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Impact of Audio-Visual Aids on the Teaching and Learning of Computer Studies in Selected Primary Schools in Bauchi Metropolis, Nigeria

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Abstract
This study examined the impact of audio-visual aids on the teaching and learning of Computer Studies in two selected primary schools in Bauchi Metropolis, Nigeria. A mixed-methods approach involving a quasi-experimental pre-test/post-test non-equivalent control group design and a descriptive survey was adopted. The study involved 120 Primary Five pupils and 285 teachers. Data were analysed using descriptive statistics, Analysis of Covariance (ANCOVA), Pearson Product Moment Correlation, and thematic analysis. Findings revealed low availability and utilisation of audio-visual resources, but pupils taught with audio-visual aids achieved significantly higher academic performance ($F(1,117)=62.33$, $p<.001$, partial $\eta^2=.346$) and developed more positive attitudes toward Computer Studies ($F(1,117)=54.12$, $p<.001$, partial $\eta^2=.316$). Significant positive relationships were found between availability and utilisation of resources ($r=.72$, $p<.001$) and between teacher training and utilisation ($r=.58$, $p<.001$). Major constraints included inadequate funding, lack of functional equipment, irregular electricity supply, and insufficient teacher training. The study concludes that effective integration of audio-visual instructional materials can substantially improve pupils' understanding, engagement, and attitudes toward Computer Studies, highlighting the need for greater investment in ICT facilities and teacher capacity development in primary education.
Keywords: Audio-Visual Aids, Computer Studies, Primary Education, Academic Achievement, Technology Integration, Bauchi Metropolis.

Introduction

The rapid advancement of digital technology in the twenty-first century has significantly transformed the education sector globally. Governments and educational institutions are increasingly integrating Information and Communication Technology (ICT) into teaching and learning to equip learners with knowledge and skills required for the digital economy. ICT integration has been recognised as a catalyst for improving teaching effectiveness, learner engagement, academic achievement, and developing critical thinking, communication, collaboration, and digital literacy skills (UNESCO, 2023; Msafiri et al., 2023; UNICEF, 2023).

One effective strategy for technology integration is the use of audio-visual aids—instructional materials combining visual and auditory elements to facilitate meaningful learning. These include videos, animations, audio recordings, multimedia presentations, projectors, interactive whiteboards, smart boards, digital simulations, and computer-assisted instructional packages. By presenting information through multiple sensory channels, audio-visual aids enhance learners'

understanding, motivation, retention, and active participation (Dorris et al., 2024; Zuhri et al., 2024; Mayer, 2021). Educational psychology research confirms that learning is more effective when verbal explanations are supported with relevant visual representations, promoting deeper cognitive processing and long-term memory retention (Mayer, 2021).

Empirical studies consistently demonstrate the educational value of audio-visual instruction. Annur et al. (2025) reported that audio-visual media significantly improve pupils' learning outcomes and classroom engagement. Similarly, Syahrir et al. (2024) and Msafiri et al. (2023) found that multimedia instruction enhances academic performance, participation, and knowledge retention, particularly among primary school learners who benefit from concrete visual demonstrations. Dorris et al. (2024) observed that technology-supported instruction is most effective when combined with learner-centred teaching strategies and adequate teacher support. Computer Studies is a subject that particularly requires practical and interactive instructional approaches. It introduces pupils to computer operations, digital literacy, internet safety, data processing, coding fundamentals, and problem-solving skills. Because many concepts are abstract for young learners, audio-visual materials provide practical demonstrations that simplify understanding and make learning more meaningful and enjoyable (Sanusi & Deriba, 2024; Msafiri et al., 2023). UNESCO (2023) emphasised that educational technology can improve learning outcomes when supported by adequate infrastructure and teacher training. Successful ICT integration depends on teacher competence, school leadership, curriculum alignment, availability of digital resources, and supportive government policies (UNESCO, 2023; Msafiri et al., 2023; World Bank, 2023).

