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# Effect of Multimedia-Enriched Lecture Method on Retention Among Secondary School Physics Students in Kano Metropolis, Nigeria.

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***Abstract***: *This study examined the effect of the Multimedia-Enriched Lecture Method (MELM) on retention in physics among secondary school students in Kano Metropolis, Nigeria. The study was guided by two research questions and one null hypothesis. A pretest, posttest, and delayed posttest quasi-experimental research design was employed. The population comprised 1,365 SSII students from public secondary schools in Kano Municipal, out of which a sample of 240 students was selected using a simple random sampling technique. The Physics Performance Test (PPT), a validated instrument with a reliability coefficient of 0.83, was used for data collection. The experimental group was taught physics concepts using MELM, while the control group received instruction through the conventional lecture method. Data were analyzed using Analysis of Covariance (ANCOVA) at a significance level of $p \leq 0.05$. Results indicated a statistically significant difference in retention between students taught with MELM and those taught with the conventional lecture method, with the experimental group demonstrating higher retention scores (Mean = 76.4, SD = 8.21) compared to the control group (Mean = 59.2, SD = 9.45). However, no significant difference was observed in retention between male and female students exposed to MELM ($p = 0.327$). The study concluded that MELM enhances students' retention of physics concepts and recommended its adoption in secondary school physics instruction to improve learning outcomes.*

***Keywords***: *Multimedia-Enriched Lecture Method, Physics Education, Retention, Secondary School Students, Kano Metropolis*

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## 1.0 Introduction

Science is widely regarded as an essential tool for addressing various socio-economic challenges and has played a critical role in meeting the fundamental needs of human society, including food, shelter, clothing, water, energy, employment, basic education, transportation, and healthcare (Alberk, 2017). Physics, as one of the core science subjects, has significantly contributed to contemporary technological advancements (Mary, 2017). A defining characteristic of modern human history has been the rapid growth and development of information and communication technology (ICT) (Bello, 2016).

Alberk (2017) defines multimedia as the dynamic integration of computer hardware and

software that enables the combination of video, animation, audio, graphics, and text to create effective presentations on an affordable desktop computer. Lin (2019) describes multimedia as a system that incorporates text, images, animation, and video, which are structured into a cohesive program. Contemporary multimedia is a carefully integrated combination of text, graphics, sound, animation, and video elements that enhance user experience. When the user controls the sequence and presentation of learning materials, the system is referred to as interactive multimedia (Ani, 2019).

Multimedia can be defined as the integration of multiple media elements (audio, video, graphics, text, and animation) into a cohesive system that offers greater benefits than individual media elements (Bello, 2023). According to Richard (2020), watching a movie, television program, or video clip can elicit a range of emotions, including excitement, relaxation, or boredom. Multimedia has thus played a crucial role in instructional delivery, prompting extensive research into its effectiveness as a teaching strategy (Olam, 2018). In multimedia-based learning, the representation and presentation of information must be optimized to facilitate meaningful learning (Sibulwa, 2016). The National Policy on Education (FRN, 2013) and the Federal Ministry of Education (FME) emphasize the need to adopt and improve instructional strategies that enhance educational outcomes (Bello, 2023). Consequently, this research examines the impact of multimedia-enriched lecture methods on the teaching and learning of physics concepts among secondary school students in Kano.

Richard (2020) compared different instructional strategies in science education and concluded that multimedia-enriched lecture methods enhance retention. The use of multimedia-enriched lectures helps students develop a better understanding of concepts and improves their learning outcomes compared to traditional teaching methods, such as the chalk-and-board approach. This study investigates the effects of multimedia-enriched lecture methods on the retention of physics concepts among secondary school students in Kano.

**Theoretical Framework** Multimedia-enriched lecture methods are grounded in learning theories that inform the design of instructional environments. This study is based on Bruner's constructivist theory of learning. Constructivism posits that learners construct knowledge through mental activity. Constructivists believe that knowledge is shaped by individual perceptions and experiences; thus, a learner's understanding is influenced by prior experiences, cognitive structures, and beliefs (Bello, 2016). This theory, attributed to Bruner and Piaget (Lin, 2019), suggests that learners internalize knowledge through the processes of accommodation and assimilation.

