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Effect of Utilizing two Instructional Media in Improving Senior Secondary School Students' Learning Outcomes in Physics in Nigeria

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Abstract

This study investigated the effect of utilizing two instructional media in improving senior secondary school students' learning outcomes in physics in Nigeria. Two hypotheses guided the study. The study adopted quasi-experimental design. A 30-item multiple-choice Physics achievement test was developed and administered by the researchers as both a pre-test and post-test. The test items were carefully aligned with the two Physics topics selected for the study to ensure content validity. To establish reliability, a test-retest procedure was conducted with SS2 students from the Smart Group of Schools. The reliability coefficient, calculated using Kuder-Richardson Formula 20 (KR-20), was 0.86. The pre-test was administered to all groups to determine baseline performance levels. Following this, the experimental groups received their respective treatments (Video and Audio instruction) over a defined instructional period, while the control group continued with traditional teaching methods. After completion of the instructional interventions, the post-test was administered to evaluate any changes in student performance. Data collected were analyzed using mean scores, standard deviations, t-test, ANOVA (Analysis of Variance) and Chi-square (χ^2) test. The findings revealed that the use of video and audio instructional media significantly enhances students' learning outcomes in Physics. The findings also revealed that gender does not influence students' engagement with or performance in ICT-enhanced Physics lessons. Based on the findings, the study recommended among others that Government bodies and proprietors of private secondary schools should ensure that all science classrooms are equipped with adequate ICT resources, including computers, projectors, and internet connectivity, to facilitate effective and interactive teaching, particularly in Physics. Teachers and school administrators should implement instructional strategies that treat male and female students equitably, recognizing that gender does not significantly affect learning outcomes in ICT-based Physics instruction.

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Introduction

The rapid advancement of information and technology (IT), particularly in its product-oriented and application-driven dimensions, has continued to reshape educational systems worldwide. Over the past few decades, innovations in Information and Communication Technology (ICT) have fundamentally altered not only the content of instruction but also the methods, strategies, and environments through which teaching and learning take place. In many developed nations, ICT has been

systematically integrated into educational practice to enhance curriculum delivery, promote learner engagement, and improve overall instructional effectiveness (Dlamini, 2025) [11]. This integration has facilitated a transition from traditional teacher-centred pedagogies to more learner-centred, interactive, collaborative, and flexible approaches that emphasize critical thinking, creativity, and problem-solving skills. Consequently, teaching and learning processes have become more dynamic, adaptive, and outcome-oriented, reflecting the demands of a rapidly changing, knowledge-driven global society. Globally, ICT is widely recognized as a powerful catalyst for educational transformation. International organizations and development agencies have consistently highlighted the potential of ICT to expand access to quality education, reduce educational inequalities, and improve the efficiency and effectiveness of educational management and administration (Singh & Kaur, 2021) [26]. Through ICT, learners are provided with opportunities to interact with digital content, engage in self-paced learning, and access vast repositories of information beyond the confines of the traditional classroom. For teachers, ICT offers diverse instructional tools that support differentiated instruction, facilitate the presentation of complex concepts, and promote active learner participation. These global developments underscore the central role of ICT in enhancing educational quality and relevance in both developed and developing contexts.

As a developing nation, Nigeria faces significant challenges in aligning her educational system with the demands and expectations of the 21st century. One of the most pressing of these challenges is the effective integration of ICT into teaching and learning across all levels of education, particularly in science and technology-related subjects (Babalola *et al*., 2026) [9]. Education, in its fundamental sense, is concerned with the systematic acquisition of knowledge, skills, attitudes, and values that enable individuals to function effectively within society and contribute meaningfully to national development (Akpoebidor-Oduru, 2024) [7]. The overarching goal of education is therefore to produce well-informed, competent, and responsible citizens capable of adapting to societal changes and participating productively in socio-economic and technological advancement. Within this framework, the integration of ICT into education is not merely an option but a necessity for achieving national educational objectives. Physics education occupies a strategic position within the Nigerian secondary school curriculum due to its central role in the development of scientific literacy, technological competence, and innovation capacity. Physics provides learners with foundational knowledge and skills that underpin advancements in engineering, medicine, information technology, and industrial development. According to Abimbola and Omosewo (2020) [1], the teaching of Physics is aimed at developing learners' intellectual abilities, scientific reasoning, and problem-solving skills necessary for understanding natural phenomena and addressing real-world challenges. Effective Physics education therefore contributes significantly to national aspirations for technological self-reliance and sustainable development. However, achieving these objectives depends largely on the quality of instructional strategies and resources employed in the teaching and learning process (Shehu *et al*., 2024) [25].

