UTILIZATION OF AUDIO-VISUAL AIDS AND ITS INFLUENCE ON STUDENTS' PERFORMANCE IN BIOLOGY AMONG SECONDARY SCHOOLS IN NANDI EAST SUB-COUNTY, KENYA

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF EDUCATION DEGREE IN INSTRUCTIONAL TECHNOLOGY OF

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DECLARATION AND APPROVAL

Declaration by the student

I confirm that this thesis is an original work undertaken by me and has not been submitted elsewhere for the fulfillment of any academic requirement.

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Approval by the supervisors

The thesis is submitted for examination with our full endorsement as the appointed supervisors.

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DEDICATION

This study is dedicated to the cherished memory of my late parents, and family, whose unwavering support sustained me throughout the journey of this thesis.

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My appreciation to Almighty Father for aiding me this far in my studies, special recognition to Mount Kenya University administration, lecturers and support staff for their immense role in assistance whenever need arose. I greatly acknowledge Dr. Jackson M. Mogeni and Dr. Emily Kirwok for their assistance throughout development of this study. Moreso, I acknowledge the respondents for willingly offering the required information. I sincerely appreciate the steadfast support and motivation provided by my colleagues. I also extend special appreciation to my nuclear family for their patience and understanding especially during moments when my commitment to this endeavor meant I couldn't fully meet my responsibilities as a spouse and parent.

ABSTRACT

Persistent underperformance in Biology among secondary school students in Nandi East Sub-County continues to undermine national educational goals, despite curriculum reforms and increased resource allocation aimed at improving science education. This study investigated the relationship between the utilization of audio-visual aids (AVA) and students' academic achievement in Biology. Specifically, the research aimed to assess the extent of student engagement in AVA-based simulations and their influence on Biology performance using test scores; evaluate the preparedness of Biology teachers to effectively utilize AVAs by examining their training and access to instructional resources; analyze teachers' perceptions regarding collaborative use of AVAs in teaching Biology and its influence on students' academic outcomes; and determine the frequency of AVA usage in Biology instruction and assess its impact on academic performance among secondary schools in Nandi East Sub-County, Kenya. Guided by Richard Mayer's Cognitive Theory of Multimedia Learning, the study adopted a descriptive-correlational mixed-methods research design to gain both quantitative and qualitative insights. The target population included Form Two Biology students, Biology teachers, Heads of Departments, and laboratory technicians from various secondary schools in the sub-county. A total of 317 students were chosen as the sample through the use of proportionate stratified and simple random sampling, while 28 teachers were selected through proportionate stratified and purposive sampling techniques. Data were collected using structured questionnaires, interview schedules, and classroom observation checklists. Instrument validity was enhanced through expert review and alignment with study objectives, while instrument reliability was confirmed through Cronbach's Alpha coefficients exceeding 0.8. The data were summarized using descriptive statistics, including measures such as means and standard deviations, while inferential statistics including Pearson correlation and multiple regression analysis were applied to determine the strength and nature of relationships among the study variables. The findings indicated that student engagement, teacher preparedness, collaborative AVA practices, and frequency of AVA use were all statistically significant predictors of students' academic performance in Biology. The regression model accounted for 48.2 percent of the variance in performance and was statistically significant at the 0.05 level. Despite the positive findings, challenges such as limited access to AVA resources, inadequate teacher training, and inconsistent implementation were identified. The study concludes that regular, collaborative integration of AVAs by adequately trained and well-prepared teachers is positively associated with enhanced learning outcomes in Biology. It recommends targeted in-service training, improved institutional support, and greater investment in educational technologies. Further research is suggested to explore the long-term impact of AVA use across other science disciplines and education levels.

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LIST OF ABBREVIATIONS AND ACRONYMS

AVA:	Audio -Visual Aids
CEMASTEA:	Centre for Mathematics, Science, Technology Education in Africa
DVD:	Digital Versatile Disc
HOD:	Head of Department
ICT:	Information Communication Technology
INSET:	In Service Education and Training
KCSE :	Kenya Certificate of Secondary Education
KIE:	Kenya Institute of Education
KNEC:	Kenya National Exam Council
SCDE	Sub-County Director of Education
SD:	Standard Deviation
SMASSE:	Strengthening of Mathematics and, Science in Secondary School Education
SPSS:	Statistical Package for Social Science
STEM:	Science, Technology, Engineering and Mathematics
UNESCO:	United Nations Educational, Scientific and, Cultural Organization
WESCA:	Western, Eastern, Central and Southern Africa

CHAPTER ONE

1.1 Introduction

Chapter One of this thesis introduces the study titled “Utilization of Audio-Visual Aids and Its Influence on Students’ Performance in Biology Among Secondary Schools, in Nandi East Sub-County, Kenya.” It provides a comprehensive overview of the study's background, highlighting the persistent low performance in Biology despite government interventions, and underscores the need for innovative instructional strategies such as Audio-Visual Aids (AVAs). This chapter outlines the research problem, purpose, specific objectives, and research questions, and further discusses the study’s justification, significance, scope, limitations, delimitations, underlying assumptions, and definitions of essential terms. It sets the stage for the investigation by examining the gap between policy and classroom practice, particularly in resource-constrained settings, and establishes the importance of evidence-based approaches to enhance Biology teaching and learning through AVA integration.

1.2 Background to the Study

In contemporary education, the integration of advanced pedagogical methods and technological tools has transformed traditional teaching practices. Historically, educational systems, particularly in indigenous settings, positioned the teacher as the sole authority while students played a passive role in the learning process (Battiste, 2002; Kirkness and Barnhardt, 1991). However, modern educational frameworks now emphasize active learning, critical thinking, and student engagement as core components of the learning process (Castagno and Brayboy, 2008). This shift towards interactive, student-centered approaches is in response to the global, regional, and local educational reforms, which advocate for the adoption of diverse instructional tools to enhance learning outcomes. Among these tools, audio-visual aids (AVAs) have gained prominence as effective instructional materials for fostering better engagement and retention.

Audio-visual aids refer to instructional materials that combine both auditory and visual stimuli to enrich the teaching and learning experience. These include videos, animations, slides, charts, and simulations, which create a multi-sensory learning environment that aids in understanding and retention (Shabiralyani et al., 2015). The use of AVAs in education dates back to the work of Amos Comenius (1592-1670), who advocated for the inclusion of images in teaching to facilitate comprehension (Ojelade, 2020). By the 1920s, AVAs were integrated into classroom instruction in the United States and subsequently adopted globally (Wandera, 2019). Research indicates that AVAs not only increase student participation and reduce distractions but also enhance retention rates when compared to traditional, text-based methods (Prasad, 2005; Mohan, 2010). In Biology, the integration of AVAs presents an opportunity to simplify abstract concepts and foster deeper understanding by making complex biological processes more tangible and engaging (Jadal, 2011).

At the global level, substantial research underscores the efficacy of AVAs in improving learning outcomes. In India, a study found that over 85% of students preferred AVA-based lessons over traditional lecture methods, citing increased engagement and comprehension (Mohan, 2010). Similarly, UNESCO-supported educational reforms have highlighted the importance of multimedia tools in enhancing student motivation and learning experiences, particularly in science education (Fensham, 2008). In industrialized nations like, the United States and, the United Kingdom, AVAs have become integral to science teaching, with evidence showing improvements in students' conceptual understanding, problem-solving skills, and overall academic performance (Shabiralyani et al., 2015; Eze, 2020).

In Africa, the use of AVAs in education has progressively gained attention, particularly through initiatives such as the Strengthening Mathematics and Science in Secondary Schools Education (SMASSE) program, which seeks to improve science instruction through innovative teaching methodologies, including AVA integration (Fensham, 2008). Research

from Nigeria and South Africa has shown that AVAs significantly enhance students' understanding of scientific concepts by creating more interactive and stimulating learning environments (Olu-Ajayi, 2016; Agyeiku, 2021). Agyeiku (2021) further emphasizes that integrating digital instructional resources alongside traditional textbooks offers a more holistic learning experience that better engages students.

In Kenya, the government has made concerted efforts to improve the quality of education through policy reforms, resource allocation, and the promotion of instructional materials. Despite these efforts, performance in science subjects, particularly Biology, continues to present challenges. Reports from the Kenya National Examinations Council (KNEC) indicate that, Biology scores in the Kenya Certificate of Secondary Education, (KCSE) have consistently dropped below the national average, with inadequate use of instructional resources being identified as a major contributing factor (KNEC, 2000, 2007, 2018). While the Ministry of Education has distributed textbooks to secondary schools, these resources alone have not been sufficient to address the pedagogical challenges in content delivery (Jamilah, 2021). The introduction of competency-based approaches in education necessitates the use of interactive teaching tools such as AVAs, which can enhance students' conceptual understanding and facilitate the practical application of knowledge (Nitu and Dahiya, 2017). Local studies in Kenya have demonstrated that AVAs help alleviate the monotony of traditional lecture-based teaching, stimulate student interest, and improve content retention in science subjects (Rasul et al., 2011).

Given the persistent challenges in Biology performance and the documented benefits of AVAs in science education globally and regionally, this study aims to evaluate the utilization of AVAs in secondary schools within Nandi East Sub-County, Kenya. Specifically, the study will assess how student participation and engagement in AVA-based instruction, teacher preparedness in using AVAs, teachers' perceptions of AVA integration, and the frequency of

AVA use influence student performance in Biology. By aligning with both global educational reforms and local needs, this research will contribute, to the growing body of literature on the effectiveness of AVAs in enhancing learning outcomes in science education. The findings will offer valuable insights for policymakers, educators, and stakeholders on how AVAs can be better integrated into teaching practices to improve student engagement and academic achievement in Biology. Ultimately, the study seeks to inform the development of future pedagogical strategies that bridge the gap between traditional teaching methods and modern, technology-enhanced learning environments.

National Biology performance trends show persistently low achievement, with reports from the Kenya National Examination Council (2022) highlighting a consistent performance gap from 2018 to 2022. This issue is particularly pronounced in Nandi East Sub-County, where despite government efforts, minimal improvement has been seen. The data suggests a need for alternative instructional strategies, such as Audio-Visual Aids (AVA), to enhance student engagement and performance in Biology.

National Biology performance trends show persistently low achievement, with reports from the Kenya National Examination Council (2022) highlighting a consistent performance gap from 2018 to 2022. This issue is particularly pronounced in Nandi East Sub-County, where despite government efforts, minimal improvement has been seen. The data suggests a need for alternative instructional strategies, such as Audio-Visual Aids (AVA), to enhance student engagement and performance in Biology. KCSE Performance in Biology for five years are provided in Table 1 below.

Table 1: Mean KCSE Scores in Biology for the Years 2018 to 2022

PAPER	**MAXIMUM SCORE**	**2018**	**2019**	**2020**	**2021**	**2022**
P1	80	15.81	18.00	16.03	19.58	24.04
P2	80	11.92	18.00	19.83	21.73	19.87
P3	40	13.62	16.00	16.59	15.72	13.47

Source: Kenya National Examination Council 2022 Report

The mean KCSE Biology scores from 2018 to 2022 reveal a persistent underperformance. Paper 1 (P1) shows a gradual increase from 15.81 in 2018 to 24.04 in 2022, yet the scores remain low relative to the maximum score of 80. Paper 2 (P2) fluctuates, rising from 11.92 in 2018 to 21.73 in 2021, before slightly dropping in 2022, indicating inconsistent improvement. Paper 3 (P3) shows a minimal decline from 13.62 in 2018 to 13.47 in 2022, suggesting difficulties with practical applications. These trends highlight the need for alternative instructional strategies, such as the integration of Audio-Visual Aids (AVA), to enhance student engagement and improve performance in Biology, particularly in regions like Nandi East Sub-County.

1.3 Statement of the Problem

The Kenyan government stands committed to ensuring universal access to education through its 100% transition policy, which mandates that all pupils progress from primary to secondary school and eventually to tertiary institutions (Republic of Kenya, 2016). The ideal situation is that all students reach their full academic potential, equipping them with the knowledge and skills required to pursue their desired career paths and contribute meaningfully to national development (Maundu, 2017).

However, the current situation in Nandi East Sub-County, Kenya, reveals a persistent and concerning low performance in Biology within the Kenya Secondary School Examinations. Over the past five years, students in this region have consistently underperformed in Biology,

a trend that mirrors national challenges in science education (Republic of Kenya, 2018). This performance gap is particularly troubling in the context of Kenya's emphasis on STEM (Science, Technology, Engineering, and Mathematics) fields, which are critical for the country's future economic and technological advancement (Mutemi, 2023).

If this issue remains unaddressed, it will continue to impede students' academic and career prospects, perpetuating the widening gap in STEM-related fields and potentially leading to low enrollment in science-based professions such as medicine, environmental science, and biotechnology (Ngugi, 2019). This stagnation may also result in a shortage of skilled professionals necessary for the growth and sustainability of key sectors in Kenya's economy (GOK, 2021).

In response to this challenge, the Ministry of Education has introduced several interventions, including the provision of textbooks and increasing the number of Biology teachers in secondary schools. However, these measures have not led to significant improvements in Biology performance, suggesting that there are deeper, unexplored challenges impacting student outcomes (Kenya Institute, of Curriculum Development [KICD], 2020).

The key gap that this study addresses is the insufficient empirical research on the role of alternative instructional strategies, particularly the use of audio-visual aids (AVA), in improving Biology performance (Adamu, 2019). Despite the government's efforts, AVAs have not been extensively explored as a potential solution, nor have they been effectively integrated into the teaching and learning of Biology in Kenyan schools. Existing literature largely focuses on traditional methods, with limited studies investigating how AVAs can enhance student engagement, comprehension, and performance in Biology (Sukma, 2018).

This study aims to bridge this gap by examining the utilization of AVAs as a strategy for improving Biology learning outcomes in Nandi East Sub-County. By investigating the extent

to which AVAs are integrated into Biology teaching, this research seeks to provide empirical evidence on the potential of AVAs to enhance student achievement in the subject, thereby contributing to the improvement of science education in Kenya (Franklin, 2022).

1.4 Purpose of the Study

This study aimed to explore how audio-visual aids (AVAs) are utilized and the extent to which they affect students' academic performance in Biology across secondary schools in Nandi East Sub-County, Kenya, by assessing student participation and engagement in AVA-based simulations, evaluating teacher preparedness through training and resource access, analyzing teacher perceptions on collaborative use of AVAs, and determining the frequency of AVA usage in relation to academic achievement.

1.5 Objectives of the Study

This research was structured around the following key objectives:

i. To assess student participation and engagement in audio-visual aid-based simulations and their influence on Biology performance using test scores in secondary schools of Nandi East Sub-County, Kenya.
ii. To assess the preparedness of Biology teachers to utilize audio-visual aids in content presentation by evaluating their training and access to resources in secondary schools of Nandi East Sub-County, Kenya.
iii. To analyze teachers' perceptions of the collaborative use of audio-visual aids in teaching Biology and their influence on students' performance by evaluating interview responses in secondary schools of Nandi East Sub-County, Kenya.
iv. To determine the frequency of audio-visual aid usage in Biology teaching and learning and analyze its influence on students' academic performance in secondary schools of Nandi East Sub-County, Kenya.

1.6 Research Questions

To facilitate the achievement of the study's aims, the following research questions were formulated to guide the investigation:

i. How does student participation and engagement in audio-visual aid-based simulations influence Biology performance, as measured by test scores, in secondary schools of Nandi East Sub-County, Kenya?

ii. How prepared are Biology teachers in secondary schools of Nandi East Sub-County, Kenya to utilize audio-visual aids in content presentation, based on their training and access to resources?

iii. How do teachers perceive the use of audio-visual aids in teaching Biology and their influence on students' performance in secondary schools of Nandi East Sub-County, Kenya?

iv. How frequently are audio-visual aids used in Biology teaching and learning, and what is their influence on students' academic performance in secondary schools of Nandi East Sub-County, Kenya?

1.7 Justification of the Study

The academic performance of students in Biology carries significant implications for key educational stakeholders, including educators, policymakers, learners, and parents. Despite the critical role of Biology in fostering scientific literacy and supporting national development goals, student performance in the subject remains a persistent concern, particularly within the Kenyan context. Reports by the Kenya National Examinations Council (KNEC, 2007) have consistently indicated fluctuating and below-average performance in Biology at KCSE level, often attributed to the inadequate and underutilized instructional resources in schools.

While previous studies have explored various determinants of academic achievement, there is limited empirical literature that specifically investigates the role of audio-visual aids (AVAs) in enhancing Biology performance in secondary schools across Kenya (Nkrumah, 2021). As the integration of technology in education becomes increasingly essential, AVAs present valuable opportunities to improve learner engagement, conceptual understanding, and retention of scientific content. However, the extent of their use and impact within the Kenyan classroom, especially in rural and under-resourced areas such as Nandi East Sub-County remains underexplored.

In response to low STEM uptake and performance, the Ministry of Education, in collaboration with CEMASTEA, introduced various interventions beginning in 2017 aimed at strengthening STEM disciplines, including Biology. Nevertheless, the integration of AVAs into instructional practice remains inconsistent, and teacher readiness to use such tools effectively varies widely.

The study sought to bridge these identified gaps by conducting a structured inquiry into the application of audio-visual aids in Biology instruction across secondary schools in Nandi East Sub-County. Specifically, the study examines the influence of AVAs on student engagement and participation, evaluates teacher preparedness and access to AVA resources, analyzes teacher perceptions regarding collaborative use of AVAs, and determines the frequency of AVA integration and its relationship to student academic performance. The findings are expected to provide empirical evidence that can inform curriculum implementation, teacher professional development, and policy formulation aimed at improving Biology performance and reinforcing Kenya's STEM education agenda.

1.8 Significance of the Study

The findings of this study hold significant implications for multiple stakeholders, including students, teachers, researchers, curriculum planners, the Government of Kenya, and society at large. As Kenya seeks to strengthen Science, Technology, Engineering, and Mathematics (STEM) education, the integration of Audio-Visual Aids (AVAs) in Biology instruction aligns with national goals of fostering scientific literacy, innovation, and workforce readiness (CEMASTEA, 2017). This study, therefore, provides empirical insights into how AVA utilization influences student engagement, teacher preparedness, and overall Biology performance in secondary schools within Nandi East Sub-County, Kenya.

For students, the research offers evidence on the role of AVAs in enhancing engagement, conceptual understanding, and performance in Biology. Prior research suggests that multimedia-based learning environments improve knowledge retention and problem-solving skills, particularly in science subjects (Mayer, 2021; Shabiralyani et al., 2015). By assessing student participation in AVA-supported learning activities, this study informs strategies to bridge existing gaps in Biology performance and encourage higher enrollment in STEM-related careers.

For teachers, the study evaluates their preparedness, perception, and frequency of AVA use in Biology instruction. Research indicates that teachers who effectively integrate AVAs in science education report increased student motivation and classroom interaction (Olu-Ajayi, 2016). The study's findings will highlight potential challenges, such as inadequate training and limited access to AVA resources, thereby informing teacher development programs and capacity-building initiatives.

For curriculum planners and policymakers, the research provides critical data on the effectiveness of AVA-based pedagogy in Biology. Given that Kenya's Competency-Based

Curriculum (CBC) emphasizes practical and inquiry-based learning (Ministry of Education, 2019), the study supports policy recommendations for structured AVA integration in science instruction. The insights from this research can guide national strategies on AVA resource allocation, ensuring equitable access to technology-enhanced learning tools.

For the Government of Kenya, the study aligns with ongoing efforts to promote STEM education and improve national examination outcomes. The Kenya National Examination Council (KNEC) has consistently reported fluctuating and below-average Biology performance, attributing poor results to limited instructional resources and outdated teaching methods (KNEC, 2007, 2018). By determining the extent of AVA utilization and its impact on student outcomes, the study informs evidence-based decision-making for investments in teacher training, digital infrastructure, and school-based AVA resource centers.

For parents and society, improved Biology performance through AVA integration has long-term economic and social benefits. As more students pursue science-related careers, Kenya can build a skilled workforce in fields such as medicine, biotechnology, and environmental science, addressing labor market demands and fostering national development (UNESCO, 2020). The study will contribute to the broader discourse on how innovative teaching methods can enhance STEM participation and prepare students for the evolving global economy.

In conclusion, this study would provide a research-based foundation for optimizing AVA utilization in secondary school Biology instruction. By aligning findings with national education goals, the study will offer practical recommendations to enhance teaching effectiveness, improve student performance, and support Kenya's vision of becoming a knowledge-driven economy.

1.9 Scope of the Study

The study focused on investigating utilization of audio-visual aids (AVAs) and their influence on students' performance in Biology among secondary schools in Nandi East Sub-County, Kenya. The study was confined to the use of audio-visual instructional materials such as videos, simulations, charts, and projectors as opposed to other resources like purely audio-based tools or print media. The selection of AVAs was based on the premise that their multisensory nature provides a more engaging and effective learning experience in Biology, a subject that often requires the visualization of complex scientific processes.

The target population comprised Form Two Biology students, who were selected because this level forms a critical foundation for subsequent Biology topics and contributes significantly to overall performance KCSE examination. In addition to students, the study involved Biology teachers, who are the primary implementers of AVA in instructional settings. Heads of Science Departments were also included to provide insights into the availability, maintenance, and departmental support for AVA resources. Laboratory technicians participated in the study to offer perspectives on the availability and accessibility of AVA-related materials within the school laboratory environment, as well as any logistical challenges encountered during their utilization.

The study was conducted during the regular school calendar when students were in session, allowing the researcher to engage directly with relevant stakeholders. A total of 28 public secondary schools were sampled from the 30 public schools in Nandi East Sub-County, ensuring broad and representative coverage. Data collection methods included student and teacher questionnaires, interviews with Heads of Science Departments and laboratory technicians, and classroom observations conducted by the researcher to document actual AVA use during Biology lessons.