In Nigeria, ICT integration has become a major educational priority. The Universal Basic Education Commission (UBEC) has introduced initiatives such as Smart Schools, interactive smart boards, teacher capacity-building programmes, and partnerships with development agencies (Federal Ministry of Education, 2022; UBEC, 2023). Despite these efforts, effective utilisation of audio-visual instructional materials in many public primary schools remains low due to inadequate infrastructure, insufficient instructional resources, unreliable electricity, poor internet connectivity, inadequate funding, and limited teacher competence in educational technology integration (Etim, 2024; Pezo, 2024; Msafiri et al., 2023).

Despite the growing body of research on ICT integration in Nigerian primary schools, previous studies have yielded inconclusive findings regarding the effectiveness of audio-visual aids in Computer Studies instruction. While some studies reported significant positive effects (Balogun, 2025; Annur et al., 2025), others found minimal impact due to contextual constraints such as inadequate infrastructure and teacher competence (Etim, 2024; Msafiri et al., 2023). These contradictory findings suggest that the effectiveness of audio-visual instruction may be highly context-dependent, necessitating further investigation in different geographical and institutional settings.

Bauchi Metropolis constitutes an important study area for several reasons. First, as the capital of Bauchi State, the metropolis encompasses a diverse range of primary schools: public, private, and faith-based; with varying levels of ICT infrastructure and instructional resources. This diversity provides an opportunity to examine how contextual factors influence the availability and utilisation of audio-visual aids. In the same vein, despite government initiatives such as the UBEC Smart Schools programme, there has been no systematic empirical investigation of audio-visual resource

utilisation in Bauchi Metropolis. And the north-eastern region of Nigeria has experienced significant educational disruptions due to security challenges, making it essential to understand how technology integration can support educational continuity and quality.

The specific gap this study addresses is threefold. First, while several studies have examined audio-visual instruction in southern Nigerian states (Balogun, 2025; Etim, 2024), there is a paucity of empirical evidence from the north-eastern region, where infrastructural and socio-economic conditions differ substantially. Second, previous studies have largely focused on either cognitive outcome (academic achievement) or affective outcomes (attitudes) in isolation, whereas this study examines both concurrently. Third, most previous studies have employed purely quantitative designs, whereas this study adopts a mixed-methods approach that integrates quantitative evidence of impact with qualitative insights into the processes and challenges of audio-visual instruction.

Bauchi Metropolitan Area provides an important setting for examining this problem because schools within the metropolis differ considerably in their ICT facilities and instructional resources. Although investments have been made in educational technology, many pupils still have unequal access to practical digital learning opportunities, reflecting broader patterns of digital inequality in developing countries (World Bank, 2023; UNICEF, 2023). In addition, many primary schools in the area face challenges such as inadequate computer laboratories, insufficient audio-visual facilities, overcrowded classrooms, unstable electricity supply, and limited teacher competence in ICT integration. These conditions restrict the use of learner-centred instructional strategies that could improve pupils' motivation, participation, and academic achievement (Mayer, 2021; Syahrir et al., 2024; Msafiri et al., 2023). Against this background, the present study investigates the impact of audio-visual aids on the teaching and learning of Computer Studies in selected primary schools within Bauchi Metropolitan Area, with particular attention to the availability and utilization of audio-visual resources and their influence on pupils' academic achievement and attitudes toward Computer Studies. The teaching and learning of Computer Studies at the primary school level in Nigeria, including Bauchi Metropolis, continue to face numerous challenges. Despite inclusion of Computer Studies in the basic education curriculum, evidence indicates that instructional quality and learning outcomes remain unsatisfactory in many Nigerian primary schools (UNESCO, 2023; Msafiri et al., 2023). Major challenges include persistent use of teacher-centred instructional approaches that fail to simplify abstract concepts, inadequate availability and utilisation of audio-visual instructional resources, insufficient teacher competence in educational technology, and infrastructural deficiencies such as unreliable electricity, poor internet connectivity, and inadequate funding (Etim, 2024; Pezo, 2024; Msafiri et al., 2023). In Bauchi Metropolis, disparities in ICT facilities among public, private, and faith-based schools create unequal opportunities for pupils to acquire practical digital competencies. This paucity of context-specific empirical evidence creates a significant knowledge gap for teachers, school administrators, curriculum developers, and policymakers requiring reliable information for planning and implementing effective ICT-based instructional strategies.