Instructional media constitute a critical component of effective teaching and learning, particularly in science education where abstract concepts and complex processes are common. Instructional media refer to the various materials, devices, and resources used by teachers to facilitate the communication of knowledge, skills, and attitudes to learners. These media serve as bridges between theoretical explanations and concrete understanding, helping learners to visualize, interpret, and internalize instructional content. Teachers utilize instructional media to enhance clarity, stimulate learners' interest, maintain attention, and improve comprehension and retention of subject matter. In contemporary educational practice, instructional media are increasingly aligned with ICT tools, reflecting global trends in digital learning. In the context of this study, emphasis is placed on video and audio instructional media as key ICT-based resources for teaching Physics. Video instructional media combine visual and auditory elements to present learning content in a dynamic and realistic manner. Through animations, simulations, demonstrations, and real-life representations, video instruction enables learners to observe scientific phenomena that may be difficult, dangerous, or impossible to demonstrate in a conventional classroom or laboratory setting. By appealing to multiple senses, video media enhance conceptual understanding, promote long-term retention, and support meaningful learning. Audio instructional media, on the other hand, convey information primarily through sound, including recorded lectures, explanations, discussions, and verbal demonstrations. Although audio media lack visual representation, they play a valuable role in reinforcing concepts, improving listening and comprehension skills, and supporting learning in situations where visual resources may be limited.

The availability and effective utilization of instructional media are widely regarded as critical determinants of educational quality and learners' academic outcomes. When instructional media are appropriately selected and systematically integrated into teaching, learning becomes more concrete, engaging, meaningful, and enduring. Akinola and Bello (2024) [5, 10] emphasised that instructional materials are indispensable in the teaching–learning process because they enhance learners' understanding, reduce abstraction, and shorten the time required for effective instruction. Similarly, Adetunji and Ojo (2025) [2] observed that instructional media simplify learning experiences and make abstract ideas more accessible when they are properly aligned with instructional objectives, content, and learners' characteristics. These assertions highlight the importance of not only the availability of instructional media but also teachers' competence and willingness to utilize them effectively. Despite the recognized importance of Physics as a core science subject, students' learning outcomes in the subject have remained persistently low over the years in Nigeria. Several empirical studies have identified a range of factors contributing to this poor performance. These factors include teachers' negative attitudes toward teaching Physics (Oguche & Yahaya, 2026) [9], reliance on ineffective and teacher-centred instructional methods (Adeyemi, 2023; Adeyemi, 2023) [3], students' inadequate background in basic science concepts (Bello, 2024; Olorundare & Adewuyi, 2023) [10, 24], and the inadequacy or poor state of laboratory facilities and equipment (Fadipe, 2025; Etukakpan, 2025) [12, 13]. Collectively, these challenges have undermined students' interest, understanding, and achievement in Physics.

