught using traditional instructional strategy.

Source	Type III sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	28900.676a	1	28900.676	220.099	0.000	0.647
Intercept	339005.069	1	339005.069	2581.765	0.000	0.956
Group	**28900.676**	**1**	**28900.676**	**220.099**	**0.000**	**0.647**
Error	15756.898	120	131.307			
Total	359130.000	122				
Corrected Total	44657.574	121				

According to Table 3, there is significant difference between the mean performance scores of students taught hydrocarbon using MIS and students' taught using TIS. (F_1, = 220.099, df = 120, P =0.00< 0.05). Therefore, null hypothesis one (1) is rejected at 0.05 alpha level.

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Hypothesis 2
There is no significant difference in average performance scores between male and female students taught hydrocarbon using MIS?

Table 4: Analysis of covariance (ANCOVA) summary highlighting the difference in average performance scores between male and female students' taught hydrocarbon using MIS.

Source	Type III sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	14.630a	1	14.630	.106	.746	.002
Intercept	238473.510	1	238473.510	1731.601	.000	.973
Gender	**14.630**	**1**	**14.630**	**.106**	**.746**	**.002**
Error	6610.490	48	137.719			
Total	246334.000	50				
Corrected Total	6625.120	49				

Table 4 indicates that there is no significance difference between the mean performance scores of male and female students' taught hydrocarbon using MIS (F_1,= 0.106, df = 48, P =0.746> 0.05). Consequently, null hypothesis two (2) is retained at 0.05 alpha level.

Discussion
The outcome of the research in table 1 and 3 above revealed that there is significant difference in academic performance of senior secondary schools II chemistry students taught hydrocarbon using MIS and those taught with TIS. The findings is in tandem with the views of Musa et al. (2023) who opine that multimedia based instruction bring about better performance when compared with the conventional teaching strategy. The study is also is also in agreement to the finding of Vershima et al. (2025) who reported that senior secondary school chemistry students taught using MIS obtained a better scores when compared to those taught with conventional teaching methods. The strategy such as animations, videos and 3-D models make abstract concept more concrete and easier to grasp. It also enhance improved engagement by reducing passive listening and boosting motivation. Additionally, the findings indicate that there is no significant difference in the average performance scores of male and female students taught hydrocarbons using the MIS. This aligns with the study by Vershima et al. (2025), which also found no significant difference between male and female students taught hydrocarbons through multimedia instruction. This outcome may be attributed to the multimedia instructional approach, which provides engaging and concrete learning experiences for all students, irrespective of gender. Again, the result implies that employing MIS could help close the gender gap amongst chemistry students.

Conclusion
In light of the current study's results, MIS has significant impact on senior secondary schools chemistry students' academic performance indicating that is an effective teaching strategy for enhancing meaningful learning. It was also deduce that employing MIS in teaching and learning of chemistry improves academic performance of students regardless of gender.

Recommendations
Taking the research findings into account, the paper set out the ensuing recommendation:
1. To boost students' academic performance, educators should employ the application of multimedia instructional technique into chemistry teaching.
2. Opportunities must be distributed equally, free from any gender disparity.

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