The main objective was to investigate the impact of audio-visual aids on the teaching and learning of Computer Studies in selected primary schools in Bauchi Metropolis. Specific objectives were to: (1) examine the availability and utilisation of audio-visual aids; (2) determine their impact on pupils' academic achievement; (3) examine their effect on pupils' attitudes; and (4) identify factors influencing effective utilisation. The following null hypotheses were tested at 0.05 significance level: H_{01}: There is no significant difference in academic achievement between pupils taught with

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audio-visual aids and those taught through conventional methods. H_{02}: There is no significant difference in attitudes between pupils taught with audio-visual aids and those taught through conventional methods. H_{03}: There is no significant relationship between availability and utilisation of audio-visual resources. H_{04}: There is no significant relationship between teacher training in educational technology and utilisation of audio-visual aids.

Literature Review

Conceptual Framework

Audio-visual aids are instructional resources combining visual and auditory elements to enhance teaching and learning. They include videos, animations, projectors, multimedia presentations, smart boards, audio recordings, educational software, simulations, and interactive digital applications. Their use promotes learners' attention, understanding, motivation, retention, and participation by presenting concepts in multiple forms (UNESCO, 2023; Msafiri et al., 2023; Syahrir et al., 2024). Audio-visual materials support meaningful learning because they engage multiple senses simultaneously, reduce abstractness, and encourage active interaction with instructional content (Mayer, 2021; Dorris et al., 2024).

Audio-visual aids can be classified into visual aids (charts, diagrams, pictures), audio aids (recordings, podcasts), audio-visual aids (videos, animations), and interactive multimedia aids (smart boards, simulations). In Computer Studies, these resources simplify abstract concepts through demonstrations and interactive learning experiences (UNESCO, 2023; Syahrir et al., 2024). However, effectiveness depends on contextual factors including teacher competence, ICT facilities, electricity supply, internet connectivity, funding, and institutional support (Etim, 2024; UBEC, 2023; World Bank, 2023).

Theoretical Framework

The study is anchored on Dual Coding Theory and Constructivist Learning Theory. Dual Coding Theory (Paivio, 1971, 1991) explains that learning is enhanced when information is processed through two interconnected systems—verbal and visual—creating multiple cognitive representations that improve understanding, storage, and retrieval. In Computer Studies, videos, animations, and multimedia presentations allow pupils to hear explanations while observing practical procedures, improving comprehension and retention (Mayer, 2021; Clark & Paivio, 1991). The findings of this study, particularly the significant improvement in academic achievement among pupils exposed to audio-visual instruction, provide empirical validation for Dual Coding Theory. The superior performance of the experimental group suggests that simultaneous activation of verbal and visual processing channels facilitated deeper cognitive processing and better retention of Computer Studies concepts. Constructivist Learning Theory (Piaget, 1970; Vygotsky, 1978) holds that learners actively construct knowledge through interaction, exploration, collaboration, and experience. Audio-visual resources support constructivist learning by enabling pupils to observe, manipulate, discuss, and apply concepts in meaningful contexts (Jonassen, 1999; Schunk, 2020). The positive attitudes and increased classroom participation observed among pupils in the experimental group can be interpreted through a constructivist lens. Audio-visual materials created a more engaging and interactive learning environment that encouraged active knowledge construction, enhancing both cognitive and affective learning outcomes. This finding supports the constructivist assertion that meaningful learning occurs when learners are actively engaged in the learning process rather than passively receiving information.

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Empirical Review

Empirical evidence consistently indicates that audio-visual instruction improves pupils' academic achievement, motivation, and classroom participation. Annur et al. (2025) reported that multimedia learning significantly enhanced learning outcomes in elementary education. Balogun (2025) found that pupils taught Computer Studies with video instructional packages performed significantly better than those taught through conventional methods. Msafiri et al. (2023) concluded that ICT-supported instruction enhances achievement, critical thinking, and classroom engagement, although poor infrastructure and inadequate teacher training remain major barriers.