Conceptually, the study was delimited to examining four key aspects: student engagement in AVA-based simulations, teacher preparedness in using AVAs, teachers' perceptions of collaborative AVA use, and the frequency of AVA utilization in Biology instruction. The study did not cover other subjects, educational levels, or teaching resources outside the scope of audio-visual aids.

1.10 Limitations of the Study

This study, which explored the use of audio-visual aids (AVAs) and their ifluence on students' performance in Biology within secondary schools in Nandi East Sub-County, Kenya, was subject to certain limitations, which were mitigated through deliberate strategies to preserve the study's credibility.

First, the focus was limited to AVAs and excluded other instructional methods such as laboratory experiments and fieldwork, which also impact Biology performance. While this narrowed the scope, the study aimed to address a specific gap in literature regarding AVA effectiveness. To mitigate this, data were triangulated through questionnaires, interviews, and classroom observations to enrich understanding and validate findings.

Second, the study was confined to public secondary schools in Nandi East Sub-County due to financial and logistical constraints, which may limit generalization to other regions. However, the sub-county was intentionally selected due to persistent low Biology performance and minimal AVA integration. Schools from diverse socio-economic settings were included to enhance representativeness.

Lastly, response bias was a concern, as some participants may have withheld full disclosure on AVA use. To counter this, the researcher ensured anonymity, clarified the academic purpose, and cross-validated responses using a mixed-method approach to maintain objectivity.

Notwithstanding these limitations, the study generates significant empirical insights into the integration of audio-visual aids in Biology instruction and offers valuable contributions toward strengthening STEM education policy and practice in Kenya.

1.11 Delimitations of the Study

This study was, delimited to public secondary schools, in Nandi East Sub-County, Kenya. The sub-county was purposefully selected due to its consistent record of low performance in Biology and the apparent underutilization of audio-visual aids (AVAs) in instruction. Although the findings may not be generalizable to all regions in Kenya, they offer valuable insights for areas with similar educational and infrastructural contexts.

The study was further limited to examining the role of AVAs in the teaching and learning of Biology, deliberately excluding other instructional methods such as laboratory experiments, fieldwork, and peer-assisted learning. This specific focus allowed for a targeted evaluation of the extent to which AVAs contribute to student engagement and academic achievement in Biology, in line with the study's objectives.

Additionally, the research targeted Form Two students, Biology teachers, and laboratory technicians. Form Two students were selected because they are at a formative stage in secondary education, where strong conceptual foundations are critical to future academic success. Teachers and laboratory technicians were included to assess their preparedness, perceptions, and the frequency with which AVAs are used in Biology instruction.

By delineating the geographical area, content focus, and target population, the study maintained a manageable and coherent scope. The findings are expected to inform instructional practices and policy decisions aimed at improving Biology performance through the integration of AVAs, thereby contributing to the advancement of STEM education in Kenya.

1.12 Assumptions of the Study

This study was guided by several key assumptions that underpinned its methodology and interpretation of findings on the influence of audio-visual aids (AVAs) on Biology performance in secondary schools in Nandi East Sub-County, Kenya.

First, it was assumed that, all sampled schools offer Biology as a subject up to the Kenya Certificate of Secondary Education (KCSE) level, providing a consistent academic context for evaluating AVA integration.

Second, the study assumed that Biology teachers were professionally trained and experienced, thus capable of effectively implementing AVAs during instruction. This was important in assessing the influence of teacher preparedness on student outcomes.

Third, it was presumed that audio-visual teaching resources such as projectors, simulations, and video content were present to some extent across the sampled schools, allowing for meaningful analysis of their utilization.

Finally, it was assumed that all respondents would provide honest and accurate responses. Confidentiality measures and anonymity were emphasized to encourage truthful participation. These assumptions provided the foundation for data collection and analysis. Where discrepancies arose, they were critically examined and considered in the interpretation of results and subsequent recommendations.

1.13 Operational Definitions of Terms

Academic Performance: The extent to which students achieve desired learning outcomes in Biology, as measured through formative and summative assessments.

Audio-Visual Aids: Instructional tools that incorporate both visual and auditory elements, such as videos, animations, and digital simulations,

used to enhance conceptual understanding and engagement in Biology lessons.

Biology Teachers: Professionally trained educators responsible for instructing Biology in secondary schools, guiding students in theoretical and practical aspects of the subject.

Instruction: The structured process of delivering Biology content to students through various teaching methods, including the integration of audio-visual aids to improve comprehension.

Instructional Aid: Any resource, including digital and non-digital materials, that facilitates the effective delivery of Biology content, making learning more interactive and comprehensible.

Involvement: The active participation of students and teachers in the use of AVAs to support Biology instruction, measured by engagement levels in lessons that incorporate these tools.

Learning: The process through which students acquire scientific knowledge and skills in Biology, facilitated by structured instruction and the integration of AVAs.

Perception: The attitudes and beliefs of Biology teachers regarding the effectiveness and applicability of AVAs in improving student understanding and performance in the subject.

Preparedness: The level of readiness and competence demonstrated by Biology teachers in integrating AVAs into their teaching, influenced by factors such as training, resource availability, and experience.

Sciences: Core academic disciplines in the Kenyan secondary school curriculum, including Biology, Chemistry, and Physics, which

are foundational to STEM education.

Science Students: Secondary school learners enrolled in Biology and other science subjects, whose performance and engagement in the subject are influenced by instructional strategies, including the use of AVAs.

Secondary School: A formal educational institution offering Biology instruction to students from Form One to Form Four, where learning outcomes are assessed through continuous and national examinations.

Utilization: The extent to which Biology teachers incorporate AVAs in lesson delivery, measured in terms of frequency, effectiveness, and alignment with curriculum objectives.

Utilization Frequency: The number of times Biology teachers employ AVAs in their lessons within a given instructional period, influencing student engagement and academic performance.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Chapter two basically presents a review of relevant literature focusing on learner involvement in using audio-visual aids and the frequency to which they are utilized in schools. It also focuses on teacher preparedness and perception on use of AVA. Review of literature brought to light the theoretical framework which forms the basis for this research. Conceptual framework of the researcher deliberated and research gaps emanating from past researches brought out.

2.2 Audio-Visual Aids

In the context of this study titled "Utilization of Audio-Visual Aids and Its Influence on Students' Performance in Biology among Secondary Schools, in Nandi East Sub-County, Kenya," audio-visual aids are defined as instructional materials that utilize both sound and visual elements to enhance the teaching and learning process. These tools are designed to stimulate multiple senses, thereby improving learners' comprehension, engagement, and retention of subject matter. In the teaching of Biology, AVAs include educational videos, digital simulations, animations, projectors, charts, diagrams, 3D models, and audio-narrated content. Such materials help to simplify abstract scientific concepts by providing visual representations and real-life simulations, which make learning more interactive and meaningful (Adamu, 2019; Diwan, 2023).

The use of AVAs in Biology instruction is particularly beneficial because the subject often involves complex processes and microscopic phenomena that are difficult to grasp through text alone. By incorporating audio-visual content, teachers can illustrate dynamic processes such as cell division, photosynthesis, or ecological interactions, thereby deepening student understanding and encouraging active participation (Boateng, 2021). Furthermore, AVAs

accommodate different learning styles, enabling both visual and auditory learners to access content more effectively (Franklin, 2022).

Within the Kenyan secondary school context, and particularly in Nandi East Sub-County, the integration of AVAs serves as an alternative instructional strategy aimed at addressing persistent poor performance in Biology. By examining how AVA usage influences student performance, this research endeavored to evaluate the degree to which AVAs contribute to improving test scores and academic outcomes in Biology education.

2.3 Review of Related Literature

There are several studies which have been done which related to what was under study.

2.3.1 Influence of AVA-based simulations on students' performance

Student participation and engagement in audio-visual aid (AVA)-based simulations play a crucial role in enhancing learning outcomes in Biology. Active involvement in AVA-supported lessons fosters deeper understanding, increases retention, and improves performance. Sukma (2018) notes that students who engage actively by asking questions and seeking clarification during AVA-based lessons demonstrate better comprehension and knowledge retention than passive learners. Similarly, Hsbollah et al. (2022) emphasize that active learners create a more conducive learning environment, which enhances participation and improves academic outcomes. Given the emphasis on interactive learning, it is important to assess how student participation in AVA-based simulations influences Biology performance in secondary schools in Nandi East, Sub-County, Kenya.

However, previous studies showed that student engagement during AVA-based instruction varies, with some learners remaining passive. Mutemi (2023) argues that while AVAs can enhance lesson interactivity, passive students may disengage if instructional materials are not designed to encourage participation. Bagila (2019) supports this view by asserting that effective use of AVAs increases student confidence and fosters active involvement. In

Biology lessons, AVAs such as animations, simulations, and interactive videos can make abstract concepts more accessible, allowing learners to visualize complex biological processes. Adamu (2019) highlights that AVAs improve concept clarity, particularly in scientific subjects where visual representation enhances understanding.

Beyond student engagement, AVAs significantly influence academic performance by increasing information retention. Diwan (2023) asserts that individuals tend to recall what they see and hear more effectively, reinforcing the importance of AVA-based simulations in Biology instruction. Franklin (2022) further observes that visualized content remains vivid in learners' memories, leading to better long-term recall. Additionally, AVA-based learning allows for individualized instruction, enabling students to learn at their own pace. Boateng (2021) notes that self-paced learning facilitated by AVAs enhances syllabus coverage and improves exam preparation. These factors collectively contribute to improved academic performance in Biology.

While existing research underscores the benefits of AVA integration, there remains a gap in empirical studies evaluating student participation in AVA-based Biology lessons within the Kenyan context. Few studies have specifically assessed the extent to which AVA engagement influences student test scores in secondary schools in Nandi East Sub-County. Moreover, most existing research focuses on AVAs as instructional tools rather than analyzing student interactions with these resources. This study aims to address this gap by assessing student participation in AVA-based simulations and evaluating their impact on Biology performance using test scores.

In summary, assessing student participation and engagement in AVA-based simulations is critical for understanding their influence on Biology performance. Existing literature highlights the role of AVAs in increasing engagement, improving retention, and fostering

self-paced learning. However, limited empirical research exists on how student participation in AVA-based simulations directly correlates with test scores in Kenyan secondary schools. This study sought to provide empirical evidence on this relationship, informing policy and pedagogical strategies to enhance Biology instruction and overall student performance.

2.3.2 Influence of Teacher Preparedness on AVA Utilization on Student Performance

The effective integration of audio-visual aids (AVA) in Biology instruction is significantly influenced by teacher preparedness, which encompasses training, technological competence, and access to necessary resources. The ability of a teacher to operate AVA equipment, plan lessons that integrate AVA effectively, and troubleshoot minor technical difficulties directly affects the quality of instruction and, consequently, student performance. Empirical research highlights that well-trained teachers who utilize AVA can enhance students' comprehension, retention, and test performance in Biology (Boateng, 2021).

Studies indicate that many Biology teachers in secondary schools lack adequate training to utilize AVA effectively. For instance, a study conducted in Kenya by Nyang'au (2020) found that over 60% of teachers in public secondary schools were not proficient in handling AVA equipment, limiting their ability to integrate these tools into lesson delivery. The same study revealed that students in schools where teachers were well-trained in AVA usage outperformed their counterparts in standardized Biology tests, demonstrating the direct impact of teacher preparedness on student outcomes.

Technophobia among teachers is another challenge that hinders AVA implementation in Biology classrooms. Many educators hesitate to adopt technology-based teaching methods due to fear of failure or lack of confidence in operating AVA tools. Giannikas (2019) emphasizes that teacher training programs must prioritize digital literacy to ensure educators effectively incorporate AVA into their instructional strategies. When teachers are proficient

in AVA usage, students benefit from engaging and interactive lessons, leading to better comprehension and improved academic performance.

Additionally, the availability of AVA resources varies significantly across schools, affecting both teacher preparedness and student learning experiences. A study by Otieno and Wekesa (2021) in Nandi County reported that only 35% of secondary schools had functional AVA tools, with a majority of the schools lacking projectors, educational videos, and interactive simulations for Biology instruction. In contrast, private schools with better access to AVA resources exhibited higher student performance in Biology, further emphasizing the role of AVA in enhancing academic achievement.

The reluctance of teachers to embrace AVA due to time constraints and perceived workload also affects its effectiveness in improving student performance. Some teachers argue that preparing AVA-based lessons is time-consuming and that the effort required to integrate these tools into the curriculum outweighs the benefits (Earl and Fa'ava'a, 2021). However, research by Adamu (2019) found that students taught using AVA retained concepts 40% better than those taught through traditional lecture methods, reinforcing the necessity of AVA integration despite the initial preparation challenges.

Teacher preparedness also influences the pace of syllabus coverage and revision, which in turn affects student achievement in national-level assessments. As reported in the research conducted by Kamau and Ndungu, (2023) on KCSE Biology performance trends, students who were exposed to AVA-based lessons had a higher retention rate and performed better in structured and essay-type questions than those who relied solely on textbook learning. This finding aligns with Franklin's (2022) assertion that visualizing biological concepts through AVA enhances long-term memory retention, making it easier for students to recall information during exams.

From the reviewed literature, it is evident that the preparedness of Biology teachers in utilizing AVA is a crucial determinant of student performance. Schools with trained and technologically proficient teachers record higher student engagement, improved comprehension, and better test scores. However, most studies focus on general teacher preparedness without assessing the specific impact in Nandi East Sub-County. The existing research does not adequately explore the correlation between teacher training, AVA utilization frequency, and student performance in local schools. Therefore, this study aimed to bridge this gap by assessing how preparedness of Biology teachers, influences student outcomes in secondary schools in, Nandi East Sub-County, Kenya.

2.3.3 Influence of Teachers' Perceptions of the Collaborative use of AVA on Students' performance

Teachers' perceptions of audio-visual aids (AVA) significantly influence their willingness to integrate these tools into their instructional strategies. A positive attitude towards AVA fosters a collaborative learning environment, enhancing student engagement and comprehension in Biology. Research indicates that teachers with a strong belief in the effectiveness of AVA are more likely to use them regularly, leading to improved student performance (Ajogbeje & Osuntuyi, 2021). However, resistance to AVA adoption due to technological apprehension, lack of institutional support, and personal teaching philosophies remains a significant barrier (Baskota, 2021).

For the effective adoption of AVA, teachers must be mentally prepared and intrinsically motivated to use these resources. A technologically confident instructor delivers content more effectively, making lessons engaging and interactive, which in turn enhances students' comprehension and test performance (Shehada & Amer, 2019). Teachers who perceive AVA as beneficial tend to integrate them into their pedagogy rather than using them solely for supplementary drills. A study by Ismail et al. (2018) found that teachers who were personally

invested in AVA usage and regularly updated their technological skills reported higher student engagement and better academic outcomes. Familiarity with technology fosters adaptability and positive perceptions of AVA. Schools equipped with computers and multimedia tools often report a higher frequency of AVA utilization, as teachers develop confidence in their application. According to Stein (2020), technology-integrated instruction significantly improves Biology students' conceptual understanding, particularly in topics that require visualization, such as cell biology and genetics. However, the reluctance of some teachers to adopt AVA stems from their personal philosophies and previous negative experiences with technology, highlighting the need for continuous professional development.

Teachers' attitudes toward AVA are also influenced by the level of institutional support they receive. Headteachers and school administrators play a crucial role in fostering a culture of technology integration. When school leadership provides tailored training and allocates resources for AVA, teachers are more likely to adopt them in their lessons (Ismail et al., 2018). The availability of AVA equipment, technical support, and professional development programs enhances teachers' confidence in using these tools. However, studies indicate that many secondary schools lack structured support systems for AVA adoption. A study conducted by Otieno and Wekesa (2021) in Kenya revealed that 45% of teachers in public secondary schools cited inadequate administrative support as a key barrier to AVA implementation. This lack of institutional encouragement results in sporadic use of AVA, limiting its potential impact on student performance. Conversely, schools that actively promote AVA integration through workshops and peer collaboration report better learning outcomes, as teachers gain confidence and develop innovative teaching strategies (Ajogbeje and Osuntuyi, 2021).

Collaboration among teachers enhances the effective use of AVA in Biology instruction. Peer mentoring, team teaching, and sharing of best practices enable teachers to overcome technical

and pedagogical challenges associated with AVA usage. Research by Shehada and Amer (2019) highlights that teachers who engage in collaborative AVA integration report greater confidence and competence, which translates into improved student performance. Additionally, collaborative use of AVA allows teachers to refine their instructional methods, making lessons more engaging and effective. A study by Kamau and Ndungu (2023) found that Biology students taught by teachers who engaged in AVA-based collaborative teaching strategies outperformed those taught using traditional methods. The study revealed that interactive AVA sessions improved students' retention rates by 35% and enhanced their ability to apply learned concepts in problem-solving tasks. This finding underscores the need for a structured, collaborative approach to AVA integration in Biology instruction.

Despite the benefits of collaboration, many schools lack frameworks to encourage teamwork among teachers in AVA utilization. Professional learning communities (PLCs) have been suggested as a viable solution to bridge this gap. According to Franklin (2022), PLCs provide a platform for teachers to exchange ideas, discuss challenges, and develop innovative approaches to AVA integration. Schools that have adopted PLCs report increased AVA usage and improved student performance in Biology.

The reviewed literature suggests that teachers' perceptions of AVA significantly influence their willingness to integrate these tools into their teaching practices. Factors such as intrinsic motivation, technological competence, and institutional support play a crucial role in shaping these perceptions. However, while existing studies highlight the impact of teacher perceptions on AVA utilization, limited research has been conducted on the collaborative use of AVA during Biology instruction in Kenyan secondary schools, particularly, in Nandi East Sub-County. Furthermore, most studies focus on general AVA adoption without specifically analyzing how teachers' perceptions impact student performance in Biology. The role of collaborative strategies in AVA implementation also remains underexplored in the local

context. Therefore, this study focused on bridging this gap by evaluating teachers' perceptions of collaborative AVA use and its influence on student performance in secondary schools of, Nandi East Sub-County, Kenya.

2.3.4 Influence of AVA Utilization Frequency on Students' Performance

The academic performance of students is a vital indicator of their comprehension and mastery of subject content, particularly in complex subjects such as Biology. The integration of audio-visual aids (AVA) into Biology instruction has been recognized as a transformative strategy for enhancing student engagement, conceptual understanding, and academic achievement. AVAs, including tools such as charts, models, simulations, animations, videos, and PowerPoint presentations, provide learners with multi-sensory experiences that cater to diverse learning styles and facilitate the retention of knowledge.

Frequent utilization of AVAs in classroom instruction has been linked to improved student performance. According to Mwangi and Muthoni (2021), students exposed to regular AVA-supported lessons demonstrated a higher grasp of abstract biological concepts, such as cellular processes and ecological systems, compared to those taught using traditional methods. Similarly, Oduor and Ochieng (2020) found that consistent use of AVAs, particularly simulations and animations, significantly improved student comprehension and participation during Biology lessons in Kenyan secondary schools.

Despite the clear benefits, the frequency of AVA utilization varies widely across schools, influenced by factors such as teacher preparedness, resource availability, and institutional support. In many rural areas, including Nandi East Sub-County, limited access to technological infrastructure and AVA resources constrains the consistent integration of these tools in instruction. Teachers often rely heavily on textbooks, with AVA usage being

sporadic and largely dependent on individual initiative (Kiprotich and Kosgei, 2021). This inconsistency undermines the potential of AVAs to enhance learning outcomes in Biology.

Effective and frequent use of AVAs enhances not only comprehension but also fosters student motivation and independence in learning. Teachers who regularly integrate AVAs into their pedagogy report increased student engagement and improved classroom interaction (Chebet and Too, 2022). Furthermore, AVA-supported instruction allows students to visualize biological processes and phenomena that are otherwise abstract or challenging to comprehend through text-based instruction alone.

However, challenges persist that limit the frequent and systematic use of AVAs. These include inadequate teacher training on AVA integration, limited access to AVA materials, and lack of institutional policies supporting technology use in teaching (Mutai and Koech, 2023). In Nandi East Sub-County, these barriers are further exacerbated by budgetary constraints and infrastructural deficiencies, which affect both the availability and frequency of AVA utilization.

In conclusion, the frequency of AVA usage plays a critical role in influencing student performance in Biology. Regular and effective use of AVAs supports deeper understanding, engagement, and retention of content, thereby enhancing academic achievement. Addressing the challenges that hinder frequent AVA utilization such as inadequate training, limited resources, and poor infrastructure is essential for improving Biology instruction in Nandi East Sub-County. This study seeks to determine the frequency of AVA usage in Biology and its direct influence on students' academic performance, with a focus on secondary schools in this region.

2.4 Theoretical Framework

This investigation is underpinned by Mayer's Cognitive Theory of Multimedia Learning, which emphasizes the importance of integrating verbal (auditory) and visual (pictorial) elements in instructional design to enhance comprehension, retention, and knowledge transfer. According to Mayer (2014), learning is most effective when learners are presented with a combination of verbal and visual inputs, as opposed to verbal information alone. This theory is pertinent to the present study, which investigates the use of audio-visual aids (AVAs) and their impact on students' academic performance in Biology within secondary schools in Nandi East Sub-County, Kenya.

Mayer's theory postulates that the human cognitive system processes information through dual channels: the auditory channel, which handles spoken words and sounds, and the visual channel, which processes images and written text. Effective learning occurs when learners actively engage with instructional materials by selecting, organizing, and integrating information through these channels. This theoretical foundation aligns with the study's objectives, particularly in assessing how AVAs support student engagement, teacher preparedness, frequency of usage, and ultimately students' academic performance in Biology.

