Utilization of Laboratory Resources and Learners' Achievement in Biology in Secondary Schools in Webuye West, Kenya

Oviyo Musimwa Safani[1], Prof. Stanly Ngome Mutsotso[2], Dr. Robert Kati[3]

Department of Curriculum and Pedagogy Kibabii University

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ABSTRACT

Laboratory practical is a learning approach that involves various activities such as investigating, recording, observing, examining, interaction with audio-visual tools to create knowledge. This research study examined the utilization of laboratory resources and learners' academic achievement in Biology in secondary schools in Webuye West Sub-County, Kenya. The objective of this study is to establish the types of laboratory resources and their effect on learners' academic achievement in Biology. Jerome Bruner's Theory of Constructivism provided the theoretical foundation for the study. A mixed research design, combining descriptive survey and experimental research methods, was adopted. The target population are in 36 public secondary schools in Webuye West Sub-County. A sample of 11 schools were selected randomly from 3 clusters.420 students of Form 4 who studies Biology were selected proportionately using Cochran's formula. In addition 11 school principals were selected purposefully, 24 teachers of Biology were randomly selected in sampled schools as respondents. Data collection instruments included questionnaires for teachers of Biology. The researcher used checklists in the laboratory, interview guides for principals, and practical tests administered to students. 210 students of Form 4 formed the experimental group, the other 210 formed control group. Data were analyzed descriptively using SPSS version 26. with chi-square test analysis for independence that showed relationship between category of school and adequacy of laboratory resources that showed significant correlation of x^2 (1) = 7.219, p=0.007. The study findings revealed disparities in the availability and adequacy of laboratory resources, which significantly influenced Biology instruction. While science laboratories were generally available, essential materials such as reagents were insufficient, limiting hands-on learning experiences. ICT resources were also inadequate, hindering digital integration in teaching. It therefore recommended that the Ministry of Education and School Administrators should increase funding for laboratory resources to ensure all secondary schools are adequately equipped.

Key words: Laboratory resources, Achievement in Biology, Constructivism theory.

INTRODUCTION

In Kenya, biology has historically been tested as a science subject in the KCSE exams by having students complete both theoretical papers and experimental paper. The purpose of the theory examinations is to assess pupils primarily on their cognitive knowledge, while the practical papers prioritize laboratory hands on abilities. As per the author's report in (KNEC. 2023), during the earlier biology practical tests administered by KCSE, applicants were permitted to handle the actual samples or operate apparatus while responding to the queries. However, starting in 2019, the KNEC modified the way the practical paper was organized. According to the author in (KNEC, 2023), the real specimens that were given to learners during the exams, some were replaced by photographs. This was done in order to address concerns about cheating. KNEC contended that instructors were using the practical, secret guidelines they had received previously to begin assembling the testing specimens to train their students on every facet of the samples that might be tested. This makes audio visual tools in the laboratory equally of value just like materials and reagents are to students for them to perform better in Biology. It's against this background, that the researcher sought to investigate how biology students in secondary schools in Webuye West Sub County, Kenya, use laboratory resources to achieve academic success in the Biology subject.

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LITERATURE REVIEW

Biology is study of living organisms. It is abroad field that encompasses other disciplines that investigate the structure, function, growth, evolution and other features of living organism. Since the inception of 8.4.4. system of Education in Kenya, Biology has been tested as a subject in National Examination. Biology Subject in National Examination is administered in three papers (KNEC,2023) i.e Biology theory paper 1 and paper II which mainly test theory but it contains photography similar to what is administered in paper III as a practical. Biology paper III entails Hands on activities and some photography. Students who excels in performance end up enrolling in professions that include Medicine, Nursing, Laboratory Technologists among other heath science courses.

Numerous researchers, including (Mogaka, 2020), (Ufonabasi et al, 2020), and (Ajiboye, 2022), have examined the connection between the kinds of equipment used in laboratories and students' academic achievement in biology. According to (Abidoye et al, 2022), pupils who had a higher percentage of biology laboratory facilities did better than those who had fewer resources. According to (Mogaka's, 2020) research, there is a statistically significant positive correlation between the three categories of laboratory equipment's availability and appropriateness. The issue of pupils performing poorly on internal and external scientific exams can be resolved by providing science teachers in public high schools with access to laboratory facilities (Ufonabasi et al., 2020).

According to (Eyenaka, 2024) evaluation of laboratory resources in science education, laboratory facilities contribute to the development of science process skills by broadening the base for inference and facilitating access to a large data set, which enhances learning. According to a (Mulinge, 2017) study on the impact of laboratory resources on students' performance in science classes at public high schools in Machakos Sub-County, Kenya, 68% of the respondents said that their schools' insufficient laboratory facilities had an impact on their students' ability to learn science classes.In a similar vein, (Mogaka's, 2020) study on the availability and utilisation of school facilities and performance in school in Kisii County's public day secondary schools found that nearly 75% of the students in these schools have the ability to utilize basic biology laboratory equipment when it comes to biology.

Chepkrui (2022) studied the effects of instructional resource availability on students' cognitive achievement in Bureti Sub County's public elementary schools. Findings indicated that student performance and the accessibility of human, physical, and learning assets were positively correlated. Although the importance of educational resources has been proven, it is still unclear whether the availability and quality of laboratory resources will improve the academic achievement of learners in secondary schools.

For this reason, laboratory materials are crucial to the learning of the sciences, particularly Biology. The success of instruction is guaranteed if it is made available, adequately supplied with the necessary supplies, and applied effectively (Akram et al, 2022). As a practical subject, Biology necessitates sufficient laboratory resources for the student to gain the necessary skills and knowledge. The examined literature is unclear, nonetheless, as there are no studies on the accessibility, sufficiency, availability, and use of laboratory resources in the understudied Webuye West Sub-County. This study analyzes laboratory resources to improve biology achievement in Webuye -West Sub-county

Biology as one of the subjects in science education is a prerequisite subject for several science related fields of learning. In Form one and Form two Biology is compulsory. Many students however choose to do Biology as compared to Physics. Despite the interest, students' Biology performance has been poor for a long time now. This state of affairs has been a national concern because Biology is a vital subject and a key entry to medical and science related careers.

The Kenya Certificate of Secondary Education (KCSE) results released in every year by Kenya National Examinations Council (KNEC, 2023) have shown that Biology is recording low (poor) grades in Webuye West Sub- County, contrary to the expectation of students, teachers and parents.

Whereas the government has made several efforts to improve the performance of sciences by introducing SMASSE Project, embracing in-service training for the teachers performing students, little has been achieved in

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terms of learners' academic achievement in Biology results in KCSE. Basing on this, it is unclear to what extent the laboratory resources are utilized and barriers that might hinder the utilization of laboratory resources. Thus, this study examined the utilization of laboratory resources and its influence on learners' academic achievement in Biology in secondary schools in Webuye West Sub-County, Kenya.

Purpose Of the Study

The purpose of the study was to examine the utilisation of laboratory resources and its influence on learners academic achievement in Secondary schools in Webuye West Sub-county,Kenya.

Objective of the Study

The objective of this study was to establish the types of laboratory resources and their effect on learners' achievement in Biology in Secondary schools in Webuye West Sub-County.

RESEARCH METHODOLOGY

This study adopted