An examination of the West African Senior School Certificate Examination (WASSCE) results over an extended

period further confirms the persistent underperformance of students in Physics, particularly at the credit level required for admission into science- and technology-related courses. This pattern of low achievement suggests systemic weaknesses in the teaching and learning of the subject. In line with Logan's position, (as cited in Olonikawu *et al*., 2024) [23], the inability of educators and learners to effectively adopt ICT-based instructional strategies contributes significantly to learners' failure to achieve desired educational outcomes. The continued reliance on traditional, lecture-dominated teaching approaches appears inadequate for addressing the learning needs of contemporary students in an increasingly technological world. The consistently low performance in Physics, as reflected in the WASSCE statistics presented in Table One, signals that Nigeria has yet to attain the level of scientific and technological competence required to independently drive her national development agenda. This situation has far-reaching implications for the country's capacity to produce skilled manpower in science, engineering, and technology-related fields. It therefore calls for urgent, deliberate, and evidence-based interventions aimed at improving instructional practices in Physics classrooms. One promising approach is the integration of ICT-based instructional media, particularly video and audio resources, to enrich teaching, enhance learners' understanding, and improve academic achievement. Consequently, this study investigates the effect of utilizing video and audio instructional media as innovative teaching strategies for improving senior secondary school students' learning outcomes in Physics in Nigeria.

Table 1: Statistics for entries and results for May/June WASSCE Physics for 1999 – 2009

Yr	Total Entry	Candidates who sat for the exam		Grades obtained by the candidates			No. of candidate absent -and' % of entry
		Total No.	Percentage	1-6	7-8	F9	
2014	213,864	210,271	98.31	64,283	61,772 77,	*W*	3,593
	•			30.57	29.37	36.95	1.68
2015	193,052	188,312	97.54	56,604	72,471	59,237	4,740
				30.05	38.48	31.45	2.45
2016	295,963	287,993	97.30	99,264	110,242	78,847	7,970
				34.46	38.27	27.25	2.69
2017	261,687	254,188	97.13	120,768	81,814	51,606	7,499
				47.51	32.18	20.30	2.86
2018	280,818	275,369	98.05	130,982	84,413	53,079	5,449
				47.56	30.65	19.27	1.94
2019	270,028	265,262	98.23	135,359	77,590	52,313	4,766
				51.02	29.25	19.72	1.76
2020	351,778	344,411	97.90	142,943	102,036	89,150	7,367
				41.50	29.62	25.88	2.09
2021	384,477	375,824	97.74	218,199	87,025	62,119	8,653
				58.05	23.15	16.52	2.25
2022	427,398	418,593	97.93	180,797	140,172	88,480	8,805
				43.19	33.48	21.13	2.06
2023	424.893	415,113	97.69	200,345	91,116	116776	9,780
			S'	48.26	21.94	28.13	2.30
2024	474,887	465,636	98.05	222,722	141,595	79,919	9,251
				47.83 :	30.41	17.16	1.95

Source: Statistics Department of West African Examinations Council (WAEC), Yaba, Lagos (2025)

Statement of the problem

Physics is universally recognized as a cornerstone of scientific inquiry and technological advancement, underpinning innovations across fields such as engineering, medicine, information technology, and energy production. Mastery of Physics not only equips students with critical analytical and problem-solving skills but also fosters an understanding of the natural laws that govern the physical universe. Despite its central importance, the learning outcomes of senior secondary school students in Physics remain consistently low, as evidenced by the recurring poor performance in both internal school assessments and external standardized examinations, such as the West African Senior School Certificate Examination (WASSCE) and the National Examinations Council (NECO) exams in Nigeria. This persistent underachievement has significant implications, limiting students' opportunities for higher education in science-related fields and constraining the nation's capacity to develop a skilled workforce capable of driving technological innovation. A major factor often implicated in this challenge is the predominance of conventional, teacher-centred instructional methods. Traditional lectures, chalk-and-talk approaches, and rote memorization, while historically widespread, have been criticized for failing to actively engage students, stimulate curiosity, or promote deep conceptual understanding.

