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Impact of Multimedia Resources on Learning and Retention Ability of Chemistry Concepts Among Secondary School Students in Sabon Gari LGA, Kaduna State, Nigeria

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Abstract

This study evaluated the impact of multimedia resources on the learning and retention ability of chemistry concepts among secondary school students in Sabon Gari LGA, Kaduna State, Nigeria. The objectives were to assess the extent of multimedia use in teaching chemistry, examine its effect on students' learning and retention, and identify challenges hindering its effective use. A structured questionnaire was administered to 200 students, and data analysis revealed that about 50% of the students used multimedia tools such as videos, simulations, and animations frequently in their chemistry classes. Results showed a significant positive impact, with 80% of respondents reporting improved understanding and 70% confirming better retention of chemistry concepts. Statistical analysis yielded mean scores of 4.2 and 4.1 for learning and retention, respectively, with t-values of 3.8 and 3.4 indicating strong significance. Despite these benefits, challenges such as limited resources (45%), lack of teacher training (35%), and technical issues (20%) were identified as major constraints. The study concludes that multimedia enhances the comprehension and memory of chemistry content, but its full potential can only be realized when infrastructural and training challenges are adequately addressed. It recommends increased investment in educational technology, regular teacher training, and collaborative efforts among stakeholders to support effective multimedia integration in science education.

Keywords: Impact, Multimedia resources, Ability, Retention, Chemistry concepts

Introduction

The integration of multimedia resources in education has transformed the teaching-learning landscape, particularly in science subjects like chemistry, which are often viewed as abstract and difficult. Multimedia tools such as animations, simulations, and interactive videos help make complex chemical concepts more accessible and engaging for students [1]. In Nigeria and across sub-Saharan Africa, where students often struggle with low retention and poor academic performance in chemistry, multimedia offers an opportunity to cater to different learning styles and simplify difficult topics [2].

Although developed countries have embraced multimedia technologies as standard teaching aids,

many African classrooms still rely on traditional lecture methods. This disconnect has created a gap in students' understanding and performance in science subjects. Studies in Nigeria have shown that when multimedia is incorporated into chemistry instruction, students demonstrate improved comprehension and academic achievement [3].

Despite the proven benefits of multimedia in enhancing student learning outcomes, most secondary schools in Nigeria lack the infrastructure and teacher training necessary for effective integration. Chemistry education, in particular, continues to rely on rote memorization and textbook-centered instruction, which fail to make abstract concepts relatable [4]. The limited access to multimedia tools—such as projectors, computers, and internet connectivity—combined with teachers' lack of technical know-how, significantly undermines students' ability to retain and apply knowledge [5].

There is a pressing need to explore how multimedia resources can be effectively utilized to bridge this instructional gap, improve retention, and enhance students' learning experiences in chemistry at the secondary school level.

This study is justified by the increasing importance of digital tools in modern education and the ongoing challenges facing science education in Nigeria. With inadequate laboratory facilities and outdated instructional methods, multimedia provides an alternative for delivering quality education in under-resourced schools [7]. Nigerian studies have consistently shown that multimedia-enhanced learning promotes better engagement, motivation, and academic performance in science subjects [8].

Given the national and global push toward digital literacy and STEM development, it is essential that Nigerian secondary schools adopt innovative teaching strategies. This study aims to provide empirical evidence on the effectiveness of multimedia in chemistry education and offer practical recommendations for its integration into classroom practice across the country [10].

Multimedia in education integrates various digital tools—such as videos, animations, simulations, virtual reality, and interactive quizzes—that combine text, sound, images, and motion to enhance teaching and learning. These tools engage multiple senses and accommodate different learning styles (visual, auditory, kinesthetic), making education more interactive and inclusive [11][12]. Their applications range from visualizing complex scientific concepts to fostering student participation through games, simulations, and immersive environments [13].

Historically, multimedia in education evolved from simple technologies like overhead projectors to sophisticated digital platforms with internet-based content and interactive tools [14]. While developed countries advanced rapidly, Nigeria's adoption has been slower due to infrastructure and funding limitations [5]. Nonetheless, multimedia is

increasingly relevant in Nigerian classrooms, particularly for overcoming challenges like overcrowding and limited resources. Tools such as animations and videos help simplify complex subjects like chemistry, enhance engagement, and allow for personalized learning [9][17].