However, contradictory findings have also been reported. Some studies have found minimal or no significant improvement in learning outcomes from audio-visual instruction, particularly in contexts with inadequate infrastructure and insufficient teacher training (Etim, 2024; Pezo, 2024). These contradictory findings suggest that the effectiveness of audio-visual aids is highly dependent on contextual factors, including the availability of functional equipment, reliable electricity supply, and teachers' pedagogical competence in integrating technology into instruction. Methodological differences across studies including variations in research design, sample size, duration of intervention, and outcome measures; further complicate direct comparisons. Dorris et al. (2024) found that digital technologies improve learning outcomes when used with learner-centred teaching methods. Similarly, Syahrir et al. (2024) also reported that animations, simulations, and interactive multimedia increase pupils' participation and retention of concepts. Evidence from developing countries supports these findings. UNESCO (2023) noted that well-integrated educational technology enhances achievement, engagement, and digital competence, while UNICEF (2023) emphasized that digital resources can help reduce educational inequalities when schools have adequate facilities and trained teachers.

In Nigeria, studies generally show positive effects of audio-visual instruction. Etim (2024) reported that multimedia resources improved pupils' understanding of Computer Studies, although inadequate facilities limited their regular use. Sanusi and Deriba (2024) found that technology-supported instruction enhanced digital literacy and problem-solving skills. However, inadequate computers, projectors, electricity, internet connectivity, and teacher competence remain major obstacles to effective use of audio-visual resources (Etim, 2024; UNESCO, 2023; World Bank, 2023).

Critical comparison of the empirical literature reveals several important patterns. Studies conducted in well-resourced schools with adequate infrastructure and trained teachers consistently report positive effects of audio-visual instruction (Annur et al., 2025; Balogun, 2025; Syahrir et al., 2024). In contrast, studies conducted in resource-constrained settings often report limited or inconsistent effects, primarily due to the unavailability of functional equipment, unreliable electricity supply, and insufficient teacher competence (Etim, 2024; Msafiri et al., 2023). This pattern suggests that infrastructure and capacity-building are essential preconditions for effective audio-visual instruction. Furthermore, studies employing rigorous experimental designs with adequate controls tend to report more robust findings than those using weaker designs, highlighting the importance of methodological quality in interpreting research evidence.

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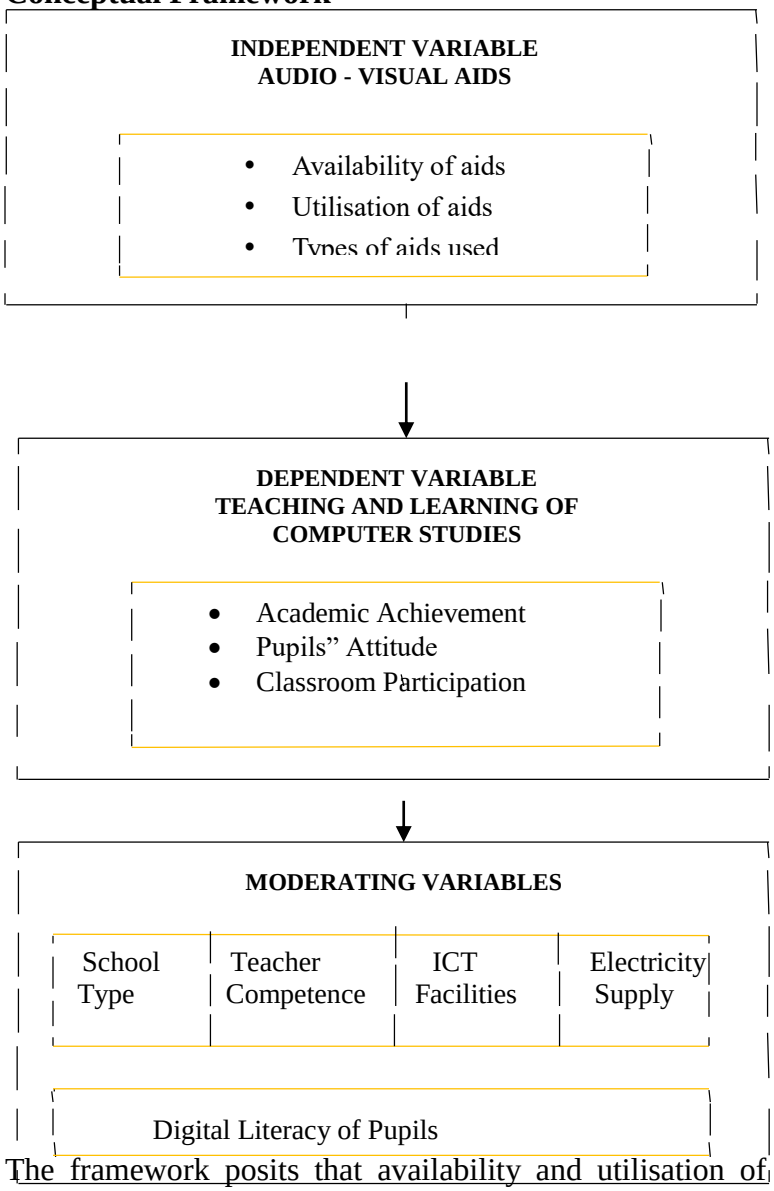
Conceptual Framework