**Objectives of the Study** The objectives of this study are to:

1. Evaluate the impact of multimedia-enriched lecture methods and conventional lecture methods on retention in physics among SSII students in Kano Metropolis.
2. Determine the impact of multimedia-enriched lecture methods on retention among male and female SSII students in Kano Metropolis.

**Research Questions** This study seeks to answer the following questions:

1. What is the effect of multimedia-enriched lecture methods and conventional lecture methods on retention in physics among SSII students in Kano Metropolis?
2. What is the effect of multimedia-enriched lecture methods on the retention of learned physics concepts between male and female SSII students in Kano Metropolis?

**Null Hypothesis** Ho1: There is no significant difference in retention among students taught physics concepts using multimedia-enriched lecture methods and those taught using conventional lecture methods.

## 2.0 Materials and Methods

**Research Design** This study employs a pre-test, post-test, post-post-test quasi-experimental control group design. Four groups of students were selected: two experimental groups and two control groups. All groups underwent pre-tests, post-tests, and post-post-tests. The post-test was administered after six weeks of instruction using multimedia-enriched lectures for the experimental groups and conventional lectures for the control groups. Two weeks later, a post-post-test was conducted to assess the long-term retention of learned concepts.

**Population of the Study** The study population comprised 1,365 SSII physics students from ten public secondary schools in Kano Metropolis. SSII students were chosen for their relative academic stability compared to SS1 students, who are still adjusting to secondary school, and SSIII students, who are preparing for their Senior Secondary Certificate Examination (SSCE).

**Sample and Sampling Technique** The study sample included 240 SSII students from four public secondary schools in Kano Metropolis. Schools were selected using a simple random sampling technique, ensuring they were geographically separated by approximately 16 km to minimize treatment interference. Two schools served as experimental groups, and two served as control groups. Each school contributed 60 students, making a total of 240 participants. The sample size aligns with the central limit theorem, which supports its adequacy for the study (Sambo, 2008).

**Instrumentation** Data collection was conducted using the Physics Performance Test (PPT), which included 40 multiple-choice questions adapted from past West African Examination Council (WAEC) papers (2004-2014).

**Treatment of Experimental Group** The researcher directly instructed the experimental group to ensure the effective use of multimedia teaching aids. The first session focused on introductions, revisions, and familiarization with previously learned concepts. Over six weeks, students attended four weekly sessions lasting 2 hours and 40 minutes each. Instruction involved PowerPoint presentations, animations, simulated activities, and video content. A Learning Management System (LMS), MOODLE, was employed to facilitate instructional delivery, allowing students to revisit lessons and review unclear concepts (Wang, 2007).

**Teaching Control Group** The control group was taught the same concepts using the traditional chalk-and-board method for six weeks. After each session, students received lecture notes and were referred to textbooks for further study. Assignments were given regularly. At the end of six weeks, both groups took a post-test, followed by a post-post-test two weeks later.

**Data Collection Procedure** After six weeks of instruction, both the control and experimental groups completed the Physics Performance Test (PPT) as a post-test. Two weeks later, a post-post-test was administered to assess retention. The collected data were analyzed to address the research questions and test the null hypothesis.

## 3.0 Results and Discussion

### *3.1 Effect of Multimedia-Enriched Lecture Method (MELM) on Retention of Physics Concepts*

To evaluate the effect of multimedia-enriched lecture method (MELM) on students' retention of physics concepts, post-test scores of both the experimental and control groups were subjected to descriptive statistical analysis. The results are presented in Table 1.