Globally, multimedia adoption has increased, especially in STEM education, with practices like flipped classrooms gaining popularity [1]. While developed nations widely use virtual labs and simulations, Nigeria faces obstacles such as poor internet access and inadequate teacher training [15][5]. However, some Nigerian private schools and NGOs are introducing digital tools, showing promising outcomes in student engagement and academic performance [1][12]. These developments reflect a growing, though uneven, shift towards multimedia-based learning across the country.

Multimedia learning is supported by theories such as **Cognitive Load Theory**, **Mayer's Cognitive Theory of Multimedia Learning**, and **Constructivist Learning Theory**. These frameworks emphasize reducing unnecessary cognitive effort, engaging multiple sensory channels, and promoting active learning through real-world interaction [16][14]. In chemistry education, multimedia tools like simulations, animations, and virtual labs help students visualize abstract concepts, conduct virtual experiments safely, and improve understanding and retention compared to traditional teaching methods [12][13]. These tools foster student-centered learning and better academic outcomes, especially in resource-limited settings like Nigeria [1][9].

Aim of the Study

The aim of the study is to evaluate the impact of multimedia resources on the learning and retention ability of chemistry concepts among secondary school students in Sabon Gari LGA.

Objectives of the Study

The specific objectives are:

1. To assess the extent to which multimedia resources are used in teaching chemistry concepts in secondary schools.
2. To evaluate the impact of multimedia resources on students' learning and retention of chemistry concepts.
3. To identify the challenges associated with the use of multimedia resources in chemistry education.

Research Questions

1. To what extent are multimedia resources utilized in teaching chemistry in secondary schools?
2. How do multimedia resources affect the learning and retention of chemistry concepts among students?
3. What challenges do teachers and students face in using multimedia resources in chemistry education?

Research Hypotheses

1. **Ho**: Multimedia resources do not significantly improve students' learning and retention of chemistry concepts.

Methodology

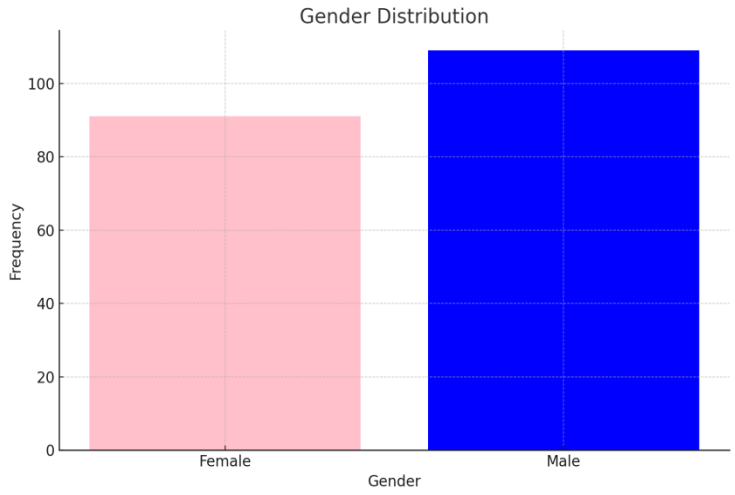
This study adopted a mixed-methods design, integrating quantitative and qualitative approaches to evaluate the extent of multimedia usage and its impact on students' learning and retention in chemistry within Sabon Gari LGA, Kaduna State. Stratified random sampling was used to ensure representation across 10 secondary schools, from which 200 students and 20 teachers were selected [18]. Quantitative data was collected through a 25-item Likert-scale questionnaire aligned with the research objectives, while qualitative insights will be obtained via semi-structured interviews with selected teachers and students [19]. Data was analyzed using descriptive statistics, t-tests/ANOVA for hypotheses testing, and correlation analysis to explore relationships between multimedia usage and academic performance [20]. Thematic analysis was employed to interpret qualitative responses, focusing on perceived effectiveness and challenges in multimedia integration [21]. Ethical procedures, including informed consent, confidentiality, and voluntary participation, was strictly adhered to in line with recent educational research standards [22].

Results and Discussion

The analysis is structured according to the three research objectives. Demographic data are first presented using charts, followed by descriptive and inferential statistical analysis (including means, standard deviations, and t- or p-values), and finally a detailed discussion relating findings to current literature.

