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Effects of Video-Based Mobile Technology Instruction on Achievement in Mechanics Concepts of Physics in Niger State, Nigeria.

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Abstract

This study investigated the effects of Video-Based Mobile Technology (VBMT) instruction on senior secondary school students' achievement in Mechanics concepts of Physics. A quasi-experimental pre-test, post-test control group design was adopted. Sixty-two (62) SS2 Physics students (37 males, 25 females) from two public secondary schools in Bida Educational Zone, Niger State, Nigeria, participated in the study. The experimental group was taught using VBMT, while the control group used the conventional lecture method for six weeks. The Mechanics Concept Achievement Test (MCAT), using a test-retest reliability coefficient of 0.90, served as the instrument for data collection. Data were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA) at a 0.05 level of significance. The findings revealed that students exposed to VBMT achieved significantly higher than those taught using the conventional lecture method ($F(1, 57) = 6.012$, $p = 0.017$). Furthermore, using the genders within the experimental group, the male students at ($F(1, 31) = 6.396$, $p = 0.017$), performed significantly higher than their female counterparts. Based on these outcomes, it is recommended that Physics educators should integrate mobile video technology as an intervention to simplify abstract concepts, while consciously deploying gender-inclusive instructional method to bridge the technology-gap for female students.

Keywords: Video Based Mobile Technology, Achievement, Mechanics. Physics.

1. Introduction

Physics is the backbone to any industrial revolution. The senior secondary school Physics curriculum, mechanics forms the structural bedrock upon which other aspects—such as electromagnetism, thermal physics, and modern physics—are built. Despite its great importance, secondary school students in Nigeria consistently exhibit low academic performance in Physics, particularly in the mechanics concepts such as Force, Power, Energy, and Newton's Laws of Motion.

This low achievement is often attributed to systemic issues, which include but not limited to ineffective but teacher-centered teaching strategies, lack of functional physical laboratories, bad foundation in mathematical computations. Traditional lecture methods isolate students making them passive observers, forcing rote memorization over conceptual mastery (Docktor et al., 2015; Garnett & Treagust, 2014).

Furthermore, the low performance in secondary school physics is deeply intertwined with sociocultural and gender dynamics. Societal biases, parental attitudes, and traditional role allocations often discourage the female child from pursuing or excelling in Science, Technology, Engineering, and Mathematics (STEM) pathways (Okebukola, 2013; Oniye, 2013). These deep-seated cultural expectations influence the cognitive upbringing and digital literacy orientation of both male and female children, frequently resulting in gendered disparities in classroom performance.

To break these traditional barriers, modern educational researchers have turned to digital interventions. Video-Based Mobile Technology (VBMT)—instruction delivered through smartphone video assets—offers a flexible solution by translating abstract formulas into dynamic visual illustrations. These portable video tools leverage micro-learning approach, allowing students to repeatedly pause, rewind, and review highly complex calculations outside the time limits of standard classrooms.

While video-based learning frameworks have shown substantial promise worldwide, there remains a critical research gap regarding how these mobile video delivery systems affect high school physics cohorts within resource-limited or rural West African settings. This study specifically evaluated the effectiveness of VBMT instruction on senior secondary school students' academic achievement and long-term knowledge retention in mechanics within Niger State, Nigeria, while analyzing its cross-interactive impact on gender.

Statement of the Problem

In Nigeria's senior secondary school Physics, mechanics stands as a crucial foundation for almost all advanced topics, from electromagnetism to thermal physics. Concepts like Force, Power, Energy, and Newton's Laws of Motion are the essential building blocks. Unfortunately, the statistics show a troubling trend. Between 2014 and 2025, national credit pass rates (grades A1–C6) in the West African Senior School Certificate Examination (WASSCE) fluctuated between 41% and 60%. This means that in several academic cycles, more than half of the students who sat for the exam failed to get a grade that would allow them into university. In Niger State and across the country, diagnostic reports point to the exact same hurdle: students are consistently tripping over the conceptual and mathematical demands of mechanics.

Adding to this challenge is the human side of gender disparity in the Nigerian society. From an early age, many girls face subtle discouragement from pursuing science. Cultural expectations and traditional gender roles often steer boys toward technical fields while quietly suggesting girls belong elsewhere. This creates an uneven playing field in terms of confidence, digital exposure, and support systems. Consequently, we see noticeable gaps not just in immediate exam scores, but especially in how well female students hold onto difficult mechanics concepts over time.