Instructional media, particularly video and audio resources, have been proposed as promising interventions to address these challenges. Video-based instruction enables dynamic visual representation of complex phenomena, providing learners with opportunities to observe experiments, simulations, and real-world applications in ways that static textbooks cannot replicate. Audio instructional resources, such as narrated explanations and podcasts, offer an additional channel for reinforcing conceptual understanding, facilitating learning through auditory processing, and accommodating diverse learning styles. When integrated into classroom instruction, these media have the potential to enhance students' engagement, sustain attention, and foster higher-order cognitive skills such as analysis, synthesis, and application. Despite their theoretical advantages, empirical research examining the effectiveness of video and audio

instructional media in improving students' learning outcomes in Physics remains limited, particularly in the context of Nigerian senior secondary schools. Questions remain regarding which media or combination thereof is most effective in enhancing students' learning outcomes, and under what instructional conditions these tools yield the greatest benefit. Given the persistent low performance in Physics and the potential of instructional media to transform teaching and learning, there is a compelling need for empirical investigation. This study aims to address this gap by examining the effect of utilizing video and audio instructional media on senior secondary school students' learning outcomes in Physics in Nigeria.

Research hypotheses

Based on the stated problems, the following null hypotheses were formulated and tested at 0.05 percent level of significance:

H01: There is no significant main effect of treatment on students' learning outcomes in Physics.

H02: There is no significant main effect of gender on students' learning outcomes in Physics.

Theoretical framework

This study was anchored on the Cognitive Theory of Multimedia Learning (CTML) propounded by Richard E. Mayer in 2001. CTML posits that learners process information through two distinct channels: the visual/pictorial channel and the auditory/verbal channel. Meaningful learning occurs when both channels are engaged simultaneously in a complementary and well-organized manner. The theory further assumes that each channel has a limited capacity; hence, learning is optimized when instructional materials are carefully designed to minimize cognitive overload and encourage active cognitive processing. The relevance of CTML to the present study lies in its explicit explanation of how video and audio instructional media facilitate understanding of abstract Physics concepts. Video-based instruction enhances visual representation of scientific phenomena, while audio instruction strengthens verbal explanation and conceptual clarification. The combined use of these media supports better information processing, retention, and achievement. Therefore, CTML provides a strong theoretical foundation for examining the effectiveness of video and audio instructional media in improving senior secondary school students' learning outcomes in Physics in Nigeria.

Review of Related Literature on Instructional Media Utilization and Physics Learning Outcomes

The integration of instructional media into the teaching and learning of Physics has continued to attract sustained scholarly attention in recent years, particularly in response to persistent low achievement and declining interest in the subject at the senior secondary school level. Physics, as a core science subject, plays a critical role in technological advancement and scientific literacy; however, its abstract nature, mathematical complexity, and limited practical exposure have contributed to students' poor performance in many educational systems, especially in developing countries such as Nigeria. In response, contemporary studies conducted consistently demonstrate that the effective utilization of instructional media, especially ICT-based, audio, video, and multimedia resources plays a significant role in enhancing students' conceptual understanding, engagement, attitude, retention, and overall academic performance in Physics. Instructional media have increasingly been recognized as essential pedagogical tools that support learner-centred instruction and promote meaningful learning. The shift from traditional teacher-dominated instructional approaches to technology-supported and media-rich learning environments aligns with constructivist and cognitive learning theories, which emphasize active participation, multiple representations of knowledge, and experiential learning. Consequently, the use of instructional media in Physics instruction has been widely investigated across diverse contexts, yielding substantial empirical evidence on its effectiveness.