2.4.1 Principles of the Cognitive Theory of Multimedia Learning

Mayer (2014) outlines three fundamental principles that guide how multimedia aids enhance learning:

Selection Principle

This principle states that learners must select relevant words and images from instructional materials for further cognitive processing. In the context of Biology education, AVAs such as diagrams, animations, and simulations help direct students' attention to critical concepts, enhancing their engagement and comprehension.

Organization Principle

Once selected, learners organize verbal and visual inputs into coherent mental structures. AVAs facilitate this process by simplifying complex biological phenomena such as DNA replication through visually appealing and logically structured content. This supports meaningful learning and aids in conceptual clarity.

Integration Principle

In this stage, learners integrate new information with their existing knowledge base. AVAs enhance this process by providing multi-sensory experiences, making it easier for students to relate new Biology concepts to prior knowledge, thus improving retention and application of information.

2.4.2 Limitations of the Cognitive Theory of Multimedia Learning

While Mayer's Cognitive Theory of Multimedia Learning provides a comprehensive and valuable framework for designing effective multimedia instruction, it is not without its limitations. One of the primary challenges associated with this theory is the risk of cognitive overload. When students are exposed to an excessive amount of multimedia content—such as animations, videos, audio, and text—simultaneously, they may struggle to process all the information effectively. This overload can hinder learning, as the brain's working memory becomes overwhelmed, leading to reduced comprehension and retention.

Another limitation lies in learner variability. The benefits of multimedia learning are not experienced uniformly across all students. Factors such as differences in cognitive capacity, prior knowledge, and individual learning preferences can significantly influence how effectively students learn from audio-visual aids (AVAs). For instance, students with limited background knowledge may find multimedia content more challenging, while those with a preference for visual or auditory learning may benefit more than their peers.

Technological constraints also pose a significant challenge, particularly in resource-limited settings such as Nandi East Sub-County. The successful implementation of AVAs depends heavily on the availability of technological resources and the proficiency of teachers in using them. In areas where infrastructure is inadequate, access to devices, electricity, or reliable internet may be limited, impeding the consistent use of AVAs in classroom instruction. Additionally, if teachers are not adequately trained or confident in using technology, the potential benefits of AVAs may not be fully realized.

2.4.3 Relevance and Application to the Study

Mayer's Cognitive Theory of Multimedia Learning offers a solid theoretical foundation for examining how audio-visual aids (AVAs) influence student performance in Biology. The theory supports the use of AVAs as effective instructional tools that engage students, simplify complex biological concepts, and enhance knowledge retention. Within this study, Mayer's principles shape the conceptual framework and guide the analysis of AVA utilization in the classroom.

The Selection Principle is closely tied to student engagement, emphasizing that learners benefit when they can focus on relevant multimedia content, thereby improving their understanding. The Organization Principle relates to teacher preparedness and perception, highlighting the importance of structuring lessons effectively with AVAs to meet specific instructional objectives. Lastly, the Integration Principle connects to the frequency with which AVAs are used, as well as the support provided by school administration. Together, these factors facilitate the integration of new knowledge, contributing to improved academic outcomes in Biology.

Overall, Mayer's theory underpins the entire research process by explaining how the thoughtful use of AVAs can lead to meaningful learning experiences, which are especially critical in the teaching and learning of Biology.

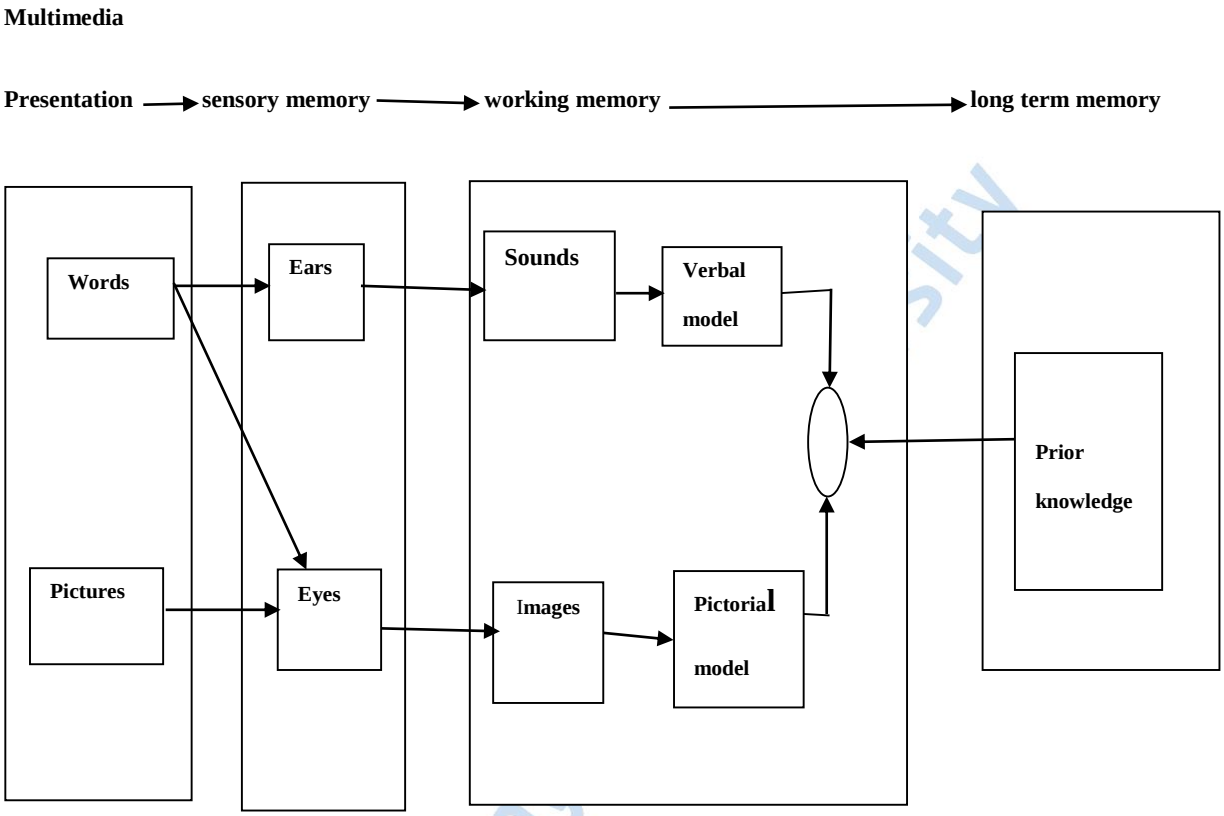

Figure 1: Cognitive Theory of Multimedia

2.5 Conceptual Framework

A conceptual framework outlines key study variables, their indicators, and the hypothesized relationships between them, guiding logical investigation and interpretation of the research problem. As noted by Antonenko (2015), it clarifies complex variable interactions, while Van der Waldt (2020) highlights its role in helping researchers me~~et o~~bjectives systematically.

This study is anchored in Richard Mayer's Cognitive Theory of Multimedia Learning (2014), which posits that meaningful learning occurs when learners process verbal and visual information simultaneously. This dual-channel approach enhances comprehension and retention, supporting the use of audio-visual aids (AVAs) in teaching complex subjects like

Biology. The theory underpins this study's investigation into how AVA use influences student performance.

The conceptual framework identifies four independent variables: student engagement, teacher preparedness, teachers' perception, and frequency of AVA utilization. Student engagement refers to attentiveness, participation in AVA-based simulations, group work, and practical. Teacher preparedness is assessed through training, access to AVA resources, and integration in lesson planning. Teachers' perception encompasses their attitudes, perceived benefits, and adaptability to AVA-supported teaching. Frequency of AVA utilization considers how regularly AVAs are used in lessons and assignments.

School administrative support is introduced as a moderating variable. It influences AVA implementation through policy development, resource provision, and teacher training, thereby affecting instructional effectiveness.

The dependent variable is students' academic performance in Biology, measured through exam scores and performance trends. The framework assumes that regular and effective AVA use, supported by engaged learners, prepared teachers, positive perceptions, and institutional backing enhances comprehension and boosts academic achievement.

Aligned with the study's objectives, this framework provides a structured, theory-driven approach to evaluating how AVA integration affects student outcomes in secondary schools of Nandi East Sub-County.

Each component of this framework corresponds directly to the study's four objectives and is grounded in the cognitive processes outlined by Mayer's theory, ensuring a coherent structure for examining how AVA integration influences Biology performance in Nandi East Sub-County.

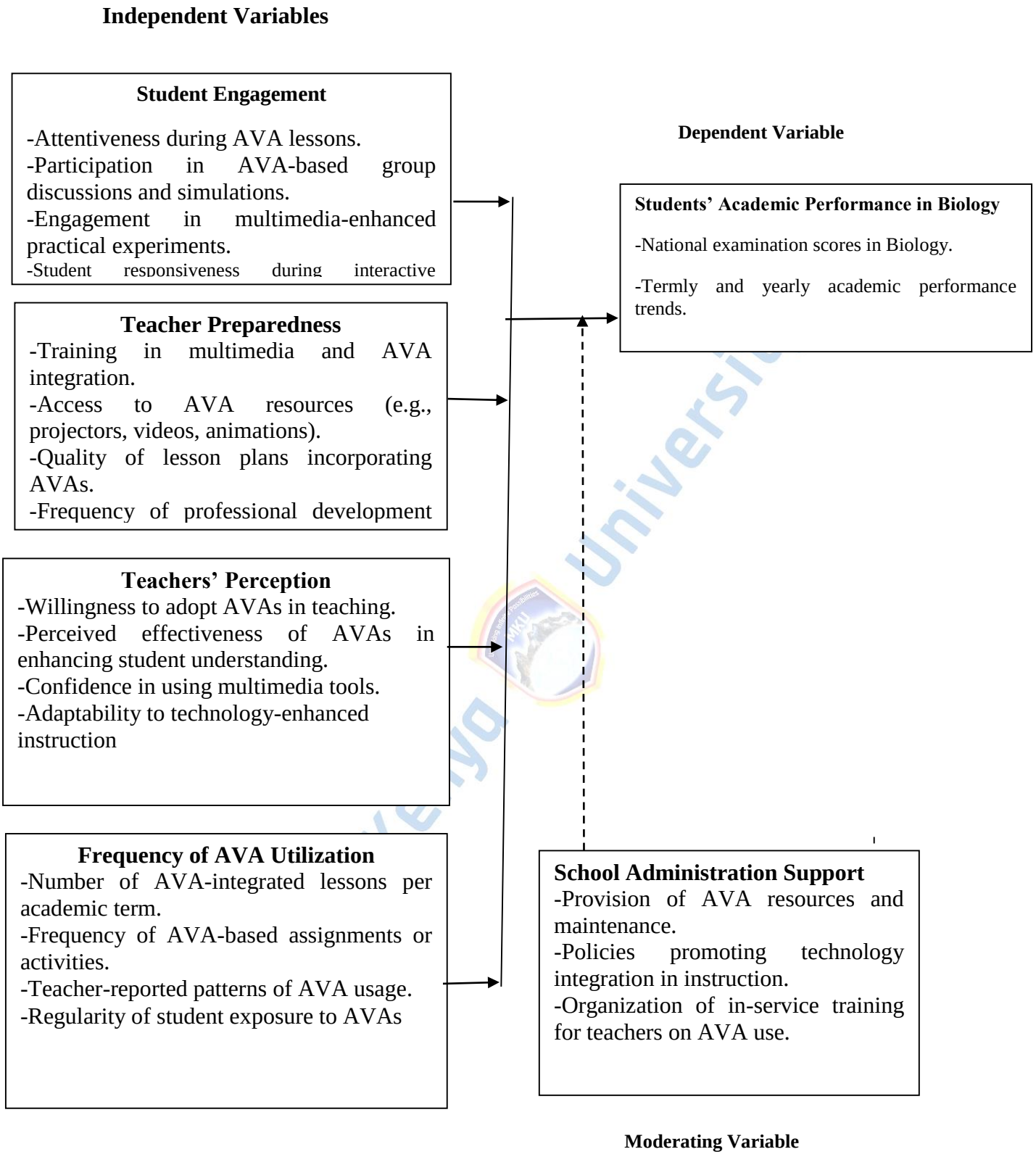

Figure 2: Conceptual Framework of the Factors Influencing Utilization of Audio-Visual Aids

Source: The Researcher (2023)

2.6 Research Gaps

Despite Kenya's commitment to educational reform through policies such as the 100% transition initiative, persistent underperformance in core science subjects especially Biology remains a major concern. In Nandi East Sub-County, KCSE Biology results have consistently reflected dismal performance over the past five years. Traditional interventions, such as textbook provision and increased teacher recruitment, have not significantly reversed this trend, highlighting the need for innovative pedagogical strategies that enhance comprehension, engagement, and performance particularly through the use of Audio-Visual Aids (AVAs).

While various studies have explored the potential of AVAs to support learning, several critical gaps limit their utility as a targeted solution for improving Biology achievement in rural Kenyan settings.

Firstly, Amalia (2019) and Jamilah (2021) examined how AVAs enhance student engagement, motivation, and retention. Although these studies affirmed AVAs' role in stimulating classroom interaction and clarifying abstract content, they did not empirically evaluate whether such cognitive and affective benefits lead to measurable improvements in academic performance—particularly in Biology, a subject known for its conceptual complexity. The current study addresses this gap by directly linking AVA-supported engagement to students' academic outcomes in Biology, using both quantitative and inferential methods.

Secondly, Idoko and Njoku (2017) emphasized that AVAs support individualized learning by allowing students to process information at their own pace. However, their study fell short of demonstrating whether this self-paced, multimodal learning translates into higher Biology test scores. Furthermore, their research context lacked specificity to Biology and did not

consider the high-stakes KCSE examination environment. The present study bridges this gap by focusing specifically on Biology instruction and investigating the relationship between AVA integration and performance within the high-pressure Kenyan secondary school context.

Thirdly, Rasalia and Peter (2023) explored teacher preparedness in integrating AVAs and acknowledged the importance of training and access to digital resources. However, their study did not establish a direct connection between teacher competence in AVA use and student academic outcomes. This limitation is particularly relevant in Nandi East Sub-County, where anecdotal evidence suggests many teachers are under-trained and ill-equipped to utilize AVAs effectively. The current study addresses this by examining how teacher preparedness including training and resource availability affects AVA usage and, subsequently, student performance in Biology.

In addition, while studies such as Wandera (2019) have highlighted teachers' positive attitudes toward AVAs, they did not examine whether these perceptions translate into actual changes in teaching practices or improvements in learner performance. Similarly, Nkrumah (2021) underscored the value of multimodal instruction but failed to explore the combined cognitive impact of audio and visual aids within the subject of Biology and in rural, under-resourced school settings.

Finally, a major limitation of the existing literature is its contextual misalignment. Much of the research has been conducted outside Kenya, in urban environments, or in subjects other than Biology, thus limiting its relevance to the unique socio-educational realities of Nandi East Sub-County. Schools in this region face challenges such as limited access to AVA tools, insufficient teacher training, and a long-standing history of underperformance in sciences. This study responds to these gaps by offering a localized, empirical analysis of how AVA

integration mediated by student engagement, teacher preparedness, teacher perceptions, and usage frequency influences academic performance in Biology.

By addressing these gaps, the study provides evidence-based insights that can inform policy and instructional practices tailored to the needs of secondary schools in rural Kenya.

2.7 Chapter Summary

This chapter presents a review of literature pertaining to the use of audio-visual aids (AVAs) and their impact on students' performance in Biology, with a particular focus on secondary schools in Nandi East Sub-County, Kenya. Grounded in Richard Mayer's Cognitive Theory of Multimedia Learning, the review underscored that meaningful learning is enhanced when learners process verbal and visual information simultaneously. The theory supports the integration of AVAs in instruction to boost comprehension, retention, and academic achievement.

The literature addressed four core areas aligned with the study objectives. First, student participation and engagement were found to be positively influenced by AVAs, particularly through simulations and interactive content that foster attention, retention, and deeper understanding. However, gaps remain in linking this engagement directly to academic outcomes, especially in Biology within rural Kenyan contexts.

Second, teacher preparedness was identified as a crucial factor in effective AVA use. Studies highlighted that while many teachers recognize the value of AVAs, a lack of training, confidence, and access to resources often hinders their implementation. These challenges are particularly pronounced in under-resourced regions like Nandi East.

Third, the review examined teachers' perceptions of AVA use and collaborative practices. Positive attitudes and shared use of AVA materials were reported, yet few studies established a measurable connection between such perceptions and student performance in Biology. The

need for deeper analysis of collaboration in resource-constrained environments was also emphasized.

Fourth, the frequency of AVA utilization in lessons was linked to improved content delivery. Nonetheless, inconsistencies in usage, due to infrastructural limitations and administrative support, were found to affect the effectiveness of AVA-based instruction. Limited data exists on how regular AVA use influences exam performance in local settings.

Finally, the review identified significant gaps in current literature. Many studies lacked a focused examination of Biology as a subject, were conducted in urban or international contexts, or failed to explore the combined impact of AVA use, teacher readiness, and institutional support on student outcomes. This study addresses these gaps by providing a localized, empirical analysis of how AVAs influence Biology performance in Nandi East Sub-County.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

Focal point of the section outlines study methodologies employed, design adopted, study location, dependent and independent variables, study population, sampling approach determination of size of the sample used. It also explains research tools used, their validity and reliability, procedure used in collecting and analyzing information. Additionally, ethical concerns were taken into account in this research.

3.2 Research Methodology

It refers to the systematic framework that guides the collection, analysis, and interpretation of data within a study. It encompasses the research design, data collection methods, sampling strategies, and analytical techniques used to achieve the study's objectives. According to Kothari (2014), research methodology outlines the logical reasoning behind the selection of specific methods, ensuring the validity and reliability of the research findings. In educational research, methodology plays a crucial role in structuring investigations to provide meaningful insights into teaching and learning processes (Creswell and Creswell, 2018).

The study adopted a Descriptive-Correlational Research Methodology to investigate utilization of audio-visual aids (AVAs) and their influence on students' performance in Biology within secondary schools of, Nandi East Sub-County, Kenya. The descriptive aspect of the methodology enabled the researcher to systematically outline the current state of AVA utilization, student engagement, and teacher preparedness in Biology instruction. Meanwhile, the correlational component facilitated the analysis of relationships between AVA usage and students' academic performance without manipulating any variables (Creswell and Creswell, 2018).

A quantitative approach was adopted to gather numerical data on AVA implementation and student outcomes. Structured questionnaires were administered to Biology teachers and students to collect data on AVA accessibility, frequency of usage, and teacher preparedness. Additionally, document analysis of student test scores provided an objective basis for assessing the impact of AVA utilization on academic achievement. Bhandari (2020) highlights that quantitative methods enable researchers to systematically measure variables and identify statistical patterns that enhance the accuracy of research findings.

To establish the degree of association between AVA utilization and student performance, correlational analysis was conducted using Pearson's correlation coefficient. This statistical technique measured the strength and direction of relationships between key variables, such as AVA engagement, teacher preparedness, and students' test scores (Field, 2018). The application of correlational methods aligns with the assertions of Gravetter and Forzano (2019), who argue that correlational research is effective in identifying relationships between educational variables while avoiding assumptions of causality. Additionally, Multiple Regression Analysis (MRA) was used to assess the predictive influence of various AVA components on students' academic achievement in Biology. MRA helped control for potential confounding variables such as teacher preparedness, availability of AVA resources, and administrative support, ensuring precise interpretation of results.

The study population included Biology teachers, students, HODs and Lab technicians in selected secondary schools within the locale. Structured questionnaire was designed for data collection on teachers' perceptions, instructional practices, and AVA resource availability. Furthermore, student test scores were analyzed to determine influence of AVA usage on academic performance.

By employing this research methodology, the study systematically explored the extent of AVA integration in Biology instruction and its potential influence on student performance. The findings contribute to the broader discourse on the effectiveness of instructional media in enhancing Biology education.

To ensure validity and reliability, data collection instruments were piloted before full-scale implementation. Ethical considerations were upheld, including obtaining informed consent from participants and maintaining confidentiality throughout the study.

3.3 Research Design

This study utilized descriptive-correlational research approach to systematically examine the utilization of audio-visual aids (AVAs) in Biology instruction and their relationship with student performance. A descriptive approach was used to document current practices, instructional methods, and teacher preparedness in using AVAs, while the correlational aspect assessed the association between AVA usage and student engagement, as well as academic achievement.

The choice of this design was guided by its ability to provide an in-depth understanding of educational phenomena by capturing existing conditions without manipulating variables (Tavakoli, 2013). According to Singh (2010), descriptive-correlational research is appropriate for investigating relationships among naturally occurring variables in real-world settings, making it suitable for this study conducted in secondary schools. This design enabled the researcher to collect both quantitative and qualitative data through questionnaires, interviews, and observations to gain deeper insights into how AVAs influence Biology instruction and student learning outcomes.

As Hennink et al. (2020) assert, descriptive research generates factual information by systematically documenting prevailing practices, instructional strategies, and learning

experiences. By integrating descriptive and correlational methods, this study categorized, analyzed, and interpreted patterns of AVA utilization and their potential influence on student performance. Onwuegbuzie and Leech (2021) emphasize that descriptive research is instrumental in providing detailed portrayals of educational practices, enabling researchers to document trends, beliefs, and instructional strategies systematically. Furthermore, correlational analysis allows for the identification of statistical associations, helping to explain how AVA usage relates to student outcomes (Creswell and Creswell, 2018).

Moreover, descriptive-correlational research plays a foundational role in educational inquiry by offering empirical evidence to guide future pedagogical decisions. As Matteson (2022) notes, methodical observation and systematic data collection enhance comprehension of instructional methods, student engagement, and teacher preparedness. By focusing on existing conditions rather than causality, this research design lays a foundation for further investigations into the effectiveness of AVAs in enhancing Biology education.