A large percentage of young people today, however, live in a world of smartphones and short videos, and this opens up a hopeful path forward. This unlocks a powerful "micro-learning" approach where students can learn at their own pace: pausing to think, rewinding confusing parts, and re-watching lessons at home. Because mobile phones are widespread even in rural Nigeria, Mobile technology tools offer an inclusive, low-cost way to bridge the massive infrastructure gaps. Consequently, this study investigated whether the use of Video-Based Mobile Technology (VBMT) instruction could address these persistent pedagogical failures and significantly improve students' achievement in mechanics.

Purpose of the Study

The objective of this study was to evaluate the effects of Video-Based Mobile Technology (VBMT) instruction on secondary school physics academic achievement in the Bida Educational Zone of Niger State. The specific objectives sought to:

1. determine the effect of Video-Based Mobile Technology instruction on students' achievement in mechanics concepts relative to the conventional lecture method.
2. examine the influence of gender on the academic achievement of students exposed to VBMT instruction in mechanics concepts.

Research Questions

The study addressed the following research questions:

1. What is the difference in the mean achievement scores in Mechanics Concept Achievement Tests (MCAT) between students taught using VBMT and those taught using the conventional lecture method?
2. What is the difference in the mean achievement scores between male and female students taught using VBMT?

Research Hypotheses

The following null hypotheses were formulated and tested at a 0.05 level of significance:

H_{01}: There is no significant difference in the mean achievement scores of students taught mechanics concepts using Video-Based Mobile Technology (VBMT) and those taught using the conventional lecture method.

H_{02}: There is no significant difference in the mean achievement scores of male and female students taught mechanics concepts using Video-Based Mobile Technology (VBMT).

Methodology

Research Design

This study adopted a quasi-experimental pre-test, post-test, non-equivalent control group design. This design is appropriate for educational settings where random assignment of individual students into isolated groups would disrupt established school structures and schedules. Instead, intact, pre-existing classroom cohorts were assigned to treatment conditions-based ability of electricity supply, Computer laboratory and Mobile phones. The operational design layout is illustrated below:

Experimental Group (Non-Randomized): O1 → X1 → O3

Control Group (Non-Randomized): O2 → X0 → O4

Where:

X1 = Experimental treatment using Video-Based Mobile Technology (VBMT) instruction.

X0 = Control treatment using the conventional lecture method.

O1, O2 = Pre-test measures administered to both groups simultaneously before instruction.

O3, O4 = Post-test measures administered to both groups simultaneously following the six-weeks of engagement.

Population and Sample

The target population comprised all Senior Secondary School Two (SS2) Physics students enrolled during the 2024/2025 academic session within the Bida Educational Zone of Niger State, Nigeria. According to data from the Ministry of Education, Science, and Technology, Minna, the broader state population of this class encompasses 43,474 senior secondary students across 224 schools, while the localized zone contains 5,505 active SS2 physics students (2,605 males; 2,901 females).

A sample of 62 SS2 Physics students (37 males, 25 females) was selected from two public secondary schools in the Bida Educational Zone using a purposive sampling procedure. The inclusion criteria required that the selected schools possess a, reliable cellular internet connectivity, and administrative permission allowing students-controlled access to smartphones for educational tasks.

Through these criteria, Government Technical College, Bida, was selected and assigned as the Experimental Group (n = 34; 21 males, 13 females), while Day Secondary School, Eyagi, Bida, was designated as the Control Group (n = 28; 16 males, 12 females). This sample size complies with the central limit theorem guidelines specified by Tuckman (1975), which states that a minimum sample of 30 participants per experimental condition is statistically viable for experimental research.

Research Instrumentation

Data collection relied on the Mechanics Concept Achievement Test (MCAT). The instrument consists of 40 multiple-choice questions, each featuring four options (A, B, C, and D), spanning core secondary mechanics domains: Newton's laws of motion, force, energy, and power.

Validity and Reliability

To establish psychometric validity, the MCAT items were built around a two-way Table of Specifications mapped directly to the cognitive dimensions of Bloom's Taxonomy.

- Content Validity: This was done by a Senior Lecturer (Ph.D.) from the Department of Science and Environmental Education and an experienced high school Physics teacher in Suleja. An English language teacher also reviewed the items to ensure linguistic clarity and eliminate reading comprehension bias.
- Face Validity: this was done by a senior lecturer to confirm alignment with regional testing guidelines.

To establish reliability, the MCAT was pilot-tested at Army Day Secondary School, Bida—an institution matching population traits but excluded from the main study to prevent contamination. The test was administered twice over a two-week interval using the test-retest method. The resulting paired scores were computed via the Pearson Product-Moment Correlation (PPMC) using SPSS software, yielding a high reliability coefficient of $r = 0.90$, confirming the instrument's stability over time.