Conceptualization of Instructional Media in Physics Education

Instructional media are broadly defined as the tools, materials, resources, and technological supports employed by teachers to facilitate the teaching–learning process by making instruction more concrete, interactive, engaging, and meaningful. Kaya (2022) [15] conceptualized instructional media as encompassing both traditional instructional resources such as charts, models, real objects, radio, and television; and modern digital technologies including videos, animations, simulations, virtual laboratories, and online learning platforms. Similarly, Urdan and Weggen (2021) [27]described instructional media as communication channels through which instructional messages are delivered to learners to enhance understanding and retention. Within the context of Physics education, instructional media are particularly indispensable because the subject deals with abstract concepts, invisible forces, microscopic phenomena, and complex mathematical relationships that are often difficult for learners to visualize. Concepts such as electric fields, electromagnetic waves, atomic structure, nuclear reactions, and wave-particle duality are not directly observable in everyday life. As noted by Yildiz and Acar (2020) [28], instructional media serve as cognitive scaffolds that bridge the gap between abstract theoretical explanations and concrete real-world representations. Through the provision of visual, auditory, and interactive representations of concepts, instructional media help reduce students' cognitive overload and enhance meaningful learning. From a theoretical perspective, the cognitive theory of multimedia learning proposed by Mayer supports the use of instructional media in Physics. The theory posits that learners understand concepts better when information is presented through both verbal and visual channels rather than through words alone. This theoretical foundation underscores the relevance of audio, video, and multimedia instructional media in facilitating deeper understanding of Physics concepts.

Video, Audio, and Multimedia Instruction in Physics Learning

Empirical evidence strongly supports the effectiveness of video-based and multimedia instruction in improving students' learning outcomes in Physics. Video instructional media combine moving images, text, sound, and demonstrations, making them particularly effective for illustrating dynamic Physics processes and experimental procedures. Abimbola and Omosewo (2020) [1] found that the

integration of video instructional packages significantly improved students' understanding of practical Physics concepts compared to conventional lecture-based teaching methods. Their study revealed that students exposed to video instruction demonstrated better conceptual clarity, improved problem-solving skills, and higher achievement scores. Similarly, Musa and Yusuf (2023) [18] reported that video-enhanced Physics lessons promoted deeper conceptual understanding among senior secondary school students by enabling learners to visualize abstract phenomena such as projectile motion, oscillations, and wave propagation. The study further established that video instruction increased students' interest and sustained attention during lessons, thereby improving learning outcomes.

More recent studies further reinforce these findings. Olonikawu *et al*. (2024) [23] demonstrated that the use of projected instructional media, including videos and PowerPoint presentations, significantly improved students' achievement in Physics in Kogi State. Likewise, Shehu *et al*. (2024) [25] reported that computer animation-based instruction enhanced students' learning outcomes in atomic and nuclear Physics by providing step-by-step visual representations of complex processes such as radioactive decay and nuclear reactions. These findings are consistent with Singh and Kaur's (2021) [26] assertion that animations improve learners' understanding of complex Physics topics such as electromagnetism by reducing cognitive load and increasing conceptual clarity. Audio-visual instructional media, which combine sound and visuals, have also been found to positively influence Physics learning outcomes. Chukwuma (2021) established that audio-visual instructional materials significantly improved senior secondary school students' achievement in Physics in Anambra State. The study attributed this improvement to increased learner engagement and improved retention of concepts. Although audio instruction lacks visual elements, research indicates that audio-based media can reinforce learning by enhancing listening skills, concentration, and memory, particularly when used to supplement other instructional strategies. Ayeshung and Ujum (2023) [8] reported that audio instructional materials, when appropriately integrated into classroom instruction, improved students' comprehension and retention of Physics concepts.