3.4 Location of the Study

Nandi East Sub-County was purposefully selected as the study locale due to its academic relevance, contextual significance, and alignment with the research problem. The region has consistently recorded low student performance in Biology in KCSE over the past five years, despite ongoing government interventions. This persistent underachievement underscores the need to explore alternative instructional approaches such as the use of audio-visual aids (AVAs) to improve learning outcomes in the subject.

Academically, Nandi East offers a suitable context to investigate the interplay between AVA utilization and Biology performance. The area encompasses a diverse range of secondary schools (Sub-County, County, and Extra-County), each with varying levels of AVA integration, teacher preparedness, and resource availability. This diversity allows for a

comprehensive analysis of how these variables influence student engagement and achievement.

Additionally, the researcher's familiarity with the local context and established rapport with key stakeholders (such as teachers and administrators) facilitated access and enhanced the reliability and validity of data collection. The region's accessibility also allowed for efficient logistical planning, minimizing disruptions during fieldwork.

Beyond its local significance, Nandi East shares educational characteristics with many rural and semi-urban regions across Kenya. Therefore, findings from this study are expected to provide valuable insights not only for local policy and practice but also for broader application in similar educational contexts across the country.

3.5 Target Population

Fricker et al. (2019) describe a population as a group of objects or individuals sharing common traits from which a researcher draws inferences. A key attribute of a target population is that it must contain relevant information on both the dependent and independent variables of the study.

The study population consisted of all schools offering Biology in Nandi East sub-county, including all students, teachers, Heads of Department and Lab technicians involved in Biology instruction. However, the target population was specifically drawn from Form two Biology students, Biology teachers, lab technicians and HODs overseeing Biology instruction within these schools. Table 2 presents a comparative overview of the study population and the target population, highlighting the specific groups under investigation.

Table 2: Comparative Overview of Study and Target Populations

Category	Study Population	Target Population	Total
Schools	Secondary schools in Nandi East Sub-County	(Not individually targeted)	-
Biology Students	All Biology students in the study schools	Form Two Biology students	1,800
Biology Teachers	All Biology teachers in the study schools	Biology teachers in the study area	58
HODs	All Heads of Science/ Biology in the study schools	HODs overseeing Biology instruction	30
Lab Technicians	All Lab Technicians in the study schools	Lab Technicians keeping and operating AVA	30

Source: SCDE Nandi East (2023)

The target population for this study comprised 1,800 Form Two Biology students, 58 Biology teachers, and 30 laboratory technicians from 30 secondary schools in Nandi East Sub-County, Kenya. This diverse group was selected to allow for a comprehensive examination of the utilization of audio-visual aids (AVAs) and their influence on students' performance in Biology.

Biology teachers were included in the study as they are the primary facilitators of instruction and the main users of AVAs in the teaching and learning process. Their insights provided valuable data on the extent and effectiveness of AVA integration in Biology instruction. Form Two Biology students were targeted because they form the foundation for advanced Biology learning and their performance at this stage has a direct impact on their future academic outcomes, including the Kenya Certificate of Secondary Education (KCSE) results. Additionally, laboratory technicians were included as they are the custodians of AVA

resources in schools and provided essential information regarding the availability, maintenance, and frequency of AVA usage in Biology instruction.

HODs for Science or Biology oversee utilization of AVA, evaluate its effectiveness, and provide guidance to teachers. They ensure alignment with educational policies and curriculum standards while offering strategic insights into the implementation and sustainability of AVAs in Biology instruction.

By targeting these specific groups, the study ensured that relevant perspectives were captured to facilitate a comprehensive understanding of AVA utilization and its impact on student learning outcomes in Biology. The findings from this research will contribute to improving AVA implementation strategies, enhancing teacher preparedness, and optimizing student engagement for better performance in Biology.

3.6 Sampling Techniques and Sample Size

It refers to the process of selecting a representative group of individuals from the larger population to ensure generalizability of the findings (Etikan and Bala, 2017). This approach enables researchers to investigate a broader phenomenon efficiently by focusing on a manageable number of participants. In this study, sampling was necessary to address practical constraints such as limited time, logistical challenges, and financial resource limitations, which made it impractical to study the entire target population. By employing appropriate sampling techniques, the researcher aimed to ensure that the selected sample accurately reflected the characteristics of the wider population, thereby enhancing the validity and generalizability of the study findings.

3.6.1 Sampling Techniques

Sampling refers to a systematic process of selecting a subset of individuals from a defined population to represent the whole (Taherdoost, 2019). In this study, a combination of

probability sampling techniques was employed to ensure representativeness across various school categories and respondent groups.

To select schools, stratified random sampling was applied to 30 public secondary schools, in Nandi East Sub-County. The schools were stratified by category (Sub-County, County, and Extra-County), after which 28 schools were randomly selected to ensure representation across all types due to the heterogeneous nature of the population.

Within the selected schools, a proportionate stratified random sampling technique was employed to draw a sample of 317 Form Two Biology students from an overall population of approximately 1,800. This method ensured that the number of students drawn from each school was proportional to its student population, with simple random sampling subsequently applied within each school to select the individual participants. For Biology teachers, proportionate stratified sampling was also applied to select 28 teachers from a total of 58, ensuring each school category was fairly represented.

All 28 laboratory technicians (one per school) were selected through total enumeration, as the population was small and accessible. Similarly, 10 Heads of Science Departments were selected using simple random sampling, drawn from the pool of HoDs across the participating schools.

These probability-based methods enhanced the study's validity by reducing sampling bias and ensuring each subgroup of interest was appropriately represented. They also supported efficient, cost-effective, and methodologically sound data collection aligned with the research objectives (Taherdoost, 2019).

3.6.2 Sample Size

The sample size refers to the number of individuals selected from a defined population to participate in a study, with the aim of obtaining reliable and generalizable findings. As noted

by Etikan and Bala (2017), determining an appropriate sample size is crucial to the validity of research outcomes, while Kothari (2019) emphasizes that it should be adequate, efficient, and aligned with research objectives.

This study targeted a population of 1,800 Form Two Biology students, 58 Biology teachers, 28 laboratory technicians, and 10 Heads of Science Departments from 30 public secondary schools in Nandi East Sub-County. A total of 425 respondents were selected through a combination of probability and non-probability sampling techniques.

The decision to focus on Form Two students was based on both practical and academic considerations. This group has received foundational instruction in Biology and is not yet subject to the pressures of national examinations, making them suitable for assessing the influence of audio-visual aids (AVAs) on learning without high-stakes bias. Although AVA usage spans all class levels, Form Two offers a balanced point for capturing instructional impact.

Based on Krejcie and Morgan's (1970) sample size determination table for finite populations, a representative sample of 317 students was selected from a total population of approximately 1,800, using a 95% confidence level and a 5% margin of error. To ensure equitable representation from the various school categories, namely extra county, county, and sub county schools, a proportionate stratified random sampling technique was employed. Thereafter, simple random sampling was conducted within each stratum to reduce the likelihood of selection bias.

Biology teachers were selected using proportionate stratified sampling, resulting in a sample of 28 from the total population of 58. Teachers with relevant experience in AVA integration were purposively identified to ensure informed input, after which simple random sampling was used to maintain objectivity and fairness.

All 28 laboratory technicians were included through total enumeration due to the small population size and their technical role in AVA implementation. Simple random sampling was employed in selection of, 10 Heads of Science Departments to provide administrative insights on AVA integration.

Overall, the sample of 425 respondents allowed for comprehensive data collection, balancing student experiences with expert perspectives from teachers, technicians, and department heads. The combination of sampling strategies ensured representativeness, minimized bias, and supported the study's objective of evaluating the impact of audio-visual aids on Biology education in Nandi East Sub-County. The information is presented in table 3 below.

Table 3: Distribution of Sample Size and Sampling Techniques

Category	Population	Sample Size	Sampling Technique
Schools	30	28	stratified random sampling
Biology Students	1800	317	proportionate stratified random sampling & simple random sampling
Biology Teachers	58	28	proportionate stratified sampling & purposive sampling
Lab technicians	30	28	total enumeration
HODs	30	10	simple random sampling

Source: Researcher (2023)

3.7 Research Instruments

To achieve the research objectives effectively, the study employed three main instruments for data collection, namely questionnaires, interview schedules, and observation checklists. Each instrument was selected based on its relevance to the specific research objectives and its capacity to provide valid, reliable, and comprehensive data.

3.7.1 Questionnaire for Teachers and Students

The study employed both structured and unstructured questionnaires to collect data from Biology teachers and Form Two students regarding the utilization of audio-visual aids (AVA) and their influence on academic performance. Structured questionnaires comprised close-

ended questions that provided predefined response options, ensuring standardized data collection and facilitating efficient quantitative analysis (Nguyen, 2021). This method minimized researcher bias, promoted consistency across different schools, and allowed for the systematic assessment of AVA frequency and resource availability (Hyman and Sierra, 2016). Additionally, structured questionnaires were cost-effective, time-efficient, and capable of reaching a large number of respondents simultaneously, making them a suitable tool for large-scale educational research (Iwaniec, 2019). To enhance reliability, respondents were assured of confidentiality, and the questionnaires were issued and collected immediately to reduce potential biases and ensure a high response rate.

Unstructured questionnaires, on the other hand, comprised open-ended questions that enabled respondents to articulate their experiences and perspectives on AVA in their own words (Reja et al., 2003). This qualitative approach was instrumental in capturing in-depth insights into students' engagement with AVA-based learning and the challenges teachers face in integrating AVA into instruction. The open-ended format allowed for detailed responses, eliminating researcher bias while providing context-specific information (Sreejesh, 2019). The combination of structured and unstructured questionnaires ensured a comprehensive understanding of the impact of AVA on Biology performance by balancing quantitative measurement with qualitative depth.

3.7.2 Interview Schedule for Laboratory Technicians and HODs

Structured interviews were conducted with 28 laboratory technicians and 10 Science HODs to address teacher preparedness to utilization of AVA resources, teacher perceptions of AVA use and its impact on performance and the fourth objective on assessment of the frequency of AVA usage.

Structured interviews used pre-determined questions, ensuring consistency in data collection and comparability of responses across participants (Kumar and Rose, 2022). Laboratory Technicians provided insights into the availability, condition, and frequency of AVA use whereas HODs offered information on AVA procurement, teacher training, and monitoring of AVA integration.

This method also allowed for flexibility to clarify and probe responses, resulting in rich qualitative data and ensuring a comprehensive understanding of AVA usage in schools.

3.7.3 Observation Checklist

To complement the questionnaire and interview data, non-participant observation was conducted using an observation checklist. This tool was essential for confirming the availability and use of AVA tools, and validating the actual use, and frequency of AVA in Biology classrooms.

Observations ensured objectivity and allowed for the identification of discrepancies between reported and actual AVA usage (Mwania and Ukulo, 2020). This triangulation increased the validity and reliability of the study's findings.

The three instruments are triangulated to ensure both depth and breadth of data in that, Questionnaires offer broad, quantifiable data, Interviews provide detailed, contextual insights. While Observation, ensures objective verification.

3.8 Research Instruments Validity and Reliability

Good research depends on researcher's fidelity to testing and increasing the tools validity as well as whether study results are reliable.

3.8.1 Instruments Validity

Validity is the degree to which a research instrument accurately measures what it is intended to measure (Heale and Twycross, 2015). For this study on the utilization of audio-visual aids

(AVA) and their influence on student academic performance in Biology, content validity, construct validity, and face validity were considered to ensure the accuracy and appropriateness of the instruments used.

Content validity ensures that the instrument's items comprehensively represent the study's variables and objectives. To achieve this, questionnaires, interview schedules, and observation checklists were developed based on thorough literature reviews and aligned with specific research objectives. Experts in Educational Technology and Biology Education reviewed these instruments, confirming their relevance and suggesting refinements to enhance clarity and coverage.

Construct validity pertains to the extent to which the instruments accurately measure the theoretical constructs intended. In this context, student and teacher questionnaires included Likert-scale items to assess engagement and perceived effectiveness of AVA, aligning with established practices in educational research. Interview schedules explored aspects like teacher preparedness and resource availability, while observation checklists documented actual AVA usage and interactions, providing a multifaceted evaluation of AVA integration.

Face validity refers to the apparent effectiveness of the instruments in measuring the intended constructs. A pilot study conducted in two secondary schools not included in the main sample ensured that respondents found the instruments clear and relevant. Feedback from this pilot led to revisions that enhanced clarity and alignment with the research focus on AVA utilization in Biology instruction.

By integrating expert reviews, aligning instruments with research objectives, and conducting pilot testing, the study ensured robust validity of its instruments, thereby enhancing the reliability of the data collected on AVA usage and its influence on student performance in Biology.

3.8.2 Instrument Reliability

Reliability in research ensures that an instrument consistently and accurately measures a concept across different populations and over time (Creswell and Creswell, 2018). A reliable instrument produces dependable and repeatable data, minimizing random errors. This study assessed the reliability of its questionnaires, interview schedules, and observation checklists through pilot testing, internal consistency analysis, and inter-rater reliability evaluation.

Connelly (2008) suggests that a pilot study sample should be approximately 10% of the projected sample size for the larger parent study. Therefore, a pilot study involved 34 students and 4 teachers. Questionnaire was administered the in real conditions, feedback on question clarity, response difficulty, and length was sought. Thereafter, Cronbach's Alpha statistical tests were used to assess reliability of Questionnaire while Inter-Rater Reliability was used for interviews and observations.

This process tested the clarity, structure, and functionality of the research instruments, identified ambiguities, and assessed whether responses remained consistent across similar participants. Based on feedback, minor revisions were made to improve clarity and usability, ensuring the instruments were well-suited for the main study.

The reliability of research instruments was assessed using Cronbach's Alpha, a widely recognized statistical measure that evaluates the internal consistency of questionnaire items. A Cronbach's Alpha value of 0.7 or higher is generally considered acceptable, indicating that the instrument consistently measures the intended construct (Taber, 2018). The results of the reliability test for different variables in this study confirm that the instruments used were highly reliable.

As seen in Table 4 below, Student engagement and participation yielded a Cronbach's Alpha of .817 across four items, indicating a strong level of internal consistency. This suggests that

the questionnaire items effectively captured students' interactions with audio-visual aids (AVA) and their level of involvement in learning activities.

The frequency of AVA usage scored .812 with four items, confirming that the instrument reliably measured how often AVA was incorporated into teaching.

Overall, these findings indicate that all variables met the reliability threshold, confirming that the research instruments were well-structured and capable of producing consistent results. This strengthens the credibility of the study by ensuring that the data collected accurately reflects student engagement and AVA usage frequency in Biology education.

Table 4: Reliability Test Results for Students Questionnaires

Variable	Cronbach's Alpha	No of Items	Conclusion
Student engagement and participation	.817	4	Reliable
Frequency of using AVA	.812	4	Reliable

For the interview schedules and observation checklists, inter-rater reliability was examined to ensure consistency in qualitative data collection. Two independent researchers reviewed and scored a sample of interview responses and observation checklists, showing strong agreement in their evaluations. This demonstrated that the instruments captured data reliably. Additionally, structured interview protocols standardized question delivery, reducing interviewer bias and further enhancing reliability.

Table 5: Reliability Test Results for Teachers' Questionnaires

Variable	Cronbach's Alpha	No of Items	Conclusion
Student engagement and participation	.877	5	Reliable
Teachers' level of preparation	.872	7	Reliable
Teachers Perception	.897	5	Reliable
Frequency of using AVA	.912	5	Reliable

By incorporating pilot testing, statistical reliability analysis, and inter-rater reliability assessments, the study ensured the dependability of its instruments. These measures strengthened the validity of the findings, providing a credible basis for evaluating the impact of audio-visual aids on student academic performance in Biology in Nandi East Sub-County.

As indicated in Table 5 above, the reliability analysis of the teachers' questionnaire, measured using Cronbach's Alpha, confirms a high level of internal consistency across all variables. Student Engagement and Participation ($\alpha = 0.877$, 5 items) and Teachers' Level of Preparation ($\alpha = 0.872$, 7 items) both exhibit strong reliability, indicating that their respective items consistently measure the intended constructs. Similarly, Teachers' Perception ($\alpha = 0.897$, 5 items) demonstrates even greater reliability, reinforcing the questionnaire's effectiveness in capturing teachers' attitudes. The highest reliability was observed in Frequency of Using Audio-Visual Aids (AVA) ($\alpha = 0.912$, 5 items), suggesting highly stable responses regarding AVA utilization.

With all Cronbach's Alpha values exceeding 0.8, the questionnaire is deemed highly reliable for research purposes. These results confirm that the instrument effectively measures teacher-related variables and is likely to produce consistent findings in repeated applications. Minimal adjustments may be considered for refinement, but overall, the questionnaire is well-structured and dependable.

3.9 Data Collection Procedure

Prior to data collection, the researcher secured ethical clearance from the Mount Kenya University Institutional, Scientific, and Ethics Review Committee (ISERC), which issued an Ethics Review Certificate authorizing the study. This approval facilitated the application to the Kenya National Commission for Science, Technology, and Innovation (NACOSTI), which subsequently issued a national research permit. With this license, the researcher sought and obtained research authorization from the Ministry of Education. The approval was further

submitted to the Nandi East Sub-County Director of Education (SCDE), who provided an official letter addressed to the principals of the sampled secondary schools.

This letter, accompanied by a researcher's self-introduction and informed consent form, was presented to school principals to request access for data collection. The introduction and authorization documents facilitated the arrangement of appointment dates and consent for conducting the research. This process enabled the researcher to carry out structured interviews, administer questionnaires, and conduct observations in alignment with the study's objectives, specifically assessing the integration and impact of audio-visual aids on Biology teaching and learning outcomes in Nandi East Sub-County.

3.10 Data Analysis Procedure

This study employed both descriptive and inferential statistical techniques to analyze the collected data. Quantitative data obtained from questionnaires administered to Biology students and teachers were entered into a computer and analyzed using, the Statistical Package for the Social Sciences (SPSS). "To analyze the data, descriptive statistics including frequencies, percentages, means, and standard deviations were applied to provide a clear summary and interpretation of the findings. Respondents' views on the utilization of audio-visual aids (AVA) in Biology teaching and learning were assessed using five-point Likert scale. The interpretation of response weightings is presented in Table 6.

Table 6: Likert Scale Response Categories and Interpretation

Response	Weighting	Cut Point Range	Interpretation
Strongly Agree	5	=>4.21 - 5.0	Strongly Agree
Agree	4	=>3.41 - 4.20	Agree
Uncertain	3	=>2.61 - 3.40	Uncertain
Disagree	2	=>1.81 - 2.60	Disagree
Strongly Disagree	1	=>1.0 - 1.80	Strongly Disagree

To analyze the relationship between audio-visual aids (AVA) utilization and students' academic performance in Biology, inferential statistical methods were employed. Pearson's correlation coefficient was specifically applied to determine the strength and direction of the linear relationship between the use of audio-visual aids (AVA) and students' academic performance. Pearson correlation (r) ranges from -1 to 1, where r = 1 indicates a perfect positive correlation suggesting that increased AVA utilization is associated with higher academic performance, while r = -1 signifies a perfect negative correlation. An r = 0 implies no linear relationship between the two variables. Although Pearson correlation identifies associations, it does not establish causation or explain underlying mechanisms (Field, 2022).

Furthermore, Multiple Regression Analysis (MRA) was conducted to assess the predictive impact of AVA components such as frequency of use, type of AVA resources, and teacher preparedness on students' Biology performance. MRA allowed for the control of confounding variables, including teacher training, resource availability, and administrative support, ensuring a more precise interpretation of the results. By integrating these statistical approaches, the study provides a comprehensive understanding of how AVA utilization influences students' academic outcomes in secondary schools, within Nandi East, Sub-County.

The research applied multiple regression model below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \alpha$$

Where: Y = Dependent variable (Students' academic performance in Biology)

β_0 = Regression intercept

β_1, β_2, β_3, and β_4 = Slopes of the regression equation

X_1 = AVA-based Simulations

X_2 = AVA-supported Lesson Presentations

X_3 = Collaborative AVA Usage

X_4 = Frequency of AVA Utilization

α = Error term

The statistical techniques used for each research objective are summarized in Table 9.

Table 7: Summary of Statistical Analysis Techniques for Research Objectives

Research Objectives	Statistical Techniques of Analysis
To assess student participation and engagement in AVA-based simulations and their influence on Biology performance	Descriptive Statistics; Pearson's Correlation Analysis and Multiple Regression
To assess the preparedness of Biology teachers to utilize AVA in content presentation	Descriptive Statistics; Multiple Regression
To analyze teachers' perceptions of collaborative AVA use and its influence on students' performance	Descriptive Statistics; Multiple Regression
To determine the frequency of AVA usage and analyze its influence on students' academic performance	Descriptive Statistics; Pearson's Correlation Analysis and Multiple Regression

The study employs a combination of descriptive statistics, Pearson's correlation analysis, and multiple regression to examine the role of audio-visual aids (AVA) in enhancing Biology performance among secondary school students. Descriptive statistics provide an overview of key variables, while Pearson's correlation measures the strength and direction of relationships between AVA-related factors and student outcomes. Multiple regression further determines the combined effect of multiple variables on performance.

The analysis focuses on four key areas: student engagement in AVA-based simulations, teacher preparedness, teachers' perceptions of collaborative AVA use, and the frequency of AVA utilization. Engagement in AVA-based simulations is assessed through correlation and regression analyses to determine its impact on student performance. Teacher preparedness is examined through descriptive statistics and regression to establish its influence on effective AVA integration. Teachers' perceptions of collaborative AVA use are analyzed to understand their role in shaping instructional effectiveness and student outcomes. Additionally, the frequency of AVA usage is explored to determine its direct and combined effects on academic performance.