The framework posits that availability and utilisation of audio-visual aids directly influence teaching and learning of Computer Studies, as measured by pupils' academic achievement, attitudes, and classroom participation. This relationship is moderated by contextual factors including teacher competence in educational technology, availability of ICT facilities, reliability of electricity supply, school type, and pupils' digital literacy. The framework guided development of research instruments and hypotheses, informing item selection for the Audio-Visual Resources Availability and Utilisation Questionnaire, design of the Computer Studies Achievement Test and Attitude Questionnaire, and formulation of hypotheses examining relationships between availability and utilisation, and between teacher training and utilisation.

Methodology

The study employed a mixed-methods approach combining a quasi-experimental pre-test/post-test non-equivalent control group design with a descriptive survey. The quasi-experimental component

determined the effect of audio-visual instruction on pupils' academic achievement and attitudes, while the survey examined availability, utilisation, and influencing factors (Creswell & Creswell, 2018; Campbell & Stanley, 1963). The quasi-experimental design was selected because random assignment of pupils to treatment and control groups was not feasible in the school setting. Intact classes were used to avoid disrupting normal school routines. To address threats to internal validity, selection bias was minimised by selecting schools with comparable characteristics; maturation effects were controlled through a control group and pre-test measures; testing effects were addressed through identical administration procedures; and the Hawthorne effect was mitigated by maintaining consistent classroom routines and not revealing experimental status to participants.

The study was conducted in Bauchi Metropolis, Bauchi State, Nigeria, comprising Bauchi Local Government Area and its environs, serving as the state capital. The area was chosen for its diverse range of primary schools with varying levels of access to technological resources. The population comprised all primary school teachers and pupils in public and private primary schools in Bauchi Metropolis. According to Bauchi State Universal Basic Education Board records, there are approximately 120 primary schools, 2,500 teachers, and 45,000 pupils. For the quasi-experimental component, the population comprised all Primary Five pupils in public primary schools.

A sample of 120 Primary Five pupils was selected from two public primary schools. Selection of only two schools was justified by the intensive nature of the intervention requiring detailed observation, consistent implementation, and repeated data collection over six weeks. Purposive sampling was used because the study required schools offering Computer Studies with at least basic audio-visual equipment, stable pupil populations, accessibility, and comparable characteristics. One school was designated experimental and the other control based on availability of functional audio-visual equipment. For the survey component, a sample of 300 teachers was selected from 120 schools using Yamane's formula at 95% confidence level and 5% margin of error. Stratified random sampling was used, stratifying schools into public and private categories.

Three instruments were used: (1) Computer Studies Achievement Test (CSAT)—a 30-item multiple-choice test covering Primary Five curriculum topics; (2) Computer Studies Attitude Questionnaire (CSAQ)—a 20-item 4-point Likert scale questionnaire covering interest, perceived relevance, confidence, and enjoyment; and (3) Audio-Visual Resources Availability and Utilisation Questionnaire (AVRAUQ)—a 40-item questionnaire covering demographic information, availability and adequacy (20 items), extent of utilisation (10 items), and factors influencing use (10 items). Semi-structured interview guides and observation checklists were also used.