Blended Learning, Gamification, and Technology-Enhanced Instruction

Beyond traditional audio-visual media, recent literature highlights the growing relevance of blended learning and technology-enhanced instructional strategies in Physics education. Blended learning combines face-to-face classroom instruction with online or digital learning resources, thereby extending learning beyond the classroom and promoting flexibility. Etukakpan (2025) [12] found that blended learning approaches significantly enhanced senior secondary school students' academic performance in Physics by encouraging independent learning and continuous engagement with instructional content. Similarly, Fadipe (2025) [13] reported that the utilization of WhatsApp-based instructional platforms improved students' achievement and collaborative learning in Physics. Technology-enhanced instruction, including the use of interactive whiteboards, virtual laboratories, and online simulations, has also been shown to improve Physics learning outcomes. Okoye *et al*. (2024) [22] reported that technology-enhanced learning significantly improved Physics achievement among secondary school students in Anambra State, noting that such approaches promoted active participation and inquiry-based learning. Gamification has emerged as an innovative instructional medium in Physics education. Gamified instructional media incorporate game elements such as points, rewards, challenges, and competition into the learning process (Okoye *et al*., 2024; Ilomuanya *et al*., 2024) [14, 22]. Okeke *et al*. (2025) [21] demonstrated that gamified instructional media significantly improved students' engagement, motivation, and achievement in Physics. These findings support Akpan and Okon's (2021) [6] assertion that instructional technologies, when grounded in sound pedagogical principles, can transform science classrooms into interactive and learner-centred environments.

Practical and Simulation-Based Instructional Media

Simulation software and practical-oriented instructional media have been identified as particularly effective in Physics instruction, especially in contexts where laboratory facilities are inadequate. Simulations allow students to manipulate variables, observe outcomes, and explore Physics concepts in a risk-free environment. Bello (2024) [10] revealed that the utilization of simulation software in teaching mechanics significantly enhanced students' achievement and conceptual understanding. The study noted that simulations enabled students to visualize motion, forces, and energy relationships more effectively than traditional methods. Similarly, Ilomuanya *et al*. (2024) [14] reported that practical teaching approaches supported by instructional media improved students' performance in topics such as reflection and refraction of light. These findings underscore the importance of experiential, inquiry-based, and visual learning approaches in Physics education, particularly in resource-constrained settings.

Instructional Media and Students' Attitudes and Higher-Order Skills

Beyond academic achievement, instructional media have been shown to positively influence students' attitudes toward Physics and the development of higher-order thinking skills. Students' negative attitudes toward Physics have long been identified as a major barrier to achievement in the subject. Oguche and Yahaya (2026) [9] found that the use of instructional materials significantly improved both students' achievement and attitudes toward Physics, leading to increased interest and confidence in learning the subject. Meta-analytic and systematic review studies further provide strong evidence of the broader educational benefits of instructional media. Mensah (2022) [17] revealed that Physics teaching materials significantly enhance students' critical thinking, creative thinking, and problem-solving skills. These findings suggest that instructional media contribute not only to cognitive outcomes but also to affective and psychomotor learning domains, thereby supporting holistic student development.

Gaps in the Literature and Relevance of the Present Study

Despite the growing body of evidence supporting the effectiveness of instructional media in Physics education, several gaps remain evident in the literature. First, many studies focus broadly on multimedia, ICT, or technology-enhanced instruction without isolating specific instructional

media such as video and audio resources. Second, there is limited empirical evidence directly comparing the utilization and effectiveness of video and audio instructional media within the same educational context, particularly in Nigerian senior secondary schools. Third, contextual factors such as availability of instructional media, teachers' competence in media utilization, infrastructural challenges, and students' access to technology continue to influence the extent to which instructional media are effectively used (Akpoebidor Oduru, 2024; Olorundare & Adewuyi, 2023) [7, 24]. Against this backdrop, the present study is positioned to contribute meaningfully to the existing literature by empirically examining the utilisation of video and audio instructional media and their effects on senior secondary school students' learning outcomes in Physics. By focusing on specific instructional media and grounding the investigation within the Nigerian secondary school context, the study seeks to generate context-relevant, evidence-based insights that can inform instructional practice, teacher professional development, curriculum implementation, and educational policy aimed at improving Physics teaching and learning outcomes.

Methodology

Design: The study employed a pre-test, treatment-control, post-test quasi-experimental design. This design is particularly suitable for educational research where random assignment of individual students may not be feasible, and intact classes serve as experimental and control groups. The use of quasi-experimental design allows for rigorous comparison between instructional interventions while maintaining ecological validity in the classroom setting.