Data Collection Procedure

The field intervention was executed over a six-week period during the third term of the 2024/2025 academic session. In the first week, the 40-item MCAT was administered as a pre-test (O1, O2) to establish baseline of entry behavior between the two groups. Over the subsequent four weeks, both groups covered identical curriculum outlines:

- Experimental Group (X1): Instructed via VBMT. Students engaged with selected visual video clips displaying physical demonstrations of forces, energy transfers, and algorithmic calculations on mobile interfaces. These clips were paired with structured mobile study guides, allowing students to review materials at their own pace.
- Control Group (X0): Instructed via the conventional lecture method. The teacher utilized traditional board work, verbal explanations, and standard textbook illustrations.

In the final week, the MCAT was re-administered as a post-test (O3, O4) to quantify immediate academic achievement. To eliminate order-memorization bias, the items were scrambled and re-sequenced for the post-test evaluation.

Method of Data Analysis

Descriptive statistics (means and standard deviations) were utilized to answer the two core research questions. Main and interaction effects were tested using Analysis of Covariance (ANCOVA) at an alpha level of alpha = 0.05. The pre-test achievement scores served as the covariate to statistically control for initial baseline variations between the intact groups. All calculations were processed through SPSS software.

Presentation of Results

Answering Research Questions

Research Question 1

What is the difference in mean achievement scores in the MCAT between students taught Mechanics using VBMT and those taught using the conventional method?

Table 1: Mean Achievement Scores and Standard Deviation of Experimental and Control Groups in the MCAT

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Gain	(Mdf)
VBMT	34	47.70	9.10	67.10	9.80	19.40	5.0
Control	28	51.64	10.37	66.00	8.88	14.36	
Toal	62						

Table 1 indicates that the experimental group exposed to VBMT achieved a post-test mean score of 67.10, whereas the control group finished with a post-test mean score of 66.00. While both instructional groups showed improvement from pre-test baselines, the experimental group achieved a higher mean gain (19.40) compared to the conventional lecture group (14.36). The final difference between the post-test mean achievement scores of the two groups was 5.04 in favor of the VBMT intervention.

Research Question 2

What is the difference in mean achievement scores in the MCAT between male and female students taught using VBMT?

Table 2: Mean Achievement Scores and Standard Deviation of Male and Female Students within the Experimental Group

Group	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Gain	(Mdf)
Male	21	47.75	9.45	63.61	11.01	15.86	14.63
Female	13	47.52	11.43	48.75	7.03	1.23	
Total							

Table 2 shows a clear performance difference between genders under the technology-enhanced instruction. Male students exposed to VBMT advanced from a pretest score of 47.75 to a post-test mean score of 63.61, yielding a mean gain of 15.86. Conversely, female counterparts within the same treatment condition started at 47.52 and completed the study at a post-test mean score of 48.75, demonstrating a minimal mean gain of 1.23. The resulting post-test mean achievement gap between male and female students was 14.63, heavily favoring male participants.

Testing the Hypotheses

Hypothesis 1 (H01) There is no significant difference in the mean achievement scores of students taught Mechanics using VBMT and those taught using the conventional method.

Table 3: ANCOVA of Student Achievement Scores by Instructional Method

Source	Type III SS	df	Mean Square	F	Sig. (p)	Partial η^2
Corrected Model	3192.625^a	4	798.156	20.945	.000	.595
Intercept	2489.769	1	2489.769	65.337	.000	.534
Pre-test (Covariate)	2908.833	1	2908.833	76.334	.000	.572
Teaching Method	229.084	1	229.0846	.012	.017	.095
Gender	0.174	1	0.174	0.005	.946	.000
Error	2172.085	57	38.107			
Total	280476.000	62				
Corrected Total	5364.710	61				

Note: a. R Squared = .595 (Adjusted R Squared = .567), Significant at $p < 0.05$.

The ANCOVA output in Table 3 indicates that the main effect of the treatment (Teaching Method) was statistically significant: $F(1, 57) = 0.12$, $p = 0.017$. Because the calculated probability value (0.017) is less than the selected significance threshold (alpha = 0.05), the first null hypothesis (H01) is rejected. This indicates that the higher achievement gains observed in the VBMT experimental group performed significantly than the control group.

Hypothesis 2 (H02)

There is no significant difference in the mean achievement scores of male and female students taught Mechanics using VBMT.

Table 4: ANCOVA of Experimental Group Achievement Scores by Gender

Source	Type III SS	df	Mean Square	F	Sig. (p)	Partial η^2	
Corrected Model	1239.003^a	2	619.502	11	.934	.000	.435
Intercept	2368.933	1	2368.933	45.635	.000	.595	
Pre-test	897.654	1	897.654	17.	292	.000	.358
Gender	332.004	1	332.004	6.	396	.017	.171
Error	1609.232	31	51.911				
Total	153604.000	34					
Corrected Total	2848.235	33					

Note: a. R Squared = .435 (Adjusted R Squared = .399), Significant at $p < 0.05$.