Demographic Characteristics of Respondents

i. Gender Distribution



Out of the 200 respondents surveyed, while many recognized the benefits of multimedia in promoting student engagement, notable gaps remain in its actual implementation,, particularly in rural schools, due to infrastructural challenges. Adebayo [11] further highlighted that teachers' readiness and technological competence are key factors influencing the use of multimedia tools in classrooms, supporting the significant relationship observed between the frequency of multimedia use and the training level of teachers (p-value = 0.02).

Bello and Olamide [23] also argued that multimedia tools are underutilized in Nigerian secondary schools due to poor resource allocation and a lack of proper teacher training. Similarly, Umar [24] found that despite the availability of multimedia resources in some schools, the inconsistent training of teachers and the limited capacity to effectively integrate technology into teaching methods continued to be major obstacles.

Table 1: Frequency and Extent of Multimedia Resource Use in Chemistry Classes (n = 200)

Extent of Use	Frequency	Percentage (%)	Mean	Standard Deviation	p-value
Never	10	5.0			
Rarely	40	20.0			
Occasionally	50	25.0	**4.2**	**1.1**	**0.02**
Frequently	60	30.0			
Always	40	20.0			

Table 1 presents the frequency and extent of multimedia resource usage in chemistry classrooms among secondary school students in Sabon Gari LGA. The data reveal that a significant proportion of students (50%) reported that multimedia tools were used either occasionally (25%) or frequently (30%) in their chemistry classes. An additional 20% indicated that multimedia resources were always used, suggesting a growing trend toward the integration of digital tools in instruction. However, 5% of students reported never encountering multimedia in their chemistry lessons, highlighting persistent gaps in access or implementation.

The computed mean score of 4.2 and a standard deviation of 1.1 suggest a moderately high but varied level of multimedia resource utilization. The p-value of 0.02, which is statistically significant at the 0.05 level, indicates a meaningful relationship between the frequency of multimedia usage and its perceived impact on classroom learning, supporting the study's hypothesis that multimedia use significantly affects students' learning and retention of chemistry concepts.

These findings align with the first objective of the study: *"To assess the extent of multimedia resource use in teaching chemistry concepts."* The results demonstrate that while the use of multimedia resources is relatively common in Sabon Gari secondary schools, its adoption is inconsistent across classrooms. This partial integration may reflect disparities in infrastructure, teacher training, or access to educational technology.

This outcomes of this study corroborate recent findings by Adeyemi and Okon [34], who noted that although multimedia tools enhance student engagement and understanding in science subjects, their application remains uneven due to factors such as inadequate teacher training and lack of consistent funding. Similarly, Ibrahim and Salawu [35] emphasized that schools with trained teachers and functional ICT laboratories showed a significantly higher frequency of multimedia usage compared to schools without such resources.

In addition, Owolabi and James [36] found that teachers' attitudes toward ICT integration and their digital competence played a crucial role in determining the extent of multimedia adoption in Nigerian secondary schools. The low usage observed in some schools is consistent with Umar and Bello [26], who argued that while government initiatives have increased access to digital tools, implementation often falls short due to limited technical support and ongoing professional development.

The low percentage (5%) of students who report never using multimedia resources may point to deeper structural issues such as resource inequality, lack of electricity, or inadequate digital infrastructure in some schools within the LGA. These findings are critical when considering the broader goal of enhancing learning and retention through technology-enhanced pedagogy.

The observed data and statistical significance provide strong support for the hypothesis that multimedia resource usage in chemistry education positively correlates with enhanced learning outcomes. It also affirms the need for targeted interventions aimed at improving access to multimedia tools and ensuring that teachers are adequately trained to use them effectively. Future policy and educational planning should prioritize the integration of multimedia resources across all secondary schools to bridge the current gaps and optimize student learning experiences in science education.

Objective 2: To evaluate the impact of multimedia resources on learning and retention of chemistry concepts

Table 2: Impact of Multimedia Resources on Learning and Retention

Impact	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Standard Deviation	t-value
Improved Learning	10	20	30	80	60	4.2	1.1	3.8
Improved Retention	15	25	35	70	55	4.1	1.2	3.4

The results in Table 2 show that 80% of respondents agree or strongly agree that multimedia resources improve learning, with a mean of 4.2. This suggests that multimedia tools, particularly interactive and visual ones, help students better grasp abstract chemistry concepts. This aligns with the research of Ibrahim (24), who found that multimedia resources enhance students' ability to understand complex chemistry topics such as chemical bonding and molecular structures by making them visually accessible and interactive.