Content and construct validation were established through expert review by three specialists in educational technology, curriculum studies, and measurement and evaluation. Content Validity Index (CVI) was computed: CSAT (CVI = 0.88), CSAQ (CVI = 0.85), and AVRAUQ (CVI = 0.83), exceeding the acceptable threshold of 0.80 (Lawshe, 1975). Construct validity was established through exploratory factor analysis, confirming hypothesised factor structures. Face validity was established through a pilot study with 30 pupils and 20 teachers, with ambiguous items revised based on feedback. Reliability was established using: CSAT (KR-20 = 0.82), CSAQ (Cronbach's Alpha = 0.85), and AVRAUQ (Cronbach's Alpha ranging from 0.76 to 0.84, overall = 0.81). Data collection was conducted in three phases over eight weeks. Phase One (Week 1): Pre-intervention data collection including CSAT and CSAQ pre-tests, AVRAUQ administration, and observations. Phase Two (Weeks 2-7): Intervention implementation—experimental group

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received instruction using videos, animations, and multimedia presentations while control group received conventional instruction, each receiving two 40-minute lessons per week. Phase Three (Week 8): Post-intervention data collection including CSAT and CSAQ post-tests and semi-structured interviews.

Ethical approval was obtained from Bauchi State Ministry of Education Research Ethics Committee. Informed consent was obtained from all participants. For pupils, parental consent was obtained through letters explaining the purpose, procedures, and voluntary nature of the study. Participants were assured of confidentiality and anonymity, and informed they could withdraw at any time without penalty. The study did not disrupt normal school routines or cause harm to participants. All data were stored securely and used only for research purposes. Quantitative data were analysed using descriptive statistics (mean, standard deviation, frequencies, percentages) and inferential statistics including ANCOVA and Pearson Product Moment Correlation at 0.05 significance level using SPSS version 25. Qualitative data from interviews were analysed thematically following Braun and Clarke's (2021) approach.

Results: Data Presentation, Analysis and Discussion

Table 1: Demographic Characteristics

Variable	Category	Frequency (n= 285)	Percentage (%)
Gender	Male	98	34.4
	Female	187	65.6
Qualification	NCE	142	49.8
	Bachelor's Degree	98	34.4
	Master's Degree	28	9.8
	Others	17	6.0
Years of Service			
	1-5years	62	21.8
	6-10years	89	31.2
	11-15years	74	26.0
	Above 15years	60	21.0

A total of 285 questionnaires were returned (95% response rate). The majority of teacher respondents were female (65.6%), while 34.4% were male. Most possessed NCE (49.8%), followed by Bachelor's Degree (34.4%), Master's Degree (9.8%), and others (6.0%). Teaching experience distribution: 6-10 years (31.2%), 11-15 years (26.0%), 1-5 years (21.8%), and above 15 years (21.0%).

Availability of Audio-Visual Resources

The grand mean for availability was 2.31 (below 2.50 benchmark), indicating low availability. Traditional resources were available: charts/diagrams (Mean = 3.45) and pictures (Mean = 3.52). However, modern resources were not available: computers (Mean = 2.15), projectors (Mean = 1.87), and smart boards (Mean = 1.52).

Utilisation of Audio-Visual Aids

The grand mean for utilisation was 2.17 (below 2.50 benchmark), indicating low utilisation. Pictures (Mean = 3.48) and charts (Mean = 3.42) were highly utilised, while videos (Mean = 1.89) and projectors (Mean = 1.76) had low utilisation.

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The experimental and control groups had comparable pre-test scores (42.35 and 41.98). After intervention, the experimental group achieved higher post-test scores (68.47) compared to the control group (49.23), with mean gains of 26.12 and 7.25 respectively.

Table 2: ANCOVA Summary for Academic Achievement

Source	Df	F	P-Value	Partial η^2	Decision
Treatment	1, 117	62.33	0.001	.346	Significant

ANCOVA results (Table 4.1) confirmed significant difference ($F(1,117) = 62.33$, $p < .001$, partial $\eta^2 = .346$), indicating a large effect size where approximately 34.6% of variance in post-test achievement scores was explained by audio-visual aids use. The 95% confidence interval for adjusted mean difference was [15.23, 21.87], confirming practical significance. H_{01} was rejected.

