Multi-Media Resources on Chemistry Students' Academic Performance in Environmental Concept in Secondary Schools in Eket Local Government Area, Akwa Ibom State

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ABSTRACT

This study investigated the effect of multimedia resources on chemistry students' academic performance and retention in environmental concepts in secondary schools in Eket Local Government Area, Akwa Ibom State, Nigeria. The study adopted a quasi-experimental design, specifically the pre-test, post-test non-equivalent control group design. The population comprised Senior Secondary School II (SS II) chemistry students, from which a sample was drawn using purposive sampling techniques. The instrument used for data collection was the Environmental Chemistry Achievement Test (ECAT), which was validated by experts and tested for reliability using the Kuder-Richardson Formula 20. Students in both experimental and control groups were taught environmental chemistry concepts. Data collected were analyzed using mean and standard deviation to answer research questions and independent t-test analysis to test hypotheses at 0.05 level of significance. The findings revealed that students exposed to educational videos with animation performed significantly better than those who were exposed to educational videos without animation. Additionally, students in the educational videos with animation group demonstrated higher retention on environmental chemistry concepts compared to their counterparts who were exposed to educational videos without animation. The study therefore concludes that multimedia resources, particularly those with animations are effective instructional tools for enhancing both academic performance and retention in chemistry. It was recommended, among others, that chemistry teachers should integrate multimedia resources into classroom instruction, and that educational stakeholders should provide necessary technological support to facilitate effective teaching and learning of environmental chemistry concepts.

Keywords: Multimedia Resources, Academic Performance, Retention, Environmental Chemistry, Animation-Based Instruction, Secondary School Students

INTRODUCTION

Education is universally acknowledged as the cornerstone of national transformation, scientific advancement, and socio-economic development. In developing nations such as Nigeria, the education sector is entrusted with the responsibility of producing scientifically literate citizens capable of addressing complex societal challenges, including environmental degradation and sustainability concerns. Secondary education, in particular, serves as a crucial transitional stage where learners consolidate foundational knowledge and develop higher-order cognitive skills necessary for tertiary education and productive citizenship. Abasi and Ado (2021) opines that a number of subjects can be identified in the school curriculum at all levels of Nigerian education with the expectation that when properly taught, a more effective learning will occur. The quality of instruction delivered across these levels significantly determines students' academic achievement, conceptual understanding, and long-term retention of knowledge.

Contemporary educational reforms emphasize learner-centered pedagogies, integration of instructional technologies, and contextualized teaching approaches to improve academic outcomes. However, despite these reforms, persistent underachievement in science subjects remains a concern across many Nigerian secondary schools. Scholars have attributed this trend to overreliance on teacher-dominated lecture methods, limited

instructional resources, and insufficient integration of innovative teaching strategies. For instance, Akpan, Udofia and Thomas, (2016); Udofia and Sambo, (2022) have consistently emphasized that the effectiveness of science education in Nigeria is closely tied to the quality of instructional delivery, teachers' innovative capacity, and the availability of supportive learning resources. Abasi (2018) also asserted that effective instructional and learning strategies can be used across grade levels and subject areas, and can accommodate a range of student differences. Therefore, these findings suggest that improving instructional strategies is essential for enhancing students' academic performance in science subjects such as chemistry.

Chemistry occupies a central position in the science curriculum because it provides the conceptual framework for understanding matter, energy transformations, environmental interactions, and industrial processes. As the "central science," chemistry bridges physics, biology, environmental science, and technological innovation. However, it is also widely regarded as one of the most abstract and conceptually demanding subjects at the secondary school level. Topics such as chemical reactions, molecular interactions, atmospheric chemistry, and biochemical cycles often require students to visualize microscopic processes that cannot be observed directly. When such topics are taught using traditional expository methods without supportive instructional aids, students may struggle to construct meaningful mental models.