By employing these statistical techniques, the study provides a comprehensive and data-driven evaluation of AVA's impact on Biology education. The findings offer valuable insights into optimizing AVA implementation to enhance teaching effectiveness and student achievement in Nandi East Sub-County.

The dependent variable, students' academic performance in Biology, was measured using Standardized Test Scores which includes use of results from national, (e.g., KCSE Biology scores in Kenya) and school-based Biology examinations.

Additionally, Teacher Confidence and Pedagogical Skills as well as Institutional Support and School Culture were considered as intervening variables, potentially influencing the relationship between AVA utilization and academic achievement

By applying Multiple Regression Analysis, the study quantified the degree of influence each component of AVA utilization had on students' academic performance. This approach strengthened the reliability of the conclusions drawn by ensuring that the observed relationships were not incidental but reflective of real-world educational outcomes.

3.11 Ethical Consideration

Ethical considerations in research encompass principles such as informed consent, confidentiality, anonymity, and the integrity of the research process. These considerations ensure that research is conducted responsibly, respecting the dignity and rights of all participants (Resnik, 2020). Prior to data collection, the researcher fully informed participants of the study's purpose, procedures, and anticipated benefits. Participation was entirely voluntary, and respondents were allowed to make an informed decision regarding their involvement.

Written informed consent was obtained from school principals, who signed consent forms on behalf of the institution. Additionally, students provided assent, acknowledging their voluntary participation. In line with established ethical guidelines, participants were assured that their responses would remain confidential and their identities anonymous. Personal identifiers were not collected, and data was aggregated to prevent traceability to individual schools or participants.

The researcher upheld the highest standards of integrity, ensuring that all data were collected and reported accurately, with no fabrications or misrepresentations. Privacy and confidentiality were maintained throughout the research process, with data securely stored and used solely for academic purposes. Even though research contributes significantly to knowledge, human dignity and rights were prioritized throughout this study (Bryman and Bell, 2019).

Ethical conduct followed the principle of beneficence, ensuring participant benefits without harm. The research goals were clearly communicated, promoting transparency (Saunders et al., 2019). These standards preserved the integrity of the schools, teachers, lab technicians, and students, ensuring anonymity.

CHAPTER FOUR
RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

The chapter presents, and discusses findings on the utilization of audio-visual aids (AVA) and their influence on students' academic performance, in Biology among secondary schools of Nandi East Sub-County, Kenya. The analysis is guided by the study's objectives, which explored students' engagement with AVA-based activities, teacher preparedness, perceptions of collaborative AVA use, and frequency of AVA integration in Biology instruction.

Data were collected through questionnaires from 28 Biology teachers and 317 Form Two students, interviews with 10 Heads of Science Departments and 28 laboratory technicians, and direct observations by the researcher. This multi-method approach enhanced the validity and reliability of the findings.

Quantitative data were processed using SPSS, where descriptive statistics, such as frequencies, percentages, means, and standard deviations, were employed to summarize patterns in the utilization of audio-visual aids. Inferential statistics, including Pearson's correlation and Multiple Regression Analysis (MRA), were applied to examine relationships between AVA utilization and student performance. Results are presented in tables and pie charts for clarity.

Each subsequent section details findings for the respective objectives, followed by interpretations within the context of relevant literature and theoretical frameworks, highlighting the impact of AVA on teaching effectiveness and student achievement in Biology.

4.2. Response Rate

The study targeted 345 respondents, comprising 28 Biology teachers and 317 students, to assess the utilization of audio-visual aids (AVA) and their influence on students' performance in Biology.

Among the 28 Biology teachers, 24 responded, yielding a response rate of 85.71%. This high participation rate indicates strong interest in the study's subject matter and its potential implications for instructional practices. According to Creswell and Creswell (2018), response rates above 80% are considered acceptable in educational research, enhancing the reliability and generalizability of findings. Teachers' perspectives on AVA usage and preparedness are crucial, as they significantly impact the effectiveness of AVA in Biology instruction.

Similarly, 292 out of 317 targeted students responded, reflecting a response rate of 92.11%. This strong participation rate underscores students' willingness to engage in discussions about their learning experiences. As noted by Fraenkel, Wallen, and Hyun (2019), student participation rates above 90% contribute to data validity, ensuring findings accurately represent the student population. The high student engagement further emphasizes the relevance of AVA in their learning process and strengthens the foundation for analyzing its impact on academic performance.

Overall, the study achieved a response rate of 91.59%, which is considered highly satisfactory. As Babbie (2020) suggests, response rates above 70% minimize non-response bias, making the results more representative of the target population. The substantial participation of both teachers and students enhances the reliability of the study's conclusions regarding AVA integration in Biology education in Nandi East Sub-County. Table 8 below gives a summary of the response rate.

Table 8: Response Rate

Respondents	Targeted Sample	Respondents number	Response rate (%)
Teachers of Biology	28	24	85.71
Biology students	317	292	92.11
Total	**345**	**316**	**91.59**

4.3 Demographic Information of the Respondents.

Respondents' demographic data was assessed and findings were presented using pie charts.

4.3.1 Demographic Information of the Students

In alignment with the study's objectives, the demographic variables considered for students included gender, Biology achievement scores, school type (extra-county, county, or sub-county), and the frequency of AVA usage.

Gender of respondents

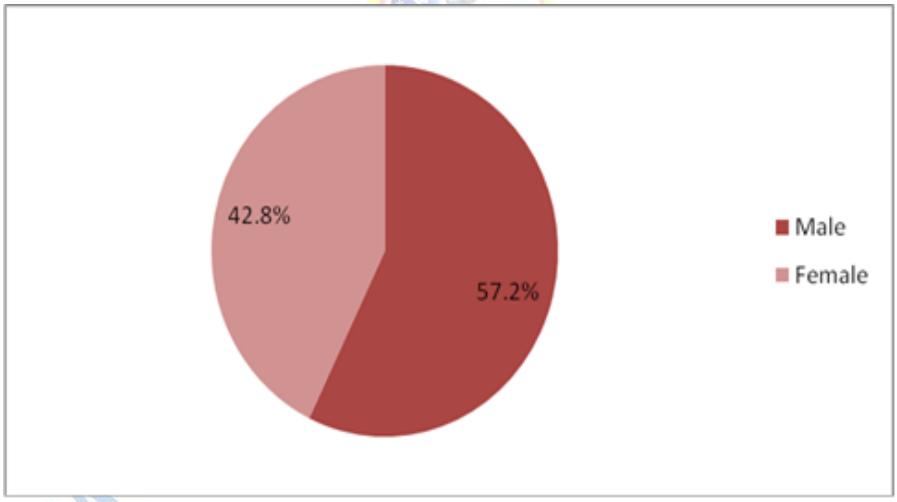

Figure 3: Distribution of Respondents by Gender

The pie chart in figure 3 above represents the gender distribution of respondents in the study. According to the data, 57.2% of the respondents are male, while 42.8% are female. This indicates a higher participation of male students compared to female students in the study sample.

Since learning experiences and engagement with AVA may differ between male and female students, analyzing gender as a demographic variable allows for the identification of potential differences in AVA effectiveness. This can inform recommendations on inclusive AVA integration strategies.

Type of school attended by respondents

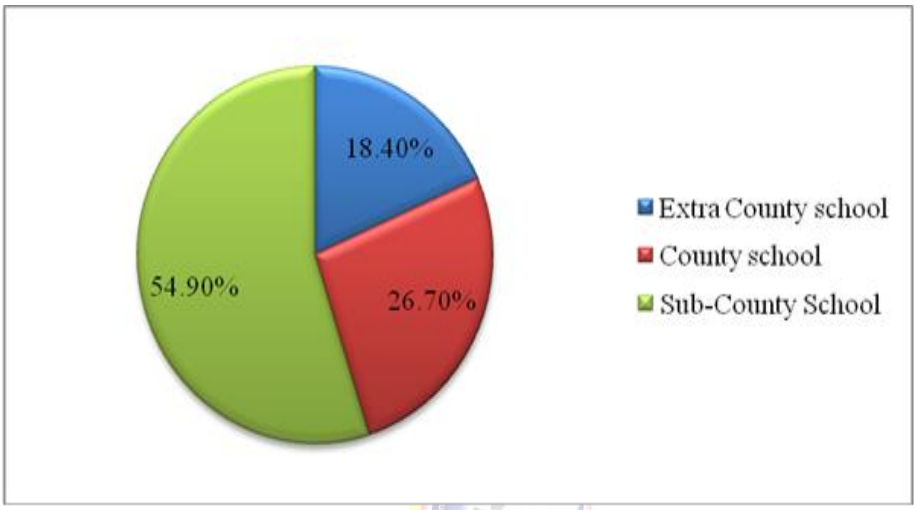

Figure 4: Distribution of Respondents by School by Type

The pie chart in figure 4 above illustrates the distribution of students by school type: Sub-County Schools (54.9%), County Schools (26.7%), and Extra-County Schools (18.4%). This variation is critical in understanding the utilization of audio-visual aids (AVAs) and their influence on Biology performance across different school categories.

Sub-County schools, which form the largest proportion, may have limited AVA resources, affecting student engagement and participation (Objective 1). County and Extra-County schools, with relatively better infrastructure, may have more access to AVA-based teaching, influencing teacher preparedness (Objective 2) and their perceptions of AVA effectiveness (Objective 3). The frequency of AVA usage (Objective 4) may also vary, with higher-tier schools likely utilizing AVAs more frequently, potentially impacting Biology performance.

Overall, the study underscores the disparities in AVA access across school types, highlighting the need for equitable resource distribution to enhance Biology learning outcomes in Nandi East Sub-County, Kenya.

Mean Grade Scored by Learners in the Previous term Biology examination

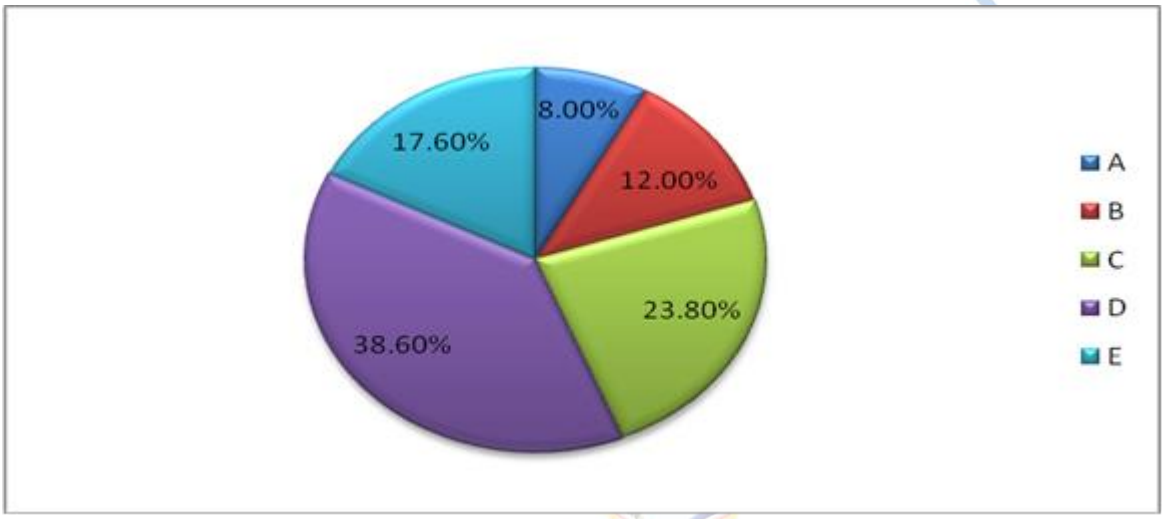

Figure 5: Distribution of Respondents by Grade scored in Biology

The pie chart in figure 5 above, presents the distribution of students' grades in Biology, with 38.6% obtaining a D, 23.8% a C, 17.6% an E, 12.0% a B, and only 8.0% attaining an A. This pattern suggests overall low performance, with a significant proportion of students scoring below average (D and E categories totaling 56.2%).

These findings align with the study's objectives by highlighting the urgent need for effective instructional strategies such as audio-visual aids (AVAs) to enhance Biology performance. The high number of low grades suggests limited student engagement (Objective 1) and potential challenges in teacher preparedness (Objective 2) to integrate AVAs effectively. Additionally, teacher perceptions (Objective 3) on AVAs may reflect the struggle to improve

outcomes, while the frequency of AVA use (Objective 4) could correlate with better performance trends among students scoring higher.

Overall, this distribution emphasizes the critical role of AVAs in fostering improved Biology learning outcomes, supporting the study's investigation into their utilization in Nandi East Sub-County, Kenya.

Table 9: Frequency of Audio-Visual Aid (AVA) Usage in Biology Lessons

Frequency Category	Percentage (%)
Rarely	40.0%
Occasionally Used	25.0%
Frequently Used	15.0%
Never Used	10.0%
Very Frequently Used	10.0%

Table 9 shows that 40% of students report AVA usage in Biology lessons as rare, while 25% experience it occasionally. Only 15% of students find AVA frequently used, and 10% report never encountering it. Another 10% experience very frequent use. Overall, the data indicates that AVA integration in Biology lessons is inconsistent, with most students having limited exposure.

Table 10: Distribution of Students' Average Biology Exam Scores (Last Three Terms)

Score Range	Number of Students	Percentage (%)
Below 30%	83	28.4%
30% - 49%	88	30.1%
50% - 64%	68	23.3%
65% - 79%	39	13.4%
80% and above	14	4.8%
Total	**292**	**100%**

Table 10 indicate distribution of students' average Biology exam scores over the last three terms. It shows that 28.4% of students scored below 30%, while 30.1% scored between 30% and 49%. A smaller percentage, 23.3%, scored between 50% and 64%. Only 13.4% scored between 65% and 79%, and 4.8% scored 80% or above. This indicates that a majority of

students (58.5%) scored below 50%, highlighting a significant portion with lower performance in Biology.

Students' Self-Rated Performance in Biology

To understand students' academic standing in Biology, respondents were asked to rate their own performance based on their exam results from the last three terms. Performance was categorized into five levels: Very Poor (Below 30%), Poor (30%–49%), Average (50%–64%), Good (65%–79%), and Excellent (80% and above). Table 11 below shows results obtained.

Table 11: Distribution of Students' Self-Rated Biology Performance

Performance Category	Number of Students (n=292)	Percentage (%)
Very Poor (Below 30%)	78	26.7%
Poor (30% – 49%)	93	31.8%
Average (50% – 64%)	73	25.0%
Good (65% – 79%)	33	11.3%
Excellent (80% and above)	15	5.1%
Total	292	100%

The table shows that 26.7% of students rated their Biology performance as very poor (below 30%), while 31.8% rated it as poor (30%-49%). A smaller percentage, 25%, considered their performance average (50%-64%). Only 11.3% rated their performance as good (65%-79%), and 5.1% rated it as excellent (80% and above). This indicates that the majority of students (58.5%) perceive their performance as below average.

4.3.2 Demographic Information of Teachers

Demographic data for teachers were collected to understand their background, experience with Audio-Visual Aids (AVA), and the availability of AVA resources in their schools. The data covers key aspects such as the type of school where the teacher is employed, the number of years they have been teaching Biology, and whether they have received any training on the use of AVA or digital simulations in teaching.

Furthermore, teachers were asked to assess the availability of AVA resources in their schools, ranging from videos, projectors, models, charts, and simulations, to evaluate how well these resources support Biology teaching. The survey also includes teachers' evaluation of the recent mean Biology exam scores for their students over the last three terms, as well as their overall assessment of students' academic performance.

This demographic data provides essential context for understanding the teachers' teaching conditions, their preparedness to integrate AVA into lessons, and the potential challenges they face in using AVA to improve student performance in Biology.

Table 12: Distribution of teachers by school type

School Type	Frequency	Percentage (%)
Sub-County	12	50.0%
County	9	37.5%
Extra County	3	12.5%
Total	**24**	**100%**

The distribution of teachers by school type in Nandi East Sub-County indicates that the majority (50.0%) are from Sub-County schools, followed by County schools at 37.5%, while the least representation (12.5%) is from Extra County schools.

This suggests that most Biology teachers in the study sample are concentrated in Sub-County and County schools, which generally cater to a larger student population compared to Extra County schools. The lower proportion of teachers in Extra County schools may reflect their typically lower enrollment numbers or a higher student-teacher ratio.

This distribution is important for understanding the availability of teaching resources, including Audio-Visual Aids (AVAs). Schools with more teachers may have better access to AVAs and more structured implementation, whereas those with fewer teachers may face challenges in resource allocation and utilization.

This demographic data helps identify key gaps, analyze contextual factors affecting AVA use, and inform practical recommendations tailored to school categories, which is essential for achieving study's objectives and addressing the core problem of poor Biology performance.

Table 13: Teaching experience

Teaching Experience (Years)	Frequency (No. of Teachers)	Percentage (%)
1-4 years	4	16.7
5-9 years	8	33.3
10-14 years	8	33.3
15 years and above	4	16.7

The table shows that most teachers (66.6%) had 5-14 years of experience, suggesting they had developed effective teaching strategies, including AVA use. Teachers with 1-4 years (16.7%) may bring innovation but need training, while those with 15+ years (16.7%) had strong subject mastery but may struggle with AVA adoption. This distribution highlights potential gaps in teacher preparedness, where experience influences AVA integration. The study assessed how these variations impact Biology performance.

Table 14: Teacher training on AVA use

Training on AVA Use	Frequency	Percentage (%)
Yes	5	20.8
No	19	79.2

As presented in Table 14, the majority of teachers (79.2%) reported having no training in the use of audio-visual aids (AVAs), whereas only 20.8% indicated that they had received such training. This suggests that despite the potential of AVAs to enhance Biology instruction, their effective integration may be hindered by inadequate teacher preparedness. Without proper training, many teachers may struggle to use AVAs effectively, limiting their impact on

student engagement and performance. This finding highlights a key gap in the study, emphasizing the need for professional development programs to equip teachers with the necessary skills to utilize AVAs optimally. The study will assess how this training deficit affects AVA adoption and its influence on Biology achievement in secondary schools.

This demographic information is vital for measuring teacher readiness, understanding AVA integration levels, and linking training to student outcomes. It supports key objectives, guides data interpretation, and shapes actionable solutions for improving Biology performance in the region.

Table 15: Teachers' Ratings of AVA Availability in Schools

AVA Availability	Frequency	Percentage (%)
Inadequate	14	58.3%
Moderate	7	29.2%
Adequate	3	12.5%
Total	**24**	**100%**

The data indicates that a majority (58.3%) of teachers reported AVA resources as inadequate, suggesting that many schools lack sufficient teaching aids to support effective Biology instruction. Only 29.2% of teachers stated that AVA resources were moderately available, while a small percentage (12.5%) found them to be adequate.

This shortage of AVA resources could limit teachers' ability to integrate visual and auditory learning tools, potentially affecting student engagement and comprehension. Schools with inadequate AVA may struggle with practical demonstrations, reducing the effectiveness of Biology lessons. Addressing this gap through increased AVA provision and teacher training on resource utilization could enhance learning outcomes.

Table 16: Teachers' Reported Average Biology Scores of Students (Last Three Terms)

Score Range	Number of Teachers	Percentage (%)
Below 30%	5	20.8%
30% – 49%	7	29.2%
50% – 64%	6	25.0%
65% – 79%	4	16.7%
80% and above	2	8.3%
Total	**24**	**100%**

Table 16 suggests that most Biology class mean scores as reported by teachers fall below 50%, with 50% (5 + 7 teachers) indicating class means under 50%. Only 2 out of 24 teachers (8.3%) reported high performance (80% and above), indicating a general trend of low to average achievement levels.

Table 17: Teachers' Assessment of Students' Performance in Biology

Performance Category	Number of Teachers	Percentage (%)
Very Poor (<30%)	6	25.0%
Poor (30–49%)	8	33.3%
Average (50–64%)	6	25.0%
Good (65–79%)	3	12.5%
Excellent (80%+)	1	4.2%
Total	**24**	**100%**

The majority of teachers (58.3%) rated their students' Biology performance as Poor or Very Poor, reflecting widespread underachievement in Nandi East Sub-County. In contrast, only 16.7% rated performance as Good or Excellent. This aligns with national concerns about persistent low Biology scores despite ongoing reforms.

The findings support the study's purpose by suggesting that limited use of audio-visual aids (AVAs) may be a contributing factor. The consistency between teacher perceptions and

actual student results reinforces the possibility that inadequate AVA integration is affecting academic performance in Biology.

4.4 Influence of Audio-Visual Aid-Based Simulations on Student Participation and Engagement

The study examined the impact of student participation and engagement in AVA-based simulations on Biology performance in Nandi East Sub-County, Kenya. Data were collected through questionnaires, interviews, and observations, with test scores analyzed to assess the relationship between AVA engagement and academic achievement.

Findings from Students' Questionnaire

Table 18: Student Opinion on Participation and Engagement in AVA-Based Simulations

Statement	N	Mean	SD
I find the lesson interesting when AVA-simulations are used in class	292	3.44	1.16
I remember what is taught with aid of audio- visual aids for a long time.	292	3.67	1.17
I actively participate and concentrate for whole lesson when AVA is used	292	3.87	1.12
AVA helps to improve my examination performance	292	4.28	1.16

The data on Table 18 reflects a generally positive student opinion on the use of Audio-Visual Aid (AVA)-based simulations in Biology lessons. Students find AVA-based lessons interesting (Mean = 3.44, SD = 1.16) and believe that AVAs help improve long-term retention of content (Mean = 3.67, SD = 1.17). Active participation and concentration are also high when AVAs are used (Mean = 3.87, SD = 1.12). Most notably, students strongly agree that AVAs positively influence their examination performance (Mean = 4.28, SD = 1.16), indicating a strong belief in the effectiveness of AVA tools for academic achievement.