Effect on Attitudes

Both groups had comparable pre-test attitude scores (52.67 and 53.12). Post-test scores were 74.82 for experimental and 56.45 for control, with mean gains of 22.15 and 3.33 respectively.

Table 3: ANCOVA Summary for Attitudes

Source	Df	F	P-Value	Partial η^2	Decision
Treatment	1, 117	54.12	0.001	.316	Significant

ANCOVA confirmed significant difference ($F(1,117) = 54.12$, $p < .001$, partial $\eta^2 = .316$), indicating a large effect size. H_{02} was rejected.

Hypothesis Testing

H_{03}: Significant positive correlation between availability and utilisation ($r = 0.72$, $p < .001$). H_{03} rejected.

H_{04}: Significant positive correlation between teacher training and utilisation ($r = 0.58$, $p < .001$). H_{04} rejected.

Table 4: Factors Affecting Utilisation

Factor	Mean	Decision
Funding	4.32	Major
Equipment	4.18	Major
Electricity	4.05	Major
Teacher Training	3.92	Major

All factors were perceived as major hindrances (grand mean = 3.78, above 3.50 benchmark): inadequate funding (Mean = 4.32), lack of functional equipment (Mean = 4.18), irregular electricity supply (Mean = 4.05), and inadequate teacher training (Mean = 3.92).

Qualitative Findings

Thematic analysis of interviews with six teachers and two principals revealed five themes:

Theme 1: Limited Resources Constrain Instruction. Teachers consistently reported lack of functional equipment as the primary barrier. One teacher stated: *"We have no computers in our school. The only audio-visual resource we have is a small television set, but it is not working. Even if we had the equipment, there is no electricity most of the time."*

Theme 2: Teacher Training is Essential. Teachers emphasised need for practical training. A teacher commented: *"I studied computer studies in college, but we were not taught how to use audio-visual aids in teaching. I know they are important, but I don't know how to use them effectively."*

Theme 3: Funding Challenges Limit Resource Acquisition. A principal stated: *"The government provides some resources, but they are never enough. Private schools have better resources because they charge higher fees, but public schools struggle to get even the basic equipment."*
Theme 4: Positive Perceptions of Audio-Visual Instruction. One teacher noted: *"When I used videos and pictures to teach computer hardware, the pupils were very interested. They understood better and could remember what they had seen."*
Theme 5: Need for Technical Support. A teacher remarked: *"We had a projector donated to the school, but it broke down after three months. There was no one to repair it. We need technicians who can maintain the equipment."*
These qualitative findings provide rich contextual insights explaining the quantitative results.

Discussion of Findings

The findings revealed low availability and utilisation of audio-visual resources, consistent with UNESCO (2023), Etim (2024), Msafiri et al. (2023), and World Bank (2023), who reported that inadequate ICT infrastructure, unreliable electricity, and limited technological resources hinder technology integration in developing countries. Despite limited availability, pupils taught with audio-visual aids performed significantly better academically, supporting Dual Coding Theory (Clark & Paivio, 1991; Mayer, 2021). The large effect size (partial $\eta^2 = .346$) indicates substantial practical significance, suggesting that even in resource-constrained settings, targeted use of available resources can yield meaningful improvements. This finding aligns with Annur et al. (2025), Balogun (2025), Dorris et al. (2024), and Syahrir et al. (2024).

However, some of the previous studies reviewed reported smaller effect sizes (Annur et al., 2025) or inconsistent findings depending on contextual factors (Msafiri et al., 2023; Etim, 2024). The larger effect size observed in this study may be attributed to several factors: the relatively controlled quasi-experimental design, the focused duration of the intervention, the specific nature of Computer Studies content which lends itself to visual demonstration, and the novelty of audio-visual resources for the participating pupils. These contextual factors may have amplified the observed effects, suggesting that future research should examine the sustainability of these effects over longer periods.