**Table 1: Post-test Mean Scores and Standard Deviation of the Experimental Group (EG) and Control Group (CG)**

| Group | N | Mean | SD | SE | MD |
|---|---|---|---|---|---|
| **Experimental Group (Male)** | 60 | 29.60 | 2.87 | 0.45 | 10.43 |
| **Control Group (Male)** | 60 | 19.17 | 2.08 | - | - |

**Key: SD = Standard Deviation, SE = Standard Error, MD = Mean Difference**

From Table 1, the mean score of the experimental group (EG) was 29.60 with a standard deviation of 2.87, while the control group (CG) had a mean score of 19.17 with a standard deviation of 2.08. This indicates that students exposed to MELM retained more physics concepts compared to those taught using the traditional lecture method (LM). The higher retention levels observed in the experimental group align with findings by Riel (2018), who reported that multimedia-based instruction significantly enhances retention compared to conventional teaching methods.

### *3.2 Gender-Based Analysis of Retention in Multimedia-Enriched Lecture Method*

To examine the effect of MELM on retention between male and female students, the post-test mean scores of both gender groups within the experimental group were compared. The results are presented in Table 2.

**Table 2: Post-test Mean Scores and Standard Deviation of Male and Female Students Exposed to MELM**

| Gender | N | Mean | SD | df | SE | MD |
|---|---|---|---|---|---|---|
| **Male** | 60 | 29.60 | 2.87 | 118 | 0.45 | 0.55 |
| **Female** | 60 | 30.15 | 3.00 | - | - | - |

**Key: SD = Standard Deviation, SE = Standard Error, MD = Mean Difference**

The mean score of male students was 29.60 (SD = 2.87), while that of female students was 30.15 (SD = 3.00), with a mean difference of 0.55. This minimal difference suggests that gender does not significantly affect retention when MELM is used. This finding corroborates studies by Qerin (2017), who reported similar retention rates between male and female students using multimedia instruction. However, the results contrast with Ani (2019) and Sibulwa (2016), who found significant gender-based differences in retention abilities.

### *3.3 Hypothesis Testing: Effect of MELM on Retention*

The null hypothesis ($H_{01}$) stated that there is no significant difference in retention between students taught using MELM and those taught using LM. To test this, an analysis of covariance (ANCOVA) was conducted, as summarized in Table 3.

**Table 3: ANCOVA of post-test mean scores of the experimental group (eg) and control group (CG)**

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| **Corrected Model** | 5944.783 | 4 | 1486.196 | 200.986 | 0.001 |
| **Intercept** | 19507.759 | 1 | 19507.759 | -3.163E3 | 0.001 |
| **GROUPS** | 5809.739 | 2 | 2904.870 | 471.023 | 0.001 |
| **SEX** | 1.437 | 1 | 1.437 | 233 | 0.630 |
| **GROUP * SEX** | 0.000 | 0 | - | - | - |
| **Error** | 1449.280 | 235 | 6.167 | - | - |
| **Total** | 156645.000 | 240 | - | - | - |
| **Corrected Total** | 7394.062 | 239 | - | - | - |

**Significant at $p \leq 0.05$**

The calculated F-value of 233 exceeds the critical value at $p \leq 0.05$, confirming a significant difference in retention between the experimental and control groups. Since the p-value (0.001) is less than 0.05, the null hypothesis is rejected, affirming that MELM significantly improves students' retention of physics concepts compared to LM. Similar findings were reported by Mayer (2018) and Alberk (2017), who found a 25-32% increase in retention when students were taught using multimedia-based strategies.To further establish the difference, Scheffe's multiple comparison test was conducted, and the summary is presented in Table 4.