The inferential data in Table 4 shows that the effect of Gender within the experimental group was statistically significant: $F(1, 31) = 6.396$, $p = 0.017$. Given that the p-value (0.017) falls below the critical value (alpha = 0.05), the second null hypothesis (H02) is rejected. This statistical outcome confirms a significant gender gap in physics achievement when utilizing VBMT, with male students outperforming female students.

Discussion of Findings

The descriptive and inferential results from this study confirm that Video-Based Mobile Technology (VBMT) instruction significantly improves senior secondary school students' academic achievement in mechanics relative to conventional teaching method. The visual and repeatable nature of smartphone-accessible video assets appears to provide an effective cognitive bridge for high schoolers grappling with complex physics principles. This positive outcome aligns with several recent findings in multimedia learning design. For instance, Speirs et al. (2021) demonstrated that when diagnostic testing or mobile video resources are aligned with foundational physics concepts, students show substantial gains because they can review complex content at their own pace. Within developing educational landscapes, these mobile instructional interventions serve as an effective substitute for missing physical lab equipment, enabling interactive learning in resource-limited classrooms (Juita et al., 2023).

The findings presented in Table 2 and Table 4 reveals a statistically significant performance gap between male and female students within the experimental group $F(1, 31) = 6.396$, $p = 0.017$). While male students thrived under the Video-Based Mobile Technology framework—demonstrating a substantial mean gain of 15.86—their female counterparts achieved a negligible mean gain of just 1.23.

This divergence highlights the critical intersection of educational technology and local gender dynamics. In many parts of Nigeria, including Niger State, domestic responsibilities and traditional role allocations often limit the female child's leisure and study time outside of school hours. Because VBMT relies heavily on self-paced, out-of-classroom engagement through mobile devices, female students may face structural barriers, such as restricted device access (where shared family smartphones are prioritized for male children) and time poverty induced by domestic chores. Furthermore, societal biases often steer girls away from technical self-efficacy, resulting in lower confidence when navigating digital learning environments independently

(Okebukola, 2013; Oniye, 2013).
However, this gender gap directly contrasts with several international and regional studies on digital instructional strategy that report gender-neutral or female-superior outcomes. Recent analyses on mobile learning frameworks show that when digital lessons are structured with cooperative, peer-led activities, female students perform just as well as, or better than, their male peers. Furthermore, studies like those by Docktor et al. (2015) emphasize that structured problem-solving modules help in minimize gender gaps in high school physics by shifting the focus from technology manipulation to collaborative conceptual reasoning. These conflicting perspectives indicate that mobile learning tools themselves are not inherently biased.

Limitations of The Study

1. Lack of Random Assignment
1. Since intact classes rather than randomly selected individuals were assigned to groups, the treatment and control groups differ in important characteristics before the intervention.

2. Limited Control of Extraneous Variables
3. Factors such as students' prior knowledge, motivation, socioeconomic background, teacher differences, and classroom environment may influence the outcomes and cannot be completely controlled.
4. Factor of Generalizability
5. Findings obtained from specific schools, classes, or geographical locations may not be generalizable to all students or educational settings.
3. Teacher Effect
6. Differences in teachers' competence, experience, enthusiasm, or instructional style may influence students' performance independently of the treatment.

Conclusion and Recommendations

Conclusion

This study demonstrates that Video-Based Mobile Technology (VBMT) instruction can serve as an effective pedagogical tool to improve high school physics achievement in mechanics, particularly within classrooms with limited laboratory resources. By providing flexible, visual access to abstract concepts, VBMT helped students achieve higher performance gains than traditional teaching method. However, the significant gender gap observed in the experimental group highlights a critical challenge: without targeted, gender-inclusiveness, the adoption of digital learning tools can inadvertently widen performance gaps between male and female students due to existing disparities in technology access.

Recommendations

Based on these findings, the following policy and instructional steps are recommended:

1. Pedagogical Integration: Secondary school Physics teachers should systematically incorporate high-quality video demonstrations into their mechanics lessons to visually support abstract calculations and foundational laws of motion.
2. Infrastructural Investment: State and federal educational ministries should prioritize funding for high school computer labs, dependable classroom internet access, and comprehensive digital

training programs for teachers.

3. Curriculum Refinement: Curriculum developers should explicitly integrate multimedia resources and modern diagnostic tools into teacher training frameworks to better measure true conceptual understanding in physics.

Declaration of Conflicting Interests

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