Findings from Teachers Questionnaire

Table 19: Teacher Opinion on Participation & Engagement in AVA-Based Simulations

Item Statement	N	Mean	SD
The use of audio-visual aid-based simulations increases student participation in Biology lessons	24	3.66	0.81
Students remain more engaged and focused during Biology lessons when I use AVA-based simulations	24	1.80	1.17
AVA-based simulations improve students' understanding of complex Biology concepts.	24	2.62	1.16
The use of AVA-based simulations has positively influenced students' Biology test scores	24	2.70	1.12
Digital simulations (e.g., virtual labs, interactive software) are an effective tool for teaching Biology	24	2.62	1.14

The data reveals mixed teacher opinions on the use of Audio-Visual Aid (AVA)-based simulations in Biology lessons. Teachers agree that AVA simulations increase student participation (Mean = 3.66, SD = 0.81), suggesting that these tools encourage active involvement. However, there is a significant contrast in their views on sustained engagement, as the mean score for student focus during AVA lessons is low (Mean = 1.80, SD = 1.17), indicating that while AVAs may initially capture attention, they struggle to maintain it throughout the lesson. Additionally, while teachers believe that AVAs help students understand complex Biology concepts (Mean = 2.62, SD = 1.16), the impact on improving Biology test scores (Mean = 2.70, SD = 1.12) is perceived as modest. The effectiveness of digital simulations like virtual labs is also questioned, with a mean score of 2.62 (SD = 1.14), suggesting that while these tools are seen as beneficial, their full potential is not universally recognized by teachers.

4.4.1 Descriptive Analysis on students' Participation and Engagement in AVA Based Simulations

The descriptive analysis reveals that students perceive audio-visual aid (AVA)-based simulations as engaging, effective in aiding retention, and beneficial to their academic performance in Biology. These findings align with existing literature, which highlights the

role of AVAs in stimulating interest, enhancing comprehension, and encouraging active classroom participation.

Hsbollah et al. (2022) emphasized that when students are actively involved through interactive technologies such as simulations, they demonstrate improved attention and conceptual understanding. Similarly, Adamu (2019) observed that AVAs help demystify abstract scientific content by allowing students to visualize biological processes, thereby making learning more meaningful.

On the other hand, teachers recognized the potential of AVAs to improve student participation but expressed reservations about their consistency in sustaining engagement and translating into academic gains. This suggests a gap between the perceived potential of AVAs and their practical implementation in classroom settings, possibly due to limitations in training or access to appropriate tools.

Overall, the analysis supports the notion that AVA-based simulations have a positive influence on student engagement and participation in Biology. However, to fully leverage these benefits, there is a need for strategic integration and adequate teacher support within schools.

4.4.2 Inferential Analysis on students' Participation and Engagement in AVA Based Simulations

To analyze the relationship between students' participation and engagement in AVA-based simulations and their influence on Biology performance, Pearson correlation analysis and Multiple Regression Analysis (MRA) were used. This analysis helped in determining how student participation and engagement with AVAs correlate with their performance in Biology and assess the impact of AVA usage on the overall performance, as outlined in the study's objectives.

Pearson Correlation Analysis

It was conducted to assess the strength and direction of the relationship between student engagement with AVA simulations and their academic performance in Biology, with the aim of understanding how AVA-based engagement impacts students' academic outcomes. The results are summarized in table 20 below.

Table 20: Pearson Correlation for AVA Simulations and Performance in Biology

Variable	**Academic Achievement in Biology**
Simulations	r = 0.492, p = 0.000 (**Significant**)

The Pearson correlation results indicate a moderate positive correlation (r = 0.492) between the use of AVA simulations and academic achievement in Biology. This correlation is statistically significant (p = 0.000), suggesting that higher engagement with AVA simulations is associated with better academic performance in Biology. These findings align with existing literature, which suggests that the use of interactive technologies, such as AVA simulations, enhances student understanding and engagement, leading to improved academic outcomes (Anderson and Bavelier, 2018; Smith et al., 2020). The significance of this relationship underscores the potential value of incorporating AVA-based simulations in teaching to foster better student performance.

4.4.3 Model Fitness and Regression Summary

To find out the predictive strength of simulations in influencing students' academic performance, a regression analysis was conducted. Table 21 presents summary the model.

Table 21: Model Fitness Summary

Model Summary Statistics	**Value**
R (Multiple Correlation Coefficient)	0.671
R^2 (Coefficient of Determination)	0.450
Adjusted R^2	0.438
Standard Error of the Estimate	0.612

The multiple regression model yielded a multiple correlation coefficient (R) of 0.671, indicating a strong positive relationship between the combined predictors and students' performance in Biology. The coefficient of determination (R^2) was 0.450, indicating that approximately 45% of the variance in students' Biology performance could be attributed to the combined influence of the four predictor variables: AVA-based student engagement, teacher preparedness, collaborative AVA use, and frequency of AVA usage.

The adjusted R^2 value of 0.438 accounts for the number of predictors in the model, and confirms that even after adjusting for possible model complexity, the independent variables still explain about 43.8% of the variance in student performance. The standard error of the estimate (0.612) indicates the average distance that the observed values fall from the regression line, and it is within an acceptable range, suggesting the model has reasonably good predictive accuracy.

Multiple Regression Analysis

MRA was employed to examine the influence of student engagement with AVA simulations on academic performance in Biology, while accounting for other potential contributing factors, in order to identify the extent to which engagement with AVA simulations predicts improvements in student performance. The results are presented in Table 22.

Table 22: MRA for Student Engagement and Academic Performance

Predictor (X)	Unstandardized Coefficient (B)	Std. Error	Standardized Coefficient (Beta)	t	p-value
AVA-Based Student Participation & Engagement	0.462	0.081	0.492	5.70	0.000

The multiple regression analysis for Objective 1, "AVA-Based Student Participation and Engagement and Its Influence on Academic Performance" indicates a statistically significant

positive relationship between student engagement with audio-visual aids and academic performance in Biology.

The unstandardized coefficient (B) = 0.462 implies that a unit increase in AVA-based participation and engagement corresponds to a 0.462 unit increase in performance scores, holding other variables constant. The standardized coefficient (β) = 0.492 reflects a moderate to strong effect size, suggesting that AVA engagement is a substantive predictor of performance. The association is statistically significant ($t = 5.70$, $p < 0.001$), indicating that the relationship is unlikely due to chance.

In summary, the findings provide empirical support for the integration of AVA-based strategies in Biology instruction, affirming that enhanced student participation and engagement through AVAs significantly improves academic achievement.

4.4.4 Discussion of findings on students' Participation and Engagement in AVA-Based Simulations

The study examined the impact of Audio-Visual Aids (AVAs) on student engagement and academic performance in Biology through quantitative and qualitative data. Student responses indicated positive perceptions, with AVAs improving interest (M = 3.44), retention (M = 3.67), and participation (M = 3.87), and a high belief in AVAs enhancing performance (M = 4.28), aligning with Sukma (2018) and Adamu (2019). Teachers also recognized AVAs' role in participation (M = 3.66), but noted limited sustained engagement (M = 1.80), supporting Mutemi (2023) on AVA's limited effectiveness for passive learners. Correlation and regression analyses confirmed that student engagement with AVAs significantly predicts academic performance ($r = 0.492$, $p < 0.001$; $B = 0.462$, $Beta = 0.492$, $p < 0.001$). Qualitative insights from Heads of Departments (HODs) and laboratory technicians indicated that while AVAs enhance engagement, challenges such as technical limitations and inconsistent use hinder sustained involvement. Observations revealed that, despite resource availability, AVA

use in classrooms was sporadic. The findings highlight the need for improved teacher training and consistent AVA implementation to maximize student engagement and performance, as emphasized by Mutemi (2023) and Bagila (2019).

4.5 Teacher Preparedness to utilize audio-visual aids in content presentation

This study evaluates Biology teachers' preparedness to use Audio-Visual Aids (AVAs) in content presentation, focusing on training, confidence, and resource access. It examines how teachers integrate AVAs like videos and simulations to enhance student engagement and comprehension, highlighting the importance of professional development and resource availability for effective AVA utilization. Data was collected using observation, questionnaire for teachers and interview for HODs and Lab technicians. Summary of findings are summarized in Table 23.

Findings from Teachers questionnaire

Table 23: Teacher Preparedness to Utilize Audio-Visual Aids in Content presentation

Level of preparation	N	Mean	SD
I prepare and watch video before lesson	24	2.50	1.25
I enjoy using AVA in class	24	3.41	1.25
I lack confidence when using AVA	24	2.75	1.29
I lack training on proper use of AVA	24	3.75	1.13
I use AVA as required in the lesson	24	2.50	1.06
I need special training to increase my competence in AVA use	24	3.70	1.08
I use AVA according to the students' academic level	24	3.29	0.99

The findings reveal key insights into Biology teachers' preparedness in using audio-visual aids (AVA) in Nandi East Sub-County. The relatively low mean score (2.50) for preparing and watching videos before lessons suggests inadequate pre-lesson AVA preparation. While teachers enjoy using AVA (Mean = 3.41), a considerable number lack confidence (2.75) and feel untrained in AVA use (3.75).

Moreover, the need for specialized training (3.70) highlights a gap in AVA competence, potentially hindering effective integration. Although teachers moderately tailor AVA use to

students' academic levels (3.29), their reported adherence to AVA requirements (2.50) remains low. These findings indicate that while teachers recognize AVA's benefits, their limited training and confidence may reduce its effectiveness, underscoring the need for targeted professional development.

4.5.1 Descriptive Analysis on Teacher Preparedness to utilize AVA in content presentation

The analysis of teacher responses on their preparedness to use audio-visual aids (AVA) in teaching Biology reveals a generally moderate level of readiness, with certain areas reflecting significant gaps. While many teachers express a positive disposition towards AVA integration, including enjoyment in its classroom application, there is a noticeable inconsistency in systematic planning and confidence. For instance, the tendency to prepare and preview AVA materials before lessons is not uniformly practiced, and the regular use of AVA as part of standard lesson delivery appears limited.

A more pressing issue emerges in relation to professional competence and training. Teachers consistently report a lack of formal training on the effective use of AVAs and express the need for specialized instructional development. This suggests that although AVAs are recognized as valuable instructional tools, many educators feel inadequately equipped to integrate them meaningfully into their pedagogical practices.

These findings resonate with the observations of Adediran et al. (2020), who noted that the absence of structured in-service training significantly limits teachers' ability to use instructional technologies effectively in science education. Similarly, Mutemi (2023) emphasized that teacher preparedness, particularly in the form of technical proficiency and content-aligned AVA application is a critical enabler of successful technology integration in classrooms.

In conclusion, while teachers demonstrate a generally favorable attitude towards AVA use, their instructional efficacy is hindered by insufficient training, low confidence levels, and

irregular planning. Addressing these gaps through targeted capacity-building initiatives and institutional support would enhance teachers' preparedness and ultimately improve the effectiveness of AVA in enhancing student learning in Biology.

4.5.2 Inferential Analysis on Teacher Preparedness to utilize AVA in content presentation

In line with the second objective, which assesses Biology teachers' preparedness in utilizing audio-visual aids (AVA) by evaluating their training and access to resources, Multiple Regression Analysis (MRA) was carried out to examine the relationship between teacher preparedness and the integration of audio-visual aids (AVAs) in instruction.. The results provide insights into how factors such as training, confidence, and resource availability influence AVA utilization in Biology instruction. These findings are crucial in identifying key areas for professional development and support to enhance AVA effectiveness in improving student performance.

Pearson Correlation

The Pearson correlation analysis for Objective 2 examines the relationship between teacher preparedness to use Audio-Visual Aids (AVA) and student performance in Biology. Summary is given in Table 24 below.

Table 24: Pearson Correlation for Teacher Preparedness for content presentation and Academic performance

Variables	Academic Performance in Biology
Teacher Preparedness	$r = 0.518$, $p < 0.001$

The Pearson correlation between Teacher Preparedness to Use AVA and Student Performance in Biology is $r = 0.518$, $p < 0.001$. This result indicates a moderate positive correlation between the two variables, meaning that as teachers' preparedness to use AVAs increases, there is a corresponding improvement in student performance in Biology.

Multiple Regression Analysis (MRA)

To determine the extent to which teacher preparedness in the use of Audio-Visual Aids (AVA) predicts student performance in Biology, a MRA was conducted. Findings were tabulated in Table 25.

Table 25: Influence of Teacher Preparedness to Use AVA on Student performance

Predictor (X)	Unstandardized Coefficient (B)	Std. Error	Standardized Coefficient (Beta)	t	p-value
Teacher Preparedness	0.213	0.099	0.218	2.15	0.037

The results of the multiple regression analysis indicate that: "Teacher Preparedness to Use AVA" has a significant positive influence on student performance. Specifically, for each unit increase in teacher preparedness, student performance increases by 0.213 units, as indicated by the unstandardized coefficient (B = 0.213). The standardized coefficient (Beta = 0.218) suggests a moderate strength of this relationship.

The t-value of 2.15 and p-value of 0.037 confirm that this effect is statistically significant at the 0.05 level, meaning that teacher preparedness to effectively use Audio-Visual Aids (AVA) plays a key role in enhancing student performance.

4.5.3: Discussion of findings on Teacher Preparedness to Utilize Audio-Visual Aids in Teaching

The study examined the level of preparedness among Biology teachers in utilizing audio-visual aids (AVAs) and evaluated the influence of this preparedness on students' academic performance, in Nandi East Sub-County. The quantitative findings revealed that while teachers acknowledged the value of AVAs, many lacked the formal training required for effective integration. A significant proportion of teachers expressed low confidence, especially in using digital simulations and multimedia tools, echoing Giannikas (2019), who identified inadequate training as a barrier to AVA integration. Nyang'au (2020) similarly

highlighted the challenge of selecting and applying appropriate AVA materials in Kenyan secondary schools.

Qualitative data from Heads of Department interviews revealed that nearly half of the teachers had received little or no AVA training, and only a minority of departments conducted regular in-service programs. This lack of professional development hindered consistent and effective AVA use, supporting Otieno and Wekesa (2021), who argued that schools must institutionalize teacher training. Laboratory technicians noted that AVA use during practical lessons was often irregular, dependent on the teacher's initiative, but where used consistently, it led to better student engagement and concept clarity, as noted by Franklin (2022).

Observational data confirmed that while AVA infrastructure was available, its use remained sporadic and mainly limited to demonstrations rather than interactive learning (Giannikas, 2019). Furthermore, teachers struggled to tailor AVAs to meet diverse student needs (Nyang'au, 2020). Overall, the study underscores the need for continuous, structured professional development to enhance teachers' technical, pedagogical, and psychological preparedness, ultimately improving AVA integration and student performance in Biology.

4.6 Teachers' Perceptions of the Collaborative use of Audio-Visual Aids

This objective explores teachers' perspectives on the collaborative integration of audio-visual aids (AVAs) in Biology instruction and how such practices influence student academic performance in Nandi East Sub-County. These perceptions, shaped by experiences in teamwork, co-teaching, and peer learning affect teachers' willingness and ability to use AVAs effectively. Collaboration involves joint planning, coaching, and shared use of tools like projectors and simulations, which enhance instruction and student understanding. While AVA collaboration is expected to boost engagement and academic achievement, its success

depends on teacher preparedness, resource availability, and institutional support. Using questionnaires, HOD interviews, and observations, the study will offer insights and recommendations to strengthen AVA-based collaboration in Biology instruction.

Findings from Teachers

In order to determine teachers' perception on utilization of audio-visual aids, various statements were given to respondents as seen in table 26 below.

Table 26: Teachers' Perceptions of the Collaborative use of Audio-Visual Aids

Statement	N	Mean	SD
I enjoy using AVA while teaching than lecture method	24	2.83	1.16
Employing AVA in my lessons makes me complete syllabus in time	24	3.37	1.13
I feel motivated to use audio-visual aids in class	24	2.96	0.95
I am conversant on the use of technology	24	2.60	1.02
The audio-visual aids in teaching Biology are necessary	24	3.71	1.04

The findings reveal varied teacher perceptions regarding the collaborative use of Audio-Visual Aids (AVA) in teaching Biology. The findings revealed that teachers showed a moderate preference for using audio-visual aids over traditional lecture methods, with a mean score of 2.83 and a standard deviation of 1.16. Furthermore, there was slightly stronger agreement that the use of AVAs facilitates timely syllabus completion, as indicated by a mean of 3.37 and a standard deviation of 1.13.Motivation to use AVAs was also moderate (M = 2.96, SD = 0.95), while their self-rated technological competence was relatively lower (M = 2.60, SD = 1.02), suggesting a potential area for improvement. However, teachers strongly acknowledged the necessity of AVAs in teaching Biology, which received the highest mean of 3.71 and a SD of 1.04. Overall, the results indicate positive but varied perceptions toward collaborative AVA use, influenced by personal motivation, technological familiarity, and perceived instructional value.

4.6.1 Descriptive Analysis on Teachers' Perceptions of the Collaborative use of Audio-Visual Aids

The findings indicate that teachers generally hold favorable views toward the collaborative use of Audio-Visual Aids (AVAs) in teaching Biology. A number of teachers preferred using AVAs over the traditional lecture method, suggesting a growing appreciation for interactive and engaging instructional strategies. This reflects broader pedagogical shifts where technology-enhanced teaching methods are becoming increasingly valued for their potential to enrich the learning experience.

Teachers also felt that incorporating AVAs enabled them to complete the syllabus more efficiently, an important consideration in content-heavy subjects like Biology. This perception aligns with literature suggesting that well-integrated AVA resources support structured and time-effective lesson delivery.

While motivation to use AVAs was moderately positive, some variation was noted. Differences in access, confidence, and institutional support may account for inconsistencies in how motivated teachers feel to adopt these tools. Moreover, not all teachers felt fully conversant with technology, indicating that a portion of the teaching workforce may benefit from further training and support. As Giannikas (2019) points out, teacher confidence in using educational technology often hinges on familiarity, access, and ongoing professional development.

Importantly, there was strong agreement on the necessity of AVAs in teaching Biology. Teachers widely recognized the value of these tools in simplifying complex concepts and enhancing student understanding. This finding is consistent with Franklin (2022), who emphasized that AVAs improve engagement and comprehension, particularly in science subjects.

Overall, while teachers acknowledge the value of AVAs and their necessity in Biology education, the findings highlight the need for continuous training and collaborative initiatives to ensure more confident and consistent use across the board.

4.6.2 Inferential Analysis on Teachers' Perceptions of the Collaborative Use Of AVA

Pearson Correlation

To examine the relationship between teacher collaborative utilization of Audio-Visual Aids (AVA) and student academic performance in Biology, Pearson correlation analysis was conducted. This analytical approach is used to assess both the magnitude and the direction of the relationship between the two variables under investigation. The findings are summarized in Table 27 below.

Table 27: Pearson Correlation for Teacher Perceptions of the Collaborative use of AVA and Academic performance

Variables	Academic Performance in Biology
Teacher Perception of collaborative utilization	$r = 0.522$, $p < 0.001$

The Pearson correlation analysis for Objective 3 reveals a moderate positive relationship between teacher collaborative utilization of Audio-Visual Aids (AVA) and student academic performance in Biology. Specifically, with a correlation coefficient of $r = 0.522$ and a p-value of less than 0.001, the data indicates that as teachers engage in collaborative efforts to use AVA tools in teaching, student performance in Biology improves. This relationship is statistically significant, suggesting that increased collaboration among teachers in utilizing AVA tools can have a positive impact on students' academic achievement in Biology. The analysis results is summarized in Table 28.

Multiple Regression Analysis

Table 28: MRA for Influence Teacher Perceptions of the Collaborative use of AVA and Academic performance

Predictor (X)	Unstandardized Coefficient (B)	Std. Error	Standardized Coefficient (Beta)	t	p-value
Teacher Perception of Collaborative AVA Use	0.187	0.094	0.194	1.99	0.049

The Multiple Regression Analysis (MRA) results related to Objective 3, which aimed to analyze teacher perceptions of collaborative use of Audio-Visual Aids (AVA) in teaching Biology and its influence on student performance, indicate a statistically significant relationship.

The unstandardized coefficient (B = 0.187) suggests that for every one-unit increase in positive perception of collaborative AVA use, there is an associated increase of 0.187 units in student performance, assuming other variables remain constant. The standardized coefficient (Beta = 0.194) further shows a moderate positive effect size, indicating that teacher collaboration in AVA use has a measurable impact on student outcomes.

The t-value of 1.99 and a p-value of 0.049, which is below the conventional threshold of 0.05, confirm that this relationship is statistically significant. This means that teachers' positive perceptions and collaborative practices, such as co-planning lessons, sharing AVA resources, and team-teaching, contribute meaningfully to improved student performance in Biology.

Therefore, the findings affirms that collaborative use of AVAs among teachers enhances learning outcomes, likely through shared expertise and more effective use of instructional tools.

4.6.3 Discussion of Findings on Teachers' Perceptions of the Collaborative use of AVA

The findings of this study underscore the significant role of teachers' perceptions regarding the collaborative use of Audio-Visual Aids (AVA) in shaping students' performance in Biology. The data collected revealed that while a notable proportion of teachers expressed motivation to use AVAs in class, their overall confidence and technological competence varied, with some reporting moderate comfort in employing such tools. Teachers agreed that AVAs were necessary for Biology instruction, with many believing these tools contributed to better syllabus coverage and more engaging lessons. However, the data also highlighted some inconsistencies between teachers' perceived value of AVA and their practical application of these tools. Mean scores for indicators such as enjoyment in using AVA, motivation, and technological competence indicated that a substantial number of teachers still felt uncertain or underprepared, suggesting that perceptions of AVA's effectiveness may not always align with their level of preparedness to use them effectively in the classroom.