Study Groups:

Experimental Groups: Two groups of students were exposed to distinct instructional media: one group received Video-based instruction, while the other group received Audio-based instruction. Both interventions were facilitated using computer-assisted learning environments to ensure uniformity in media delivery.

Control Group: The control group received conventional Physics instruction without the aid of computer-facilitated media. This group served as the baseline for measuring the effectiveness of the experimental treatments.

Study Locations: The research was conducted across three secondary schools in Ibadan, Oyo State, to ensure a diverse sample representative of the population: Maverick College, Bodija; Wallbrook College, Samonda; Orogun Grammar School.

Instrumentation: A 30-item multiple-choice Physics achievement test was developed and administered as both a pre-test and post-test. The test items were carefully aligned with the two Physics topics selected for the study to ensure content validity.

Reliability: To establish reliability, a test-retest procedure was conducted with SS2 students from the Smart Group of Schools. The reliability coefficient, calculated using Kuder-Richardson Formula 20 (KR-20), was 0.86, indicating a high level of internal consistency and suitability for measuring students' learning outcomes.

Data Collection Procedures: The pre-test was administered to all groups to determine baseline performance levels. Following this, the experimental groups received their respective treatments (Video and Audio instruction) over a defined instructional period, while the control group continued with traditional teaching methods. After completion of the instructional interventions, the post-test was administered to evaluate any changes in student performance.

Data Analysis: Data collected were analyzed using both descriptive and inferential statistics to ensure comprehensive interpretation:

Descriptive Statistics: Mean scores and standard deviations were used to summarize student performance and identify general trends in learning outcomes.

Inferential Statistics: t-test was used to compare the mean scores of two groups to determine if differences were statistically significant; ANOVA (Analysis of Variance) was employed to examine differences among the multiple groups and identify the effect of instructional media on learning outcomes; while Chi-square (χ^2) test was applied to assess the association between categorical variables, such as gender and performance outcomes.

Findings

Hypothesis One (H_{01})

H_{01}: There is no significant main effect of treatment on students' learning outcomes in Physics.

Table 2: Effectiveness of Video and Audio on Students' Learning

V1edia	Pretest mean score	Post-test mean score	F-value	Actual p- value
Video Audio	31.54 29.98	33.54 31.92	3.27* 2.67*	7.35 x 10-^{4} 4.43 x 10-^{4}

Mean score values are significantly different ($p<0.05$)

Table Two presents the level of significant difference between the two instructional methods and the control. The mean score of students in the pre-test, conducted prior to the introduction of the instructional material (video) was 31.54, whereas the mean score in the post-test, conducted after exposure to the instructional material, increased to 33.54. The post-test mean is significantly higher than the pre-test mean ($p < 0.05$), as determined by the student t-test. This result indicates that the instructional material had a significant positive effect on students' achievement in Physics. Therefore, Hypothesis **H_{01}** was not accepted.

Hypothesis Two (H_{02})

H_{02}: There is no significant main effect of gender on students' learning outcomes in Physics.

Table 3: Descriptive Statistics of Males and Females Students tested with Achievement Test

Summary	Count	Sum	Average	Variance
Video	2	50	25	8
Audio	2	50	25	18
Control	2	50	25	[98] o«\i
Male	3	87	29	
Female	3	63	21	

Table 4: ANOVA: Two-Factor without Replication on Students' Gender using Students' Achievement Test

Source of Variation	55	~w~	¯MS-	F		*P-value*	*F critical*
Rows	0	2	0	0		I	19
Columns	96	1	96	6.85714	3	0.120117	18.51282
Error	28	2	14				
Total	124	5					

Table Three shows the descriptive statistics and ANOVA results for students' achievement in physics by gender. The analysis indicates no significant main effect of gender, as the F-values for both rows (F = 6.86) and columns (F = 18.51) are below their respective F-critical values, and the P-value exceeds 0.05 ($p > 0.05$). These results suggest that students' learning outcomes do not differ significantly across genders, and thus Hypothesis **H_{02}** is accepted.