Empirical evidence from Nigerian educational research indicates that students' performance in chemistry has remained inconsistent, particularly in conceptually intensive areas that require visualization and application. Udofia (2016) highlighted the importance of integrating information and communication technologies (ICT) into science instruction to address conceptual difficulties and promote deeper engagement. Similarly, Udofia and Sambo (2022) underscored the role of scientific attitude and innovative pedagogy in enhancing learners' achievement and long-term understanding. Additional studies attribute low student performance in the subject to the use of unsuitable teaching approaches by educators (Udofia & Sambo, 2021). These studies collectively suggest that traditional instructional approaches may be insufficient for achieving desired learning outcomes in chemistry. The conventional teaching method which is confined to storytelling, reading, and memorizing has failed to be effective in the acquisition of scientific knowledge by learners as it emphasizes mere transmission of already known information to learners without allowing the students to see, touch, manipulate, ask questions, allow learners to independently find solutions and draw conclusions during their learning activities (Akpan, Umanah & Udofia, 2025).

Environmental concepts constitute a critical component of the chemistry curriculum at the secondary school level. Topics such as pollution, erosion, and deforestation are increasingly emphasized due to their relevance to global sustainability agendas and Nigeria's environmental realities. Pollution, for instance, requires understanding chemical contaminants, atmospheric reactions, acid rain formation, and water treatment processes. Erosion involves chemical and physical interactions within soil systems, while deforestation connects to carbon cycling, biochemical processes, and ecological equilibrium. These topics demand interdisciplinary reasoning and the ability to integrate chemical knowledge with environmental awareness.

In regions such as Eket Local Government Area of Akwa Ibom State; characterized by oil exploration and industrial activities, environmental issues are not merely theoretical concepts but lived realities. Students in such communities are exposed to environmental challenges that directly affect their surroundings. However, without effective instructional strategies, learners may fail to connect classroom knowledge with real-world environmental phenomena. This disconnect can lead to superficial understanding and poor academic performance in environmental chemistry topics.

The integration of multimedia resources has been widely advocated as a transformative approach to addressing these instructional challenges (Sunday, Umanah & Udofia, 2025). Multimedia resources encompass animations, simulations, videos, interactive graphics, and digital presentations designed to enhance cognitive processing (Akpan, Atabang & Udofia, 2025; Akpan, Udofia & Uko, 2025). According to the Cognitive Theory of Multimedia Learning proposed by Richard E. Mayer (2014), learners process information more effectively when presented with coordinated verbal and visual representations. This dual-channel processing reduces cognitive overload and facilitates deeper comprehension of complex material.

Animations, in particular, have proven highly effective in science education because they provide dynamic visualizations of processes that are otherwise invisible to the naked eye. In chemistry, animations can illustrate molecular collisions, chemical bonding, diffusion of pollutants, greenhouse gas accumulation, and soil degradation processes in ways that static diagrams cannot. Through movement and sequencing, animations help learners build accurate mental models, thereby strengthening conceptual understanding.

Research evidences supports the positive impact of multimedia instruction on students' academic achievement (Umoessien, Udofia & Umanah, 2025; Udofia, Akpan, Babayemi & Jonah, 2024; Udofia, Babayemi & Sambo, 2024). Okure, Uko, Udofia and Umanah (2025) reported that ICT-enhanced science instruction significantly improved student engagement and conceptual clarity in Nigerian classrooms. Further studies within science education literature between 2017 and 2024 have shown that multimedia integration enhances motivation, fosters active participation, and promotes collaborative learning. These pedagogical advantages contribute directly to improved academic performance.

Beyond immediate academic performance, retention remains a critical dimension of effective learning. Retention refers to the ability of students to store information in long-term memory and retrieve it accurately after a period of time. In chemistry education, poor retention often results from rote memorization without conceptual understanding. When learners fail to construct meaningful connections between concepts, knowledge fades quickly after examinations.

Multimedia resources, particularly animations, enhance retention through multimodal reinforcement. Visual imagery combined with auditory explanation strengthens encoding processes within memory systems. Cognitive psychologists argue that information presented through multiple sensory channels is more likely to be retained because it forms interconnected neural pathways. Udofia and Sambo, (2022) emphasized that sustainable academic success depends not only on exposure to content but on meaningful cognitive engagement facilitated by innovative instructional strategies. By enabling students to visualize environmental processes repeatedly, multimedia tools support long-term memory consolidation and knowledge transfer.