These findings resonate with existing literature, particularly the work of Ajogbeje and Osuntuyi (2021), which emphasizes the significant role teachers' attitudes play in the integration of AVA into instruction. A positive perception of AVA is often associated with regular use, which in turn boosts student engagement and academic performance. In this study, teachers who held a positive view of AVA were more likely to engage in collaborative practices, such as sharing resources. However, co-teaching—a key aspect of collaborative AVA use remained notably limited. This reflects the arguments put forward by Kamau and Ndungu (2023), who stress that collaboration improves lesson delivery through AVA, particularly when best practices and peer support are emphasized. Their study revealed a 35% improvement in student retention rates in schools where AVA was used interactively. Similarly, in this study, collaborative use of AVA was seen to positively influence student understanding and academic performance, suggesting that when teachers integrate AVA in a

collaborative context, students benefit from more engaging and effective learning experiences.

In alignment with Shehada and Amer's (2019) conclusions, the current study found that teacher confidence and mental preparedness were crucial for effective AVA integration. Teachers who were more technologically confident and intrinsically motivated were more likely to use AVA as a central teaching tool rather than a supplementary resource. However, many teachers in this study demonstrated only moderate confidence in using AVA, which echoes Baskota's (2021) argument that personal philosophies and apprehension towards technology can hinder effective implementation. Qualitative data from interviews with Heads of Department (HODs) revealed that 40% of teachers lacked the necessary training to use AVA effectively, and many teachers felt that the existing training opportunities were insufficient. This supports Otieno and Wekesa's (2021) findings, which highlight administrative barriers, such as inadequate institutional support, as key impediments to the adoption of AVA in Kenyan secondary schools. These qualitative insights underscore the need for enhanced teacher training and institutional backing to address these challenges and foster a more widespread and effective use of AVA.

Institutional support also emerged as a decisive factor in this study. While material sharing was common among teachers, deeper collaborative practices such as co-teaching and joint lesson planning were limited, often due to resource and technical constraints. This finding aligns with Ismail et al. (2018), who emphasize the role of school leadership in promoting AVA integration through targeted training and resource allocation. Without structured support systems and continuous professional development, even well-intentioned teachers may revert to traditional, non-collaborative teaching methods. The qualitative interviews with HODs in the current study revealed that 60% of schools reported technical and resource barriers as limiting the potential for deeper collaboration. The lack of structured professional

development programs further exacerbated this challenge, as teachers had limited opportunities to collaborate and build the necessary skills to integrate AVA meaningfully into their pedagogy. These barriers were especially prominent in Nandi East Sub-County, where many schools lacked adequate resources for AVA implementation.

The findings also support Franklin's (2022) proposition that Professional Learning Communities (PLCs) could bridge the existing gaps in AVA utilization. Although PLCs were not formally established in the surveyed schools, informal collaborative efforts, such as sharing AVA resources and ideas, were observed among some teachers. HODs reported that in schools with informal collaboration, students benefited from more interactive and engaging Biology lessons. This informal collaboration mirrors the concept of PLCs, which are known to enhance peer learning, build technological confidence, and institutionalize collaborative teaching practices. This supports the idea that structured professional learning communities could further boost the integration of AVA and improve student outcomes.

In conclusion, this study aligns with the reviewed literature in asserting that teachers' perceptions significantly influence how AVA is adopted and applied in Biology instruction. While the collaborative use of AVA has a measurable impact on student outcomes, its effectiveness is mediated by factors such as teacher motivation, technological competence, and institutional support. Despite the growing body of evidence highlighting the importance of AVA, research specifically focused on the collaborative use of AVA in Biology classrooms in Kenya remains limited. This study contributes to filling that gap by providing empirical evidence from Nandi East Sub-County and emphasizing the need for school-level initiatives that support teacher collaboration, training, and technological integration. These initiatives could empower teachers to leverage the full pedagogical potential of AVA, ultimately enhancing student engagement, understanding, and performance in Biology.

4.7 Frequency of AVA usage and its influence on students' academic performance

This study seeks to determine the frequency of audio-visual aid (AVA) usage in Biology instruction, and analyze its influence on students' academic performance in secondary schools, of Nandi East Sub-County, Kenya. The frequency of AVA usage refers to how often teachers integrate AVAs, such as projectors, videos, and simulations, into Biology lessons, while students' academic performance is measured through Biology exam scores, test results, and overall performance trends. Data were collected using questionnaires and interviews administered to HODs to assess AVA usage frequency, classroom observations to verify actual AVA utilization in teaching, and observation of student performance records to establish correlations between AVA usage and academic outcomes.

Findings from students

Table 29: Frequency of AVA Usage and its Influence on Students' Academic Performance

Item	N	Mean	SD
How often does your Biology teacher use videos (e.g., animations, documentaries) during lessons?	292	2.02	0.95
How often do you use digital simulations or interactive software in your Biology lessons?	292	2.50	1.01
How frequently do you see projectors (Overhead or digital) being used to display Biology content in class?	292	2.40	0.94
How often do your teachers use charts and 3D models to explain Biology concepts?	292	2.45	0.97

The data suggests that AVA tools are used infrequently in Biology lessons. The mean for video usage is 2.02, indicating videos are rarely used. Digital simulations have a mean of 2.50, showing moderate use, while projectors and charts/3D models are used occasionally, with means of 2.40 and 2.45, respectively. The standard deviations (0.94–1.01) suggest some variability in student perceptions, but overall, AVA tools are not integrated consistently into lessons, pointing to an opportunity for more frequent and effective use of these resources in teaching.

Findings from teachers

Table 30: Frequency of Teacher Usage of Audio-Visual Aids: Teachers' Perspective

Statement	N	Mean	SD
How often do you use television programs when teaching Biology?	24	2.20	1.10
How often do you use projectors and transparencies when teaching Biology?	24	2.45	0.93
How often do you incorporate videos in your Biology lessons?	24	2.50	1.10
How often do you use computers and slides when delivering Biology content?	24	2.50	1.10
How often do you use films in your Biology instruction?	24	2.41	1.06

The findings reveal that teachers use Audio-Visual Aids (AVAs) in Biology instruction at a moderate level. The mean frequency of using television programs is 2.20 with a standard deviation of 1.10, indicating it is the least frequently used AVA. Projectors and transparencies are used with a mean of 2.45 and a SD of 0.93. Videos and computer slides are the most frequently used ,both with a mean of 2.50 SD of 1.10. Films are used with a mean of 2.41 and SD of 1.06. These results suggest that while AVAs are incorporated into lessons, their usage is inconsistent and generally occasional across the sampled teachers.

4.7.1 Descriptive Analysis on the frequency of AVA usage and its influence on students' academic performance

The data from both students and teachers reveal a pattern of infrequent use of Audio-Visual Aids (AVA) in Biology lessons. Students indicated that videos, digital simulations, projectors, and charts/3D models were used to varying extents in their classes. The data shows that videos, such as animations and documentaries, were rarely utilized, with students reporting limited exposure to them during lessons. Digital simulations and interactive software were used more frequently but still not on a regular basis. Projectors and charts/3D models were somewhat more common but still not consistently integrated into the classroom. These findings point to an underutilization of AVAs, which may be an opportunity for

teachers to enhance their instructional methods and student engagement through the more frequent and effective incorporation of these tools.

On the teachers' side, a similar trend is observed. Television programs were the least frequently used AVA tool, with most teachers using them rarely. Projectors and transparencies were somewhat more common, but their use was still infrequent. Videos, computer slides, and films were used at moderate levels, indicating that AVAs were occasionally incorporated into lessons. However, the variability in responses, as reflected by the standard deviations, suggests that while some teachers may use these resources more regularly, others employ them less frequently, leading to inconsistency in the overall AVA utilization. This inconsistency in AVA usage among teachers may have a significant impact on student engagement and academic outcomes, as it limits the full potential of AVAs to support learning.

These findings resonate with the work of Ajogbeje and Osuntuyi (2021), who noted that the integration of AVAs into teaching practices is often inconsistent due to various barriers, including lack of training and resources. Similarly, Kamau and Ndungu (2023) emphasized that the regular and effective use of AVAs is crucial for fostering student engagement and improving academic performance, a goal that can only be achieved through sustained teacher involvement and professional development.

4.7.2 Inferential Analysis on the frequency of AVA usage and its influence on students' academic performance

Pearson correlation

A Pearson correlation analysis was performed separately for students' and teachers' responses to determine the strength and direction of the relationship between frequency if AVA use and students' academic performance. The results are summarized in Table 30.

Table 31: Pearson Correlation for frequency of AVA use and Student' performance

Respondents	Academic Achievement in Biology
Students	r = 0.492, p = 0.002 (Significant)
Teachers	r = 0.457, p = 0.001 (Significant)

The Pearson correlation analysis reveals a moderate positive relationship between the use of Audio-Visual Aids (AVA) and academic achievement in Biology for both students and teachers. Specifically, for students, the correlation coefficient of r = 0.492, p = 0.002 indicates a significant and moderate positive relationship between the frequency of AVA usage and student performance in Biology. As students engage more frequently with AVA resources, their academic performance improves. The p-value of 0.002, which is well below the conventional threshold of 0.05, confirms that this finding is statistically significant and unlikely to have arisen by chance. This result is consistent with previous studies that have emphasized the value of AVA in improving student engagement and learning outcomes (Ajogbeje and Osuntuyi, 2021).

Similarly, a moderate positive correlation was observed between teachers' use of AVA tools and students' academic performance in Biology. With a correlation of r = 0.457, p = 0.001, it is clear that the more frequently teachers incorporate AVA into their teaching, the better students perform academically. The p-value of 0.001 signifies that this relationship is statistically significant, supporting the notion that teacher use of AVA can directly enhance student achievement. This finding further underscores the pedagogical value of AVA as an instructional tool that, when used effectively by teachers, can have a positive impact on student outcomes.

In conclusion, both student and teacher engagement with AVA tools are positively correlated with academic achievement in Biology, suggesting that regular use of AVAs by both students and teachers plays a vital role in enhancing academic performance. These statistically

significant results highlight the importance of integrating AVA into both student learning experiences and teaching practices to improve Biology outcomes.

Multiple Regression Analysis (MRA)

To further explore the relationship between AVA usage and academic performance, Multiple Regression Analysis (MRA) was employed in relation to Objective 4 of the study, which examines the frequency of AVA usage and its influence on students' academic performance in Biology. MRA was as presented in Table 31.

Table 32: MRA for Frequency of AVA Use and Its Impact on Performance

Predictor (X)	Unstandardized Coefficient (B)	Std. Error	Standardized Coefficient (Beta)	t	p-value
Frequency of AVA Use & Impact on Performance	0.108	0.053	0.136	2.04	0.042

The unstandardized coefficient (B = 0.108) indicates that for every one-unit increase in the frequency of audio-visual aid (AVA) use, students' performance in Biology increases by 0.108 units, assuming other variables remain constant.

The standardized coefficient (Beta = 0.136) shows a small but positive effect size, suggesting that frequency of AVA use is a modest predictor of performance.

The t-value of 2.04 and p-value of 0.042 indicate that this relationship is statistically significant at the 0.05 level, meaning there is enough evidence to conclude that increased frequency of AVA usage has a significant positive influence on students' academic performance in Biology.

4.7.3 Discussion on Influence of Frequency of AVA Utilization on Student Academic Performance

The frequency of Audio-Visual Aids (AVA) usage in Biology lessons is a significant factor influencing student performance. The integration of AVAs, such as digital microscopes,

simulations, videos, and interactive models, provides a multi-sensory learning experience that enhances student engagement, conceptual understanding, and academic achievement. The findings of this study reveal that AVAs are used with moderate frequency, as reported by both students and teachers. For example, students reported that videos (Mean = 2.02), digital simulations (Mean = 2.50), and charts (Mean = 2.45) were used regularly, although the frequency varied across lessons. This reflects the work of Mwangi and Muthoni (2021), who found that students exposed to regular AVA-supported lessons demonstrated a better understanding of abstract biological concepts. However, the study also highlighted that AVA usage is often dependent on individual teacher initiative, rather than a systemic integration across the curriculum, leading to inconsistencies in usage.

The qualitative data gathered from laboratory technicians and Heads of Department provides further context for these inconsistencies. Laboratory technicians noted that tools like digital microscopes and interactive simulations were underused due to a lack of adequate resources, which is consistent with Mutai and Koech (2023), who identified infrastructure and resource access as major barriers to effective AVA integration. Similarly, HODs highlighted that while some teachers actively used AVAs, others struggled due to resource shortages and a lack of formal training. This variability aligns with the observations of Kiprotich and Kosgei (2021), who pointed out that AVA use is particularly sporadic in rural schools, with reliance on individual teacher efforts.

Despite these barriers, both laboratory technicians and HoDs recognized the potential of AVAs to enhance student learning. They pointed out that when AVAs were used, students demonstrated better engagement and a deeper understanding of complex biological concepts. This finding echoes Chebet and Too (2022), who reported that students showed greater involvement and understanding in lessons incorporating AVAs. Additionally, collaboration among teachers, as noted by HODs, could enhance the effectiveness of AVA use by pooling

resources and strategies, supporting the idea that collective teacher engagement is essential for maximizing AVA impact (Oduor and Ochieng, 2020).

From a quantitative perspective, the Pearson correlation analysis revealed a significant positive relationship between the frequency of AVA usage and student performance. For students, the Pearson correlation coefficient was r = 0.492, with a p-value of 0.002, indicating a strong and significant relationship between AVA usage frequency and academic achievement. Teachers also exhibited a significant correlation (r = 0.457, p = 0.001), further confirming that increased AVA usage was associated with better student performance. These findings support the work of Mutai and Koech (2023), who emphasize the role of AVA usage in enhancing student learning experiences.

The Multiple Regression Analysis (MRA) further corroborated the findings, with the frequency of AVA use emerging as a significant predictor of student performance. The unstandardized coefficient (B = 0.108) and standardized coefficient (Beta = 0.136) indicated that for every unit increase in the frequency of AVA usage, there was a corresponding increase in student performance, with a t-value of 2.04 and a p-value of 0.042, which is statistically significant. This analysis highlights the critical role of AVA frequency in influencing academic outcomes, emphasizing that increased AVA use has a positive impact on student performance.

Furthermore, the MRA revealed that teacher preparedness to use AVAs also significantly influenced student performance. Teachers who were more confident and consistent in their AVA use contributed to better academic outcomes. This finding aligns with the study of Mutai and Koech (2023), who noted the importance of teacher training and preparedness in maximizing the effectiveness of AVAs in the classroom. Additionally, the collaborative use of AVAs among teachers also significantly impacted student performance, with coordinated

efforts among teachers resulting in more engaging and interactive lessons (Chebet and Too, 2022).

However, the study also identified several barriers to the consistent use of AVAs in Biology lessons. These include inadequate teacher training, limited access to AVA resources, and infrastructure challenges. The lack of AVA tools in some schools, as reported by laboratory technicians and HODs, exacerbates these limitations. These barriers were confirmed by the findings of Oduor and Ochieng (2020), who highlighted that such obstacles hinder the frequency and effectiveness of AVA usage, ultimately impacting student performance.

In conclusion, the frequency and effective utilization of AVAs in Biology lessons have a significant influence on student performance. Regular and effective use of AVAs enhances student engagement, comprehension, and retention of biological concepts. The study's Pearson and MRA analyses confirm that both the frequency of AVA use and teacher preparedness are positively correlated with improved student performance. However, challenges such as resource shortages, inadequate teacher training, and inconsistent AVA integration limit their impact. Addressing these barriers, through improved infrastructure, teacher training, and collaboration, is crucial for maximizing the potential of AVAs in improving student performance in Biology. Overcoming these challenges will be essential to ensuring full benefits of AVAs are realized in secondary schools, in Nandi East, Sub-County, as emphasized in literature reviewed in this study.

4.8 Summary

Chapter Four presented the findings study based four research objectives. The data were collected from students, Biology teachers, and Heads of Department through questionnaires, interviews, and classroom observations. The chapter analyzed the influence of Audio-Visual

Aid (AVA) utilization on students' academic performance, in Biology in secondary schools across Nandi East, Sub-County.

Objective One examined student participation and engagement in AVA-based simulations. The findings indicated that students perceive AVA-supported lessons as interesting and engaging, with high mean scores for active participation (M = 3.87), better retention (M = 3.67), and improved exam performance (M = 4.28). However, teacher responses showed mixed perceptions, with lower scores in areas such as student engagement during AVA use (M = 1.80) and understanding complex concepts (M = 2.62). Despite the disparity, regression analysis confirmed that student engagement significantly influences Biology performance.

Objective Two evaluated teacher preparedness in using AVAs. While teachers expressed enjoyment in using AVAs (M = 3.41), they also acknowledged significant gaps in training and confidence. The highest concern was lack of training (M = 3.75) and the need for special training to improve AVA competence (M = 3.70). Interviews with Heads of Department reinforced these findings, noting that only 40% of departments provide regular AVA training. Multiple Regression Analysis (MRA) showed a significant positive influence of teacher preparedness on student academic performance ($\beta = 0.218$, $p = 0.037$).

Objective Three focused on teachers' perceptions of collaborative AVA use. Descriptive data indicated moderate levels of motivation and technological familiarity, with high recognition of AVAs as necessary tools (M = 3.71). While 70% of HODs reported that material sharing was the most common form of collaboration, co-teaching was rare (20%). Regression results confirmed that positive perceptions of collaborative AVA use significantly influence student performance in Biology ($\beta = 0.194$, $p = 0.049$).

Objective Four assessed the frequency of AVA use and its influence on performance. Students and teachers alike reported infrequent use of AVAs, with mean scores ranging from 2.02 to 2.50 across various tools like videos, simulations, and projectors. Despite the known

benefits of regular AVA use—such as increased comprehension and participation—the data showed that usage remains sporadic due to limited resources, inadequate training, and lack of institutional support. Nevertheless, inferential statistics indicated that frequency of AVA use had a moderate but positive influence on student performance.

Overall, Chapter Four highlights that while AVAs positively influence student engagement and performance in Biology, their effective use is constrained by training gaps, low frequency of use, and insufficient collaboration. Addressing these issues through policy, training, and investment in AVA infrastructure can significantly enhance Biology learning outcomes in Nandi East Sub-County.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides synthesis of key findings from the study on, the utilization of Audio-Visual Aids (AVA) and its influence on students' performance in Biology in secondary schools within Nandi East Sub-County, Kenya. The findings are discussed in relation to the research objectives, followed by a conclusion that encapsulates the study's overall contributions. Based on the insights gathered, practical recommendations for improving the use of AVAs in Biology instruction are presented. This chapter also outlines suggestions for future research that can further explore and address the gaps identified in the current research.

5.2 Summary of Research Findings

The study explored utilization of Audio-Visual Aids (AVAs) and their influence on student performance in Biology in secondary schools within Nandi East Sub-County, Kenya. The investigation was driven by the ongoing challenge of poor performance in Biology, despite various government interventions. The main aim was to assess whether the use of AVAs could provide an alternative instructional strategy to enhance academic outcomes in the subject.

Data for the study were collected through a combination of student and teacher questionnaires, interviews with Heads of Department (HODs)and Lab Technicians as well as observations. The research was structured around four primary objectives: to assess student participation and engagement in AVA-based simulations and their impact on performance, to evaluate teacher preparedness for using AVAs in Biology instruction, to analyze teacher perceptions of collaborative AVA use and its influence on student performance, and to examine the frequency of AVA usage and its relationship with student academic outcomes.

The findings of the study highlighted several important insights. In terms of student participation, high engagement was observed during AVA-based lessons, with students reporting increased interest, improved retention, and enhanced perceived exam performance. However, teachers presented mixed opinions, with some indicating low student engagement and limited understanding. Despite these contrasting views, regression analysis confirmed that student engagement in AVA lessons was a significant factor contributing to improved academic performance.

Regarding teacher preparedness, the study revealed that teachers recognized a lack of sufficient training and often expressed low confidence in using AVAs effectively. While many teachers enjoyed using AVAs, their ability to fully integrate these tools into instruction was hindered by resource constraints and limited institutional support. Regression analysis showed that teacher preparedness was positively associated with student performance, suggesting that adequate training and support could enhance the impact of AVA use.

On the issue of collaborative AVA use, most teachers acknowledged the importance of collaboration in using AVAs but reported limited instances of co-teaching or structured teamwork. Instead, material sharing was the most common form of collaboration observed. The regression model indicated that teacher perceptions of collaborative AVA use also significantly influenced student performance, highlighting the value of teamwork and shared resources in improving outcomes.

Finally, with respect to the frequency of AVA usage, both students and teachers reported infrequent use of tools such as videos, projectors, simulations, and 3D models. This limited usage was attributed to challenges such as inadequate infrastructure and a lack of proper training. Nevertheless, the frequency of AVA use was found to have a moderate but positive

effect on student performance, suggesting that even occasional integration of AVAs can contribute to better academic outcomes.

5.3 Conclusion

The study concludes that the use of Audio-Visual Aids (AVAs) plays a substantial role in influencing student outcomes in Biology, particularly when these tools enhance student engagement, are used frequently, and are supported by well-prepared teachers and effective collaboration. However, the full potential of AVAs has not yet been realized in Nandi East Sub-County. This is largely due to several challenges, including the infrequent and inconsistent use of AVA tools, insufficient teacher training, and low confidence in integrating AVAs into teaching practices. Furthermore, there are issues with inadequate infrastructure and resource support, as well as weak institutional policies that fail to guide the systematic use of AVAs and foster collaboration among teachers. Without addressing these gaps, the effectiveness of AVAs in improving Biology outcomes will remain limited, despite their proven educational value.