Discussion of Findings

Main Effect of Treatment on Students' Learning Outcomes

The findings of this study revealed a significant main effect of the instructional treatment on students' performance in the Physics Achievement Test (PSAT). Specifically, students exposed to ICT-based instruction, particularly video-assisted learning, demonstrated higher achievement compared to those taught using conventional teaching methods. The t-test results in Table 3 indicate a pre-test mean score of 31.54 and a post-test mean score of 33.54, with a statistically significant difference at $p < 0.05$ ($p = 7.35 \times 10^{-4}$). This outcome suggests that ICT-based instructional media positively influence students' understanding of Physics concepts. These results are consistent with prior research that emphasizes the effectiveness of ICT tools in enhancing learning outcomes. Mensah (2022) [17] found that students exposed to computer-assisted learning in science performed better than those who relied solely on traditional instruction. Similarly, Okafor and Nwankwo (2020) [20] reported that video and audio media improve retention and understanding of abstract scientific concepts. Jonah and Kulik (as cited in Musa & Yusuf, 2023) [18], also observed that multimedia instructional approaches, including interactive video presentations, significantly increase students' cognitive achievement in Physics. This body of evidence suggests that incorporating ICT tools into the teaching and learning process enhances students' engagement, conceptual clarity, and problem-solving abilities. Moreover, ICT-based instruction provides students with opportunities for self-paced learning, repeated exposure to difficult concepts, and immediate visualization of complex phenomena, all of which contribute to improved academic performance.

Main Effect of Gender on Students' Learning Outcomes

The study further examined whether gender influenced students' learning outcomes in Physics. Analysis presented in Table four indicated that there was no statistically significant difference in the performance of male and female students ($p > 0.05$). This finding suggests that both male and female students responded similarly to ICT-based instructional media and achieved comparable results on the PSAT. In practical terms, gender does not appear to limit or enhance a student's ability to engage with video or audio instructional packages in Physics. These findings corroborate earlier studies that reported minimal or no gender differences in academic achievement when students are exposed to ICT-supported learning environments. For instance, research by Onasanya *et al*. (as cited in Ayeshung & Ujum, 2023) [8] indicated that multimedia learning strategies level the playing field for male and female students, as both genders benefit equally from interactive and visually enriched instructional materials. This reinforces the idea that equitable access to ICT resources is more critical than gender-specific interventions in science education. Additionally, the absence of gender disparities implies that instructional strategies that emphasize technology integration can promote inclusivity, ensuring that all students, regardless of gender, have the opportunity to achieve their maximum potential in Physics.

Conclusion

From the findings of this study, it can be concluded that the use of video and audio instructional media significantly enhances students' learning outcomes in Physics. ICT-based instruction supports active learning, improves conceptual understanding, and promotes higher achievement compared to traditional teaching methods. The study also confirmed that gender does not influence students' engagement with or performance in ICT-enhanced Physics lessons. Therefore, both male and female students derive similar benefits from video and audio-assisted instruction, emphasizing the potential of ICT to provide inclusive and effective learning experiences.

Recommendations

In light of these conclusions, the following recommendations were proposed:

1. Government bodies and proprietors of private secondary schools should ensure that all science classrooms are equipped with adequate ICT resources, including computers, projectors, and internet connectivity, to facilitate effective and interactive teaching, particularly in Physics.

2. School managements should also consider providing access to multimedia libraries and educational software to support continuous learning.
3. Teachers and school administrators should implement instructional strategies that treat male and female students equitably, recognizing that gender does not significantly affect learning outcomes in ICT-based Physics instruction.
4. Secondary school administrators should make efforts to create a learning environment that is free from gender biases; which promotes inclusivity and equal participation.
5. Physics teachers should undergo professional training on the design, development, and integration of video and audio instructional materials into their lesson plans.
6. Policymakers, school administrators, and curriculum planners should promote the systematic integration of ICT-based instructional methods into science education.

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