Pupils exposed to audio-visual instruction developed more positive attitudes, supporting Constructivist Learning Theory (Jonassen, 1999; Schunk, 2020). The large effect size for attitudes (partial $\eta^2 = .316$) further underscores the practical significance of audio-visual instruction beyond cognitive outcomes, highlighting its potential to transform pupils' affective engagement with Computer Studies. This finding suggests that audio-visual instruction may be particularly valuable for addressing negative attitudes and low motivation often observed in technology-related subjects. Similar conclusions were reached by Balogun (2025), Annur et al. (2025), and Syahrir et al. (2024).

The significant positive correlation between availability and utilisation ($r = 0.72$, $p < .001$) confirms that availability is a necessary condition for utilisation, although it is not sufficient on its own. This suggests that other factors—including teacher training, infrastructure, and institutional support—intervene to determine whether available resources are actually used in instruction. Similarly, the moderate positive correlation between teacher training and utilisation ($r = 0.58$, $p < .001$) indicates that professional development is a key enabler of technology integration.

Furthermore, the study identified inadequate funding, lack of functional equipment, irregular electricity supply, and insufficient teacher training as the major factors limiting effective utilization of audio-visual aids. These findings agree with Msafiri et al. (2023), Etim (2024), UNESCO (2023), and the World Bank (2023), who emphasized that successful technology integration

requires adequate infrastructure, teacher competence, institutional support, and proper maintenance. The qualitative findings revealed that even when equipment was available, lack of technical support and unreliable electricity supply severely constrained sustained utilisation, highlighting the interconnected nature of these challenges.

These findings have important implications for classroom practice, educational policy, and future research. For classroom practice, the results suggest that teachers should be encouraged to integrate even simple audio-visual resources into Computer Studies instruction, as even limited use can yield significant improvements in learning outcomes. For educational policy, the findings underscore the need for sustained investment in ICT infrastructure, reliable electricity, and teacher professional development. For future research, longitudinal studies are needed to examine the sustainability of audio-visual instruction effects, and comparative studies across different subject areas and educational levels would further strengthen the evidence base.

Conclusion

Based on the findings, it is concluded that audio-visual aids have a significant positive impact on the teaching and learning of Computer Studies in selected primary schools within Bauchi Metropolis. Pupils exposed to audio-visual instruction demonstrated substantially higher academic achievement (with a large effect size of .346) and developed more positive attitudes (with a large effect size of .316) toward the subject than those taught through conventional teaching methods. These findings have practical educational significance, suggesting that audio-visual instruction can meaningfully improve both cognitive and affective learning outcomes in Computer Studies. However, effective utilisation remains constrained by inadequate ICT infrastructure, insufficient funding, irregular electricity supply, inadequate instructional equipment, and limited teacher competence. The findings apply primarily to the sampled schools within Bauchi Metropolis and should be interpreted within this contextual framework

Recommendations

For Teachers and School Administrators: Teachers should regularly integrate multimedia and learner-centred instructional strategies into Computer Studies teaching and receive regular training on educational technology skills. School administrators should ensure proper maintenance and effective management of available ICT facilities by well-trained personnel.

For UBEC and State Universal Basic Education Boards: UBEC and State Universal Basic Education Boards should increase funding for ICT infrastructure in primary schools, specifically targeting procurement and maintenance of audio-visual resources, and expand the Smart Schools initiative to reach more schools in Bauchi State and other underserved areas

For Teacher Education Institutions and Curriculum Developers: Teacher education institutions should revise curricula to include comprehensive training in educational technology and pedagogical use of audio-visual aids. Pre-service teachers should be equipped with practical technology integration skills, and in-service professional development programmes should be strengthened. Curriculum developers should explicitly require use of audio-visual aids in Computer Studies instruction and develop age-appropriate, culturally relevant multimedia resources aligned with curriculum objectives.

For ICT Policy Implementation: Government and relevant stakeholders should improve funding, electricity supply, and internet connectivity to support technology-enhanced learning. A comprehensive national policy on audio-visual instruction in basic education should be developed, addressing resource provision, teacher training, curriculum integration, and quality assurance.

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