Despite documented benefits, the implementation of multimedia resources in many secondary schools in Akwa Ibom State remains inconsistent. Challenges include inadequate infrastructure, limited teacher training, erratic power supply, and insufficient policy support. Moreover, while general studies have explored ICT integration in science education, there remains limited empirical evidence specifically examining the effect of multimedia animations on students' academic performance and retention in environmental chemistry concepts within Eket Local Government Area.

Given the environmental sensitivity of Eket and the conceptual complexity of pollution, erosion, and deforestation topics, investigating the pedagogical value of multimedia resources is both timely and necessary. Understanding whether animation-supported instruction significantly improves students' academic performance and retention can provide empirical evidence to guide curriculum planners, policymakers, and educators in optimizing instructional strategies.

The relevance of multimedia resources to chemistry instruction, particularly in environmental concepts, has been strongly emphasized. In their study on ICT integration in science education, Udofia, Akpan, and Thomas (2016) established that the use of technology-driven instructional materials significantly improves students' understanding of complex scientific concepts. When applied to environmental chemistry topics such as pollution, erosion, and deforestation, multimedia tools, especially animations; provide visual representations of abstract processes, enabling students to connect theoretical knowledge with real-life environmental issues. This is particularly important in regions like Eket Local Government Area, where environmental challenges are prevalent and require meaningful scientific understanding.

Furthermore, the issue of students' academic performance in chemistry has been linked to instructional strategies and learning conditions. Udofia and Sambo, (2022) in examining the role of scientific attitude and learning engagement, reported that students exposed to innovative and interactive teaching methods demonstrated significantly higher academic achievement compared to those taught using traditional approaches. In the context of this study, animation-based multimedia instruction is expected to enhance students' interest and engagement

in environmental chemistry concepts, thereby improving their academic performance. This is crucial for topics such as pollution and deforestation, which require not only theoretical understanding but also critical thinking and real-world application.

In addition, retention of learned concepts remains a major challenge in chemistry education, particularly when students rely on rote memorization.

Empirical evidence such as Edem, Akpan and Udofia (2023) revealed that the use of multiple instructional resources significantly enhances students' retention and recall ability in science subjects. The study showed that students exposed to multimedia-rich environments were better able to retain and apply scientific knowledge over time. Relating this to environmental chemistry, animation-based instruction is expected to strengthen students' memory of key processes such as pollutant formation, soil degradation, and ecosystem disruption. Therefore, integrating multimedia resources in the teaching of environmental concepts in Eket Local Government Area may not only improve immediate academic performance but also ensure long-term retention of knowledge.

Therefore, this study seeks to examine the influence of multimedia resources particularly animations on chemistry students' academic performance and retention in environmental concepts in secondary schools in Eket Local Government Area, Akwa Ibom State, Nigeria. By situating the investigation within a real environmental context and grounding it in contemporary educational theory and empirical research, the study aims to contribute meaningfully to science education scholarship and instructional innovation.

Statement of the Problem

Despite the recognized importance of science education in fostering environmental awareness and sustainable development, students' academic performance in chemistry at the secondary school level in Nigeria remains a persistent concern. Environmental chemistry concepts such as pollution, erosion, and deforestation are critical components of the curriculum due to their relevance to contemporary global and local environmental challenges. However, these concepts are often abstract, interdisciplinary, and cognitively demanding for learners, especially when delivered using predominantly lecture-based instructional methods.

Empirical evidence suggests that traditional teaching approaches in many Nigerian secondary schools emphasize verbal exposition and textbook dependency, with limited integration of innovative instructional technologies. Scholars have consistently noted that inadequate utilization of instructional resources and limited pedagogical innovations contribute significantly to low academic achievement in science subjects. Furthermore, research on ICT integration in science classrooms indicates that although multimedia tools possess strong pedagogical potential, their practical implementation remains inconsistent and underutilized in many public secondary schools.

In environmentally sensitive regions such as Eket Local Government Area of Akwa Ibom State where industrial activities and ecological degradation are prevalent the need for effective environmental education is particularly urgent. Students in this locality are expected not only to understand theoretical chemical principles but also to apply such knowledge in interpreting environmental issues within their communities. However, anecdotal classroom observations and regional academic reports indicate that students often demonstrate weak conceptual understanding and poor retention of environmental chemistry topics. This suggests a disconnection between curriculum intentions and classroom instructional realities.

While previous studies have examined ICT integration and general multimedia use in science education, there is limited empirical evidence specifically addressing the impact of animation-based multimedia resources on students' academic performance and retention in environmental chemistry concepts within Eket Local Government Area. Moreover, few studies have simultaneously examined both immediate academic achievement and long-term retention outcomes within this specific contextual setting. Therefore, the core problem underpinning this study is the persistent low academic performance and inadequate retention of environmental chemistry concepts among secondary school students in Eket Local Government Area, potentially resulting from insufficient integration of multimedia instructional resources. The absence of localized empirical evidence on

the effectiveness of animation-supported multimedia instruction creates a research gap that necessitates systematic investigation.

Consequently, this study seeks to determine whether the integration of multimedia resources, particularly animations can significantly enhance students' academic performance and retention in environmental chemistry concepts (pollution, erosion, and deforestation) in secondary schools in Eket Local Government Area, Akwa Ibom State, Nigeria.

Purpose of the Study

The main purpose of this study is to investigate the effect of multimedia resources on chemistry students' academic performance and retention in environmental concepts in secondary schools in Eket Local Government Area, Akwa Ibom State, Nigeria.

Specifically, the study seeks to:

1. Determine the effect of educational videos with animation on students' academic performance in environmental concepts in chemistry (pollution, erosion, and deforestation).
2. Determine the effects of educational videos with animation on students' retention in environmental concepts.

Research Questions

1. What is the difference in academic performance scores of students in chemistry when taught environmental chemistry concepts using educational videos with animation and those exposed to educational videos without animation?
2. What is the mean difference in retention scores of students when taught environmental chemistry concepts using educational videos with animation and those exposed to educational videos without animation?

Hypotheses

1. There is no significant difference in the mean performance scores of Chemistry students when taught environmental chemistry concepts using educational videos with animation and those exposed to educational videos without animation.

2. There is no significant difference in the mean retention scores of students in chemistry taught environmental chemistry concepts using educational videos with animation and those exposed to educational videos without animation.

METHODS

This study adopted a quasi-experimental research design, specifically the pre-test, post-test non-equivalent control group design. The choice of this design was informed by the nature of the school system where intact classes are used and random assignment of individual students is practically difficult. The design enabled the comparison of students exposed to multimedia resources (educational videos with animation and those exposed to educational videos without animation). Both groups were pre-tested before treatment to establish baseline equivalence, post-tested after the instructional period to determine academic performance, and later assessed using a delayed post-test to measure retention.

The study was conducted in Eket Local Government Area of Akwa Ibom State, Nigeria. Eket is an environmentally sensitive region characterized by oil exploration activities and environmental issues such as pollution and land degradation. The contextual relevance of environmental chemistry concepts to students in this area made it an appropriate location for investigating the effect of multimedia resources on learning outcomes.

The population of the study comprised all 2300 Senior Secondary School II (SS II) chemistry students in public secondary schools in Eket Local Government Area during the 2025/2026 academic session. SS II students were selected because environmental chemistry concepts such as pollution, erosion, and deforestation are embedded

within their curriculum and they are not examination-bound exit classes, thereby minimizing external academic pressures.

A simple random sampling technique was used to select two public secondary schools with functional ICT facilities capable of supporting multimedia instruction. From the selected schools, intact SS II classes were used for the study. This approach ensured minimal disruption to normal school activities while maintaining internal validity. The instrument used for data collection was a researcher-developed Environmental Chemistry performance Test (EPAT). The EPAT consisted of 20-items structured multiple-choice questions with options A-D covering topics on pollution, erosion, and deforestation. The instrument was designed to measure both academic performance and retention. Academic performance was assessed using pretest and post-test scores; while retention was measured using the same instrument reshuffled and re-administered four weeks after the post-test. In scoring the instrument, every correct option response was awarded 1mark and wrong option response 0mark giving a total of 20marks.

To ensure instrument validity, the EPAT was subjected to face and content validation by experts in Chemistry Education and Measurement and Evaluation. Their recommendations regarding clarity, content relevance and alignment with instructional objectives were incorporated before final administration. A pilot study was conducted using 50 students outside the study sample to establish reliability. The reliability of the instrument was determined using the Kuder-Richardson Formula 20 (KR-20) due to the dichotomous nature of the test items. A reliability coefficient of 0.70 was obtained and considered acceptable for the study.

The procedure for data collection involved several stages. First, the pre-test was administered to both experimental and control groups to determine their initial equivalence in environmental chemistry knowledge. Following the pre-test, the experimental group was taught selected environmental chemistry concepts; pollution, erosion, and deforestation using multimedia resources, particularly educational videos with animation and educational videos without animation, for a period of four weeks. These multimedia tools included animated visualizations, instructional videos, and interactive digital presentations designed to enhance conceptual understanding. At the end of the treatment period, a post-test was administered to both groups to measure academic performance. Four weeks after the post-test, a retention test was conducted to determine the extent to which students retained the learned concepts.

Data collected were analyzed using both descriptive statistics. Mean and standard deviation were used to answer the research questions by comparing the performance and retention scores of both groups. Independent t-test statistics was employed to test the null hypothesis at 0.05 level of significance. This statistical procedure enhanced the precision of the treatment effect estimation and strengthened the validity of the findings.

RESULTS AND DISCUSSION OF FINDINGS

The result were presented according to research questions and corresponding hypothesesResearch question one: What is the difference in academic performance scores of students in chemistry when taught environmental chemistry concepts using educational videos with animation and without?

Table 1:Mean and standard deviation scores of students on pretest and posttest classified by treatment groups

Treatment	N	Pre-test		Post-test		Posttest Mean difference
		Mean	SD	Mean	SD	
Educational videos with animation	25	44.16	4.91	77.40	8.31	
						8.40
Educational videos without animation	25	44.09	4.59	69.00	19.09	

Table 1 showed the descriptive statistics of students taught the environmental concepts using educational videos with animation and those taught without animations. The table revealed student's pretest scores of 44.16 and 44.09 for both groups showing that the group pre-entry abilities were equivalence before treatment. The table further revealed that students taught environmental concept had a posttest mean score of 77.40 while those taught

without animation had 69.00 with a posttest mean difference of 8.40. This observation shows that students taught the environmental concepts using educational videos with animation show superiority in academic performance than those taught without animation.

Research Question two: What is the mean difference in retention scores of students when taught environmental chemistry concepts using educational videos with animation and without?

Table 2: Mean and standard deviation on retention scores of chemistry students taught environmental concepts using educational videos with animation and without.

Treatment	N	$\bar{X}$	SD	Mean difference
Educational videos with animation	25	80.00	7.71	
				4.65
Educational videos without animation	25	75.35	8.66	

In Table 2, the results showed that students taught environmental concepts using Educational videos with animation and those without had retention scores of 80.00 and 75.35 respectively with retention difference of 4.65. This observation showed superiority of students exposed to environmental concepts using educational videos with animation.

Testing of Hypotheses

Hypothesis one: There is no significant difference in the mean performance scores of chemistry students when taught environmental chemistry concepts using educational videos with animation and without.