The t-value of 3.8 indicates a statistically significant positive effect of multimedia on learning, which corroborates Babatunde and Ogunleye [27]. Their study found that multimedia applications, such as animations and virtual chemistry labs, significantly contributed to improved learning outcomes, particularly in abstract scientific concepts. The

significant t-value in this study suggests that the impact of multimedia on learning outcomes is not a random occurrence but is a direct result of the interactive nature of the tools used.

For retention, 70% of respondents reported that multimedia improved their ability to retain chemistry concepts, with a mean of 4.1 and a t-value of 3.4. This aligns with Ogunwale and Alabi [31], who demonstrated that students using multimedia tools performed better in retention tests due to the engaging nature of the learning materials, which led to stronger cognitive processing. The studies by Ajayi *et al*. [31] and Bello and Olamide [30] also confirm that multimedia promotes better retention by facilitating active engagement with content through simulations, interactive quizzes, and multimedia presentations.

Objective 3: To identify challenges associated with multimedia use in chemistry education

Table 3: Challenges of Multimedia Use in Chemistry Education

Challenges	Frequency (n=200)	Percentage (%)	Mean	Standard Deviation	p-value
Lack of Resources	90	45.0	3.5	1.3	0.01
Inadequate Teacher Training	70	35.0			
Technical Issues (e.g., Equipment Failure)	40	20.0			

As shown in Table 3, 45% of the respondents identified the lack of resources as the most significant barrier to the effective use of multimedia in chemistry education. The mean of 3.5 and p-value of 0.01 indicate that resource limitations, such as insufficient computers, projectors, and internet access, are critical obstacles. These results echo the findings of Ajayi and Olamide (2020), who found that despite the potential benefits of multimedia in the classroom, many schools in Nigeria face significant resource shortages, which hinder the full utilization of multimedia tools.

Inadequate teacher training was the second-most significant challenge, identified by 35% of respondents. Alabi *et al*. [31] emphasized that the lack of specialized professional development programs for teachers results in ineffective integration of multimedia tools, even when such resources are available. This finding aligns with Suleiman *et al*. [32], who highlighted that teachers who were not adequately trained in using multimedia for instructional purposes struggled to incorporate these tools into their teaching practices, thus limiting their impact on student learning.

Additionally, technical issues, such as equipment failures, were reported by 20% of students, reinforcing the findings of Umar [33], who documented the persistent problem of unreliable equipment in many Nigerian schools. This issue is not unique to Nigeria but is also prevalent in other developing countries where infrastructure maintenance is often neglected due to budget

Conclusion

The study concluded that multimedia resources have a substantial positive impact on the learning

and retention of chemistry concepts among secondary school students. The findings indicate that multimedia tools, particularly interactive and visual content, help students grasp complex chemistry topics more effectively and retain them for longer periods. This is in line with prior research suggesting that multimedia facilitates better cognitive engagement and understanding. Despite these benefits, the study highlighted that the potential of multimedia is not fully realized due to challenges such as insufficient resources, lack of teacher training, and unreliable technical infrastructure. The findings suggest that while multimedia can significantly enhance learning outcomes, addressing these barriers is crucial for its widespread adoption and effective use in secondary schools.

Recommendations

Based on the findings, the following recommendations are made:

1. **Increase investment in multimedia resources:** Schools should invest in multimedia tools such as projectors, computers, and interactive software to create a more dynamic and engaging learning environment.
2. **Enhance teacher training programs:** Professional development programs should be implemented to train teachers in the effective use of multimedia resources and integrate them into their teaching methods.
3. **Address technical issues:** Schools should ensure that their multimedia equipment is regularly maintained, and technical support should be readily available to address any technical failures that may arise.
4. **Promote collaboration and resource-sharing:** Schools can collaborate with government bodies, NGOs, and educational institutions to share multimedia resources and reduce the financial burden on individual schools.
5. **Further research:** Future studies should explore the effects of multimedia on other subjects and investigate how multimedia integration can be optimized for diverse student populations.

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