5.4 Recommendations

Drawing from the study's findings, a number of recommendations are suggested to strengthen the use of Audio-Visual Aids (AVAs) and foster improved academic achievement in Biology. First, there is a need to enhance teacher training and professional development. The Ministry of Education, together with County Education Offices, should organize regular in-service training programs that focus on the effective use of AVAs. These sessions should include practical, hands-on experience with tools such as simulations, projectors, and digital educational software to build teacher confidence and competence.

Secondly, improving access to AVA infrastructure is crucial. Schools should prioritize the procurement of essential AVA tools like 3D models, projectors, and interactive software,

either through government funding or partnerships with private stakeholders. In addition, establishing AVA resource centers within schools or school clusters could promote shared access and ensure that even resource-constrained institutions benefit from these tools.

Another recommendation is to promote a culture of collaboration among teachers. Institutional policies should encourage co-teaching, peer mentoring, and team lesson planning that integrates AVA use. School leadership should actively support and recognize collaborative efforts by providing incentives and platforms for sharing best practices.

Furthermore, there is a need to increase the frequency and structured use of AVAs during Biology instruction. Teachers should be encouraged to make AVA integration a regular part of their lesson planning and delivery, rather than reserving these tools for revision or special sessions. To support this, lesson observation frameworks should include checklists for AVA utilization to ensure consistent application and accountability.

Lastly, strengthening institutional support and policy frameworks is essential. School Boards of Management and headteachers should develop clear policies that guide the procurement, maintenance, and systematic use of AVAs. At the county level, education departments should play an active role in monitoring the integration of AVAs into classroom instruction and providing the necessary support to schools in implementing these technologies effectively.

5.5 Suggestions for Further Studies

Given the scope and limitations of this study, several areas are suggested for further research to deepen understanding and build on the current findings. One recommendation is to conduct a longitudinal study to assess the long-term impact of Audio-Visual Aid (AVA) usage on student performance in Biology. Such a study would provide insights into whether consistent use of AVAs leads to sustained academic improvement over time.

Another area worth exploring is an experimental study that compares AVA-based instruction with traditional teaching methods across other science subjects such as Chemistry and

Physics. This would help determine whether the benefits observed in Biology are transferable to other disciplines, thereby strengthening the case for broader AVA integration in science education.

In addition, a cost-benefit analysis of AVA integration in rural versus urban school settings would offer valuable information about the feasibility and return on investment in different educational contexts. This could guide policymakers in resource allocation and infrastructure planning.

Lastly, an investigation into students' digital literacy and how it affects their ability to benefit from AVA-based learning would be valuable. Understanding the role of digital competence can inform strategies for preparing students to effectively engage with modern educational technologies and maximize the impact of AVAs in the classroom.

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APPENDICES

APPENDIX A: STUDENTS' QUESTIONNAIRE

The researcher is carrying research on Utilization of audio-visual aids and its influence on Biology academic performance. You are hereby humbly asked to respond to given questions by either using a tick or writing where appropriate. The questionnaire is meant for educational research only and any information provided therefore, is extremely confidential.

Part A: Demographic Information

1. Please specify your gender (i) Female [ ] (ii) Male [ ]

2. What category does your school belong to? Extra county [ ] County [ ] Sub -County [ ]

3. What grade did you score in Biology exam for the end of last term?

A [ ] B [ ] C [ ] D [ ] E [ ]

4. How often does your Biology teacher use Audio-Visual Aids (such as videos, animations, charts, or simulations) during lessons?

☐ Very Frequently Used ☐ Frequently Used ☐ Occasionally Used

☐ Rarely Used ☐ Never Used

5. What is your average Biology exam score over the last three school terms? (Provide an average based on your past performance, enter as a percentage, e.g., 70 %) Average Score: _____ %

6. On a scale of 1 to 5, how would you rate your overall performance in Physics based on your exam results?

[ ] 1 – Below 30% (Very Poor) [ ] 2 – 30% to 49% (Poor)

[ ] 3 – 50% to 64% (Average) [ ] 4 – 65% to 79% (Good)

[ ] 5 – 80% and above (Excellent)

Part B: Student Participation and Engagement in AVA-Based Simulations

Tick the appropriate box following the ratings criteria provided. Tick on the column with **1** if you **Strongly Disagree**, **2** if you **Disagree**, **3** if you **Neither Agree nor Disagree**, **4** if you **Agree**, and **5** if you **Strongly Agree**.

Statement	**1**	**2**	**3**	**4**	**5**
I find the lesson interesting when AVA simulations are used in class					
I remember what is taught with aid of audio- visual aids for a long time.					
I actively participate and concentrate for whole lesson when AVA is used					
AVA helps to improve my examination performance					

Part C: Frequency of audio-visual aid usage in Biology teaching and learning

How often does your Biology teacher use the following audio-visual aids during lessons? Please tick where applicable.

Key: 1 = Never, **2** = Rarely, **3** = Sometimes, **4** = Often, **5** = Always

Item	1	2	3	4	5
How often does your Biology teacher use videos (e.g., animations, documentaries) during lessons?					
How often do you use digital simulations or interactive software in your Biology lessons?					
How frequently do you see projectors (Overhead or digital) being used to display Biology content in class?					
How often do your teachers use charts and 3D models to explain Biology concepts?					

#END

Thank you for your time.

APPENDIX B: TEACHERS' QUESTIONNAIRE

You are kindly asked to respond to the questions below by either using a tick or writing where appropriate. The questionnaire is meant for educational research purposes only.

PART A: Demographics Information

1. What type/Category of School do you teach?

[ ] Extra County [ ] County [ ] Sub-County

2. For how long have you taught Biology?

(i) 1-4years ( ) (ii) 5-9 years ( ) (iii) 10-14 years ( ) (iv) 15 years and above ( )

3. Have you received any training on the use of audio-visual aids or digital simulations in teaching? [ ] Yes [ ] No

4. How would you rate the availability of Audio-Visual Aids (e.g., videos, projectors, models, charts, simulations) in your school for teaching Biology?

Inadequate [ ] Adequate [ ] Moderate [ ]

5. What is the most recent class mean score for Biology over the last three school terms in percentage? Mean Score: _____ %

6. Based on your experience, how would you rate the average Biology performance of your student's exam results?

[ ] 1 – Below 30% (Very Poor) [ ] 2 – 30% to 49% (Poor)

[ ] 3 – 50% to 64% (Average) [ ] 4 – 65% to 79% (Good)

[ ] 5 – 80% and above (Excellent

Part B: Student involvement in utilization of AVA

Tick the appropriate column to indicate the level of agreement on statements given on students' engagement and participation when AVA-based simulation is used in Biology class. Use the rating criteria: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4) and Strongly Agree (5)

Statement	1	2	3	4	5
The use of audio-visual aid-based simulations increases student participation in Biology lessons					
Students remain more engaged and focused during Biology lessons when I use AVA-based simulations					
AVA-based simulations improve students' understanding of complex Biology concepts.					
The use of AVA-based simulations has positively influenced students' Biology test scores					
Digital simulations (e.g., virtual labs, interactive software) are an effective tool for teaching Biology					

PART C: Teacher preparedness to usage of audio-visual aids in teaching biology

Using the ratings criteria; Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), Strongly Agree (5), indicate your agreement level with the following statements. Tick at the appropriate box.

Level of preparation	1	2	3	4	5
I prepare and watch video before lesson					
I enjoy using AVA in class					
I lack confidence when using AVA					
I lack training on proper use of AVA					
I use AVA as required in the lesson					
I need special training to increase my competence in using AVA					
I use AVA according to the students' academic level					

Part D Teacher perception on utilization of audio-visual aids

Please show your level of agreement with each of the following statements by marking the appropriate box. Use the following scale for your responses: 1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree.

Statement	1	2	3	4	5
I enjoy using AVA while teaching than lecture method					
Employing AVA in my lessons makes me complete syllabus in time					
I feel motivated to use audio-visual aids in class					
I am conversant with usage of technology					
The audio-visual aids are necessary in teaching of Biology					

Part E: Frequency of utilization of audio-visual aids in Biology teaching

13. How often do you use the following audio-visual aids when teaching Biology? (Tick where applicable). **Key: 1** = Never, **2** = Rarely, **3** = Sometimes, **4** = Often, **5** = Always

AVA	**1**	**2**	**3**	**4**	**5**
How often do you use television programs when teaching Biology?					
How often do you use projectors and transparencies when teaching Biology?					
How often do you incorporate videos in your Biology lessons?					
How often do you use computers and slides when delivering Biology content?					
How often do you use films in your Biology instruction?					

#END

Thank you.

APPENDIX C: INTERVIEW GUIDE FOR LABORATORY TECHNICIANS

1.How many years have you worked as a Laboratory Technician in this school?

2.How often do students engage with AVAs (e.g., digital microscopes, simulations, videos, interactive models) during Biology practical lessons? *(Daily, weekly, rarely)*

*3.*In your observation, how do students respond when AVAs are used in Biology practicals?

4. In your opinion, how confident and skilled are Biology teachers in using AVAs during practical sessions?

5.How do Biology teachers collaborate in using AVAs for practical lessons?

6.Which types of audio-visual aids are most frequently used in Biology practical?

APPENDIX D: INTERVIEW GUIDE QUESTIONS FOR HODs

The study seeks to examine the utilization of audio-visual aids (AVAs) in the teaching of Biology and how it influences student academic performance. Your insights as a departmental head are essential in understanding how AVAs are managed, implemented, and perceived within your school. All information provided will remain confidential and will be utilized exclusively for academic research purposes.

1.How do students respond when audio-visual aids are used in Biology lessons or simulations?

2.In your view, does the use of AVAs improve students' understanding and performance in Biology

3.Have you observed any performance trends (improvement or decline) linked to AVA usage in your department?

4.Have Biology teachers in your department received training on the use of audio-visual aids or simulations?

5.Are there any in-house workshops or departmental initiatives to promote AVA usage?

6.How frequently are AVAs used in Biology lessons by your teachers?

7. How do teachers collaborate in the department regarding the use of AVAs?

APPENDIX E: OBSERVATION CHECKLIST

Title: ***Utilization of Audio-Visual Aids and Its Influence on Students' Performance in Biology Among Secondary Schools in Nandi East Sub-County, Kenya***

Lesson Context

Date of Observation: _____ Observers Name _____

School Type: _____

Item to be Observed	**Availability**	**Utilization Observed**
Smart Television	☐ **Yes** ☐ **No**	☐ **Yes** ☐ **No**
Video clip	☐ **Yes** ☐ **No**	☐ **Yes** ☐ **No**
Interactive whiteboard	☐ **Yes** ☐ **No**	☐ **Yes** ☐ **No**
PowerPoint presentation	☐ **Yes** ☐ **No**	☐ **Yes** ☐ **No**
Overhead projectors and slides	☐ **Yes** ☐ **No**	☐ **Yes** ☐ **No**
Films	☐ **Yes** ☐ **No**	☐ **Yes** ☐ **No**
Computer and multimedia	☐ **Yes** ☐ **No**	☐ **Yes** ☐ **No**

APPENDIX F: INTRODUCTION LETTER

Dear respondent,

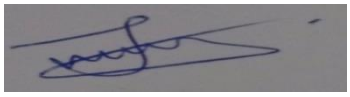
RE: DATA COLLECTION ON UTILIZATION OF AUDIO-VISUAL AIDS

I am a student of Mount Kenya University currently pursuing Masters Education in Instructional Technology. I am carrying out research on Utilization of Audiovisual Aids and its effect on Biology academic performance of students in Nandi East Secondary schools, Kenya.

You have been identified as one of the respondents. Therefore, I kindly request you to answer all the questions attached herein to facilitate the success of this study. Any responses received from you will be handled confidentially and used purely for academic reasons.

Your corporation and positive response shall be highly appreciated.

Yours Sincerely,



Nancy Jeptoo

APPENDIX G: CONSENT FORM

I, agree to participate in the research project titled "**Utilization of Audio-Visual Aids and Its Influence on Students' Performance in Biology Among Secondary Schools in Nandi East Sub-County, Kenya"** conducted by Nancy Jeptoo who have discussed the research project with my school principal. I've received and reviewed the informational letter. I've had the chance to inquire about this research and have been provided with adequate answers. I grasp the overall objectives of this study.

I assent to the consent made by the principal to participate in the research project and the following has been explained to me that; the research may not be of direct benefit to me, my participation is fully voluntary, I have a right to withdraw from the study at any point, and that any information I provide will be treated with confidentiality and handled securely. Moreover, I consent to publication of results from this study on condition that my identity is concealed.

Principals' Signature ……. **Date:** …….....

Researchers' signature ……. **Date** ……

APPENDIX H: INTRODUCTORY LETTER

Mount Kenya University

ELDORET CAMPUS

Building: Mount Kenya University Plaza **Telephone**: +254 20 2641361

Street: Ronald Ngala Street **Fax**: +254 64 51 437

Postal Address: P.o. Box 2591 30100 Eldoret **Cell**: +254 724205425, +254 724205432

Email: eldoretcenter@mku .ac.ke

OFFICE OF THE DEPUTY DIRECTOR, ACADEMIC AND RESEARCH AFFAIRS

Ref No. MKU05/ IDD-ARA/ 005/2021/001

5th January, 2021

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

RE: JEPTOO NANCY REG NO, MED/2019/58066

This is to confirm that the above named is a bona-fide student in our institution in the School of Education pursuing Master of Education in Instructional Technology.

She has successfully completed her coursework and currently working on the Thesis.

Any assistance accorded to her is highly appreciated.

Thank you.

Yours faithfully,

Mount Kenya University ELDORET CAMPUS DEPUTY DIRECTOR Academics

Dr. Stephen Tomno C

DEPUTY DIRECTOR ACADEMIC AND RESEARCH AFFAIRS

APPENDIX I: ETHICAL REVIEW CERTIFICATE

MOUNT KENYA UNIVERSITY

REF: **MKU/ISERC/2472** Date: **01 November 2022**

TO: **NANCY JEPTOO** REG: **MED/2019/58066**

Dear Sir/Madam,

RE: UTILIZATUION OF AUDIO-VISUAL AIDS AND ITS EFFECTS ON BIOLOGY ACADEMIC PERFORMANCE AMONG SECONDARY SCHOOLS IN NANDI EAST SUB-COUNTY, KENYA

This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **1545.** The approval period is **28/10/2022 -27/10/2023**.

This approval is subject to compliance with the following requirements;

i. Only approved documents including informed consents, study instruments, MTA will be used

ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**

iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification

iv. Any changes, anticipated or otherwise that may increase the risks or affect the safety or welfare of, study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours

v. Clearance for export of biological specimens must be obtained from relevant institutions.

vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal

vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

Prior to commencing your study, you will be expected to obtain, a research license from National Commission for Science, Technology and, Innovation (NACOSTI).https://research-portal.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

The Chairman
Mount Kenya University
Ethics Review Committee
P. O. Box 342 - 0100, Thika

Mount Kenya University

Dr.Peter G.Kirira

CHAIRMAN MOUNT KENYA UNIVERSITY ISERC

APPENDIX J: RESEARCH LICENSE

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 132186

Date of Issue: 21/November/2022

RESEARCH LICENSE

This is to Certify that Ms.. NANCY JEPTOO of Mount Kenya University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nandi on the topic: UTILIZATION OF AUDIO-VISUAL AIDS AND ITS EFFECTS ON BIOLOGY ACADEMIC PERFORMANCE AMONG SECONDARY SCHOOLS IN NANDI EAST SUB COUNTY, KENYA for the period ending : 21/November/2023.

License No: NACOSTI/P/22/22204

132186

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

APPENDIX K: AUTHORIZATION

MINISTRY OF EDUCATION

STATE DEPARTMENT OF EARLY LEARNING AND BASIC EDUCATION

Telegrams: "EDUCATION",
Telephone: 053 643340/0208008149
Email: moenandieast@gmail.com
When replying please quote

SUB COUNTY EDUCATION
NANDI EAST
P.O. Box 13
NANDI HILLS

20TH JANUARY, 2023

REF: NED /ADM/R/V267/VOL1/57

NANCY JEPTOO
MOUNT KENYA UNIVERSITY
P. O. BOX 2591 - 30100
ELDORET.

RE: AUTHORITY TO CARRY OUT RESEARCH

Reference is made to your letter dated 1/11/2022 requesting permission to carry out research in public secondary schools in Nandi East Sub County.

I wish to inform you that you have been granted permission to carry out your research entitled "**Utilization of Audio -visual aids and its effects on Biology Academic performance among secondary schools in Nandi East Sub-County, Kenya"** .

You are further informed that you strictly conform to the research period ending 27/10/2023 and share a copy of your findings to this office. Wishing you luck in your research.

JAPHETH N. OMARIBA

SUB - COUNTY DIRECTOR OF EDUCATION
NANDI EAST SUB-COUNTY
20 JAN 2023
P. O. Box 13-30301,
NANDI HILLS

FOR SUB COUNTY DIRECTOR OF EDUCATION- NANDI EAST

cc: COUNTY DIRECTOR OF EDUCATION - NANDI COUNTY

APPENDIX L: TURNITIN REPORT

UTILIZATION OF AUDIO-VISUAL AIDS AND ITS INFLUENCE ON STUDENTS' PERFORMANCE IN BIOLOGY AMONG SECONDARY SCHOOLS IN NANDI EAST SUB-COUNTY, KENYA

by Nancy Jeptoo

Submission date: 12-May-2025 02:58PM (UTC+0300)
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UTILIZATION OF AUDIO-VISUAL AIDS AND ITS INFLUENCE ON STUDENTS' PERFORMANCE IN BIOLOGY AMONG SECONDARY SCHOOLS IN NANDI EAST SUB-COUNTY, KENYA

ORIGINALITY REPORT

20%	17%	13%	6%
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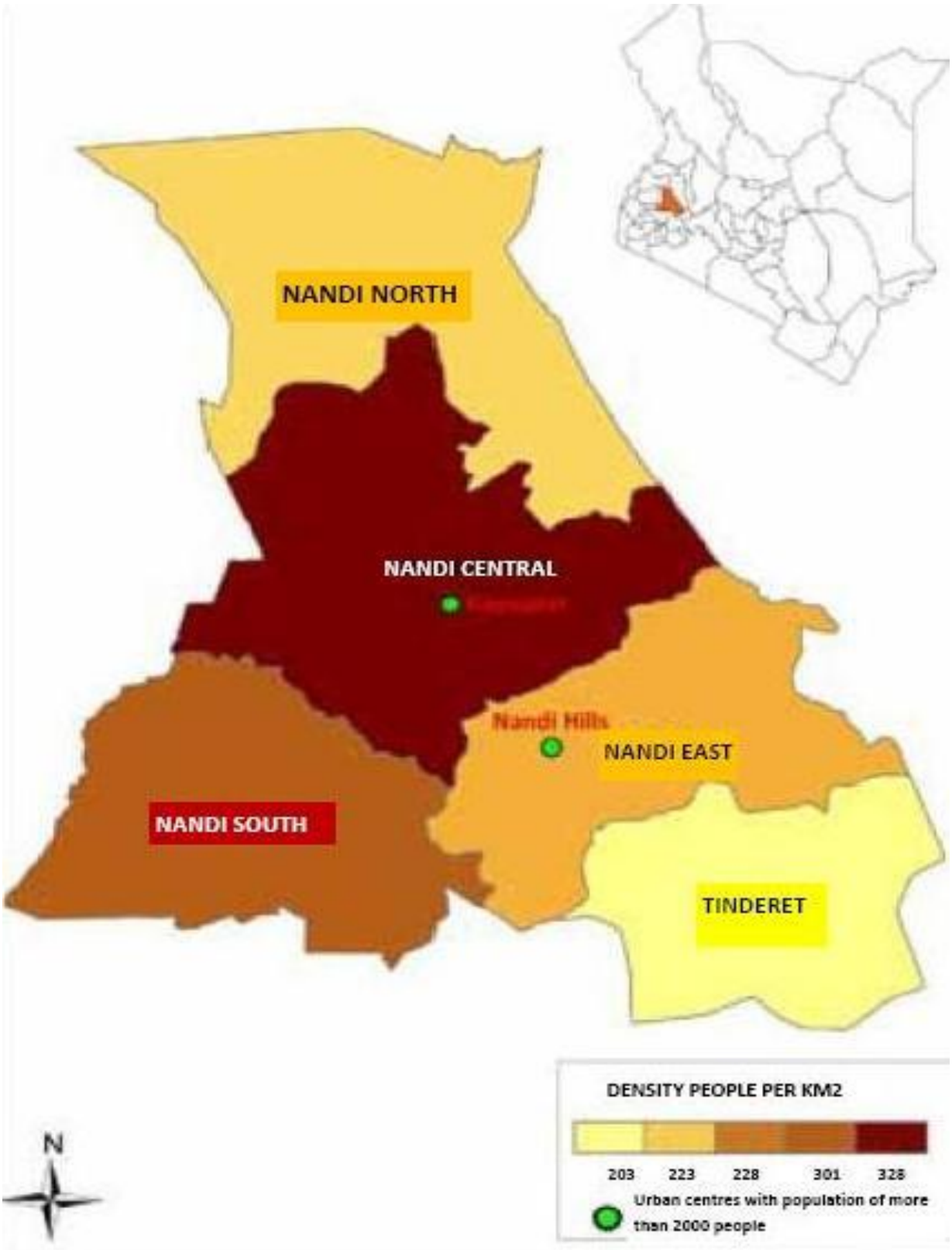
APPENDIX M: MAP SHOWING POSITION OF NANDI EAST



APPENDIX N: FINITE POPULATION SAMPLE SIZE DETERMINATION

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
[30]	**[28]**	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	[**1800]**	**[317]**
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note: "N" is population size, "S" is sample size.
Source: Krejcie, Robert V., Morgan, Daryle W., "Determining Sample Size for Research Activities", Educational and Psychological Measurement, 1970.