Table 3: Independent t-test analysis of posttest scores of students taught environmental chemistry concepts using educational videos with animation and without (N=50)

Treatment	N	$\bar{X}$	SD	df	t-cal.	t-crit.	Remarks
Educational videos with animation	25	77.40	8.31				
				48	2.12*	2.01	S
Educational videos without animation	25	69.00	19.09				

*significant @ 0.05 level of significance

In Table 3, the calculated t- value for the main effect of treatment at 48 degree of freedom is 2.12 while its corresponding t-critical value is 2.01 indicating that treatment had significant effect on the performance of students in environmental concept in chemistry. Hence the null hypothesis earlier stated is rejected at 0.05 level of significant.

Hypothesis two: There is no significant difference in the mean retention scores of students in chemistry taught environmental chemistry concepts using educational videos with animation and without.

Table 4: Independent t-test analysis of retention scores of chemistry students taught environmental concept using educational videos with animation and without (N=50)

Table 4.	N	$\bar{X}$	SD	df	t-cal.	t-crit.	Remarks
Educational videos with animation	25	80.00	7.71				
				48	2.41*	2.01	S
Educational videos without animation	25	75.35	8.66				

*significant @ 0.05 level of significance

In Table 4, the calculated t-value for the main effect of treatment at 48 degree of freedom is 2.41 while its corresponding t-critical value is 2.01, indicating that statistically there is significant effect on the retention mean

scores of students in environmental concept taught using educational videos and those taught without. Hence, the null hypothesis earlier stated is rejected at 0.05 level of significance.

DISCUSSION OF FINDINGS

These findings revealed that there was statistically significant difference between the academic performances mean scores of students taught environmental concept using educational videos with animation and those taught without. This implies that treatment offered to the groups played a key role in improving students' knowledge in environmental concepts in chemistry. These findings support the study of Akpan, Udofia and Uko (2025) whose finding revealed a significant difference in the mean performance scores of science education undergraduate students taught atmospheric photochemistry using electronic and print instructional resources in favour of those that were taught using electronic resources. The finding also support the assertion of Udofia (2024) who affirmed that ineffective teaching method adopted in chemistry, often leads to poor academic performance. Thus employing appropriate teaching method makes learning very easy.

The result of hypothesis two revealed that there exist a significant difference in the retention mean scores of chemistry students when exposed to environmental concept using educational videos with animation and those taught without animation. The result of this study agrees with the results of Ekpo, Utibe and Udofia (2024) who in their study to assess retention scores of students in physics maintain that teaching strategies to a greater extent affect students' retention in science. Also in support of this finding, Atabang and Umanah (2024) reported from their findings a significant difference in the mean retention score of basic science and technology students taught using computer animation with text and those taught using computer animation with narration.

CONCLUSION

The following conclusions were made based on the findings of this study:

The result of this study provides empirical evidence that the use of educational videos with animation enhance student academic performance in chemistry, Secondly, there is significant difference in the retention mean scores of students exposed to environmental concepts using educational videos with animation.

RECOMMENDATIONS

The following recommendations were made based on the finding of this study:

1. Since the use of educational videos with animation enhances academic performance, it should be employ in classroom teaching and learning.
2. Secondary schools teachers\lecturers should be encouraged to be computer literate. This would enable them appreciate and use educational videos with animation to promote effective teaching.
3. The federal Government, State Government, local Government and organizations should help chemistry teachers to attend Conferences, Workshops; seminars organize in Nigeria and outside the country.
4. Authors of Chemistry textbooks should shift emphasis from traditional method of writing to educational videos with animation.

Limitations of the Study

This study was limited by certain factors. The sample size of 50 students drawn from only two public secondary schools in Eket Local Government Area may limit the generalization of the findings to all secondary schools in Akwa Ibom State or Nigeria as a whole. The duration of the treatment was also relatively short, which may not have adequately captured the long-term effects of the educational videos with animation and without animation on students' retention of the knowledge of environmental concepts. Additionally, the study focused only on environmental concepts in Chemistry, so the findings may not be directly transferable to other topics. Financial and time constraints also restricted the scope of the study. Despite these limitations, the findings provide useful insights into the effectiveness of educational videos with animations and without animations on chemistry students' academic performance and retention in the environmental concepts.

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