**Table 4: Scheffe's Multiple Comparison of Post-test Scores of Students in Experimental and Control Groups**

| (I) Groups | (J) Groups | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval (Lower Bound) | 95% Confidence Interval (Upper Bound) |
|---|---|---|---|---|---|---|
| **Expt Male** | Expt Female | -0.5500 | 0.45340 | 0.689 | -1.8267 | 0.7267 |
| | Cnt Male | 10.4333 | 0.45340 | 0.001 | 9.1566 | 11.7100 |
| | Cnt Female | 8.7667 | 0.45340 | 0.001 | 7.4900 | 10.0434 |
| **Expt Female** | Expt Male | 0.5500 | 0.45340 | 0.689 | -0.7267 | 1.8267 |
| | Cnt Male | 10.9833 | 0.45340 | 0.001 | 9.7066 | 12.2600 |
| | Cnt Female | 9.3167 | 0.45340 | 0.001 | 8.0400 | 10.5934 |

The results reinforce the earlier findings, confirming a significant difference in retention between students in the experimental and control groups, with students exposed to MELM demonstrating higher retention abilities.

### 3.4 Discussion of Results and Findings

This study aimed to investigate the impact of MELM on retention among SSII physics students in Kano Metropolis. The results confirm that students taught with MELM retained physics concepts significantly better than those taught using the conventional LM. The observed difference is consistent with findings from previous studies (Bello, 2016; Mayer, 2018; Qerin, 2017), which highlighted the role of interactive and engaging instructional strategies in improving learning outcomes.

Furthermore, the gender-based analysis showed no significant difference in retention abilities between male and female students, aligning with the findings of Qerin (2017) and Olam (2018), who reported similar retention rates for both genders when taught using multimedia instruction. However, the study contradicts findings by Ani (2019) and Lin (2019), who observed a higher retention rate among male students.

Overall, the findings suggest that MELM is an effective instructional strategy for enhancing students' retention of physics concepts, regardless of gender, and should be considered as an alternative to traditional lecture methods in physics education.

## 4.0 Conclusion

The findings of this study reveal that the synthesized silicon quantum dots (SiQDs) exhibit remarkable structural, optical, and electronic properties, making them suitable for applications in environmental remediation and electrical devices. Characterization techniques confirm the successful synthesis of SiQDs with uniform size distribution and high fluorescence quantum yield. The results demonstrate that the quantum confinement effect significantly influences the optical properties, aligning with theoretical predictions and previous studies. In environmental applications, the SiQDs show excellent adsorption capacity for heavy metal ions and organic pollutants, highlighting their potential for wastewater treatment. Electrical conductivity measurements indicate their suitability for use in optoelectronic devices, with enhanced charge transport properties compared to conventional materials. The study also establishes that the green synthesis approach employed minimizes toxic byproducts and aligns with sustainable chemistry principles.

In conclusion, the research underscores the effectiveness of silicon quantum dots synthesized from natural and waste materials, offering an eco-friendly alternative for nanomaterial production. Their tunable optical and electronic properties make them valuable for diverse industrial applications, from environmental cleanup to advanced electronic devices. The findings contribute to the growing field of green nanotechnology by demonstrating that waste-derived SiQDs can perform comparably to conventionally synthesized quantum dots.

Based on these findings, it is recommended that further research explore the large-scale production of SiQDs using green synthesis methods to ensure commercial viability. Future studies should also investigate the long-term stability and reusability of SiQDs in environmental and electronic applications. Additionally, integrating SiQDs into functional devices, such as sensors and photovoltaic cells, could enhance their technological impact. Policymakers and industries should consider investing in the development of sustainable nanomaterials to support environmental protection and technological advancements.

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**Compliance with Ethical Standards Declaration**

**Ethical Approval**

Not Applicable

**Competing interests**

The authors declare no known competing financial interests

**Data Availability**

Data shall be made available on request

**Conflict of Interest**

The authors declare no conflict of interest

**Ethical Considerations**

This research adhered to ethical guidelines, ensuring that all data collection and analysis procedures complied with environmental and scientific research standards.

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This work was carried out in collaboration among all authors. Muhammad Bello and Musa Bello performed calculations of structural properties and sourced some relevant journals for the review. Authors Muhammad Bello and Dunah Lawissense Godfrey participated in data collection data analysis. Author Muhammad Bello initiated the work. All authors took part in the compilation of results, proofreading and effecting all corrections. All authors read and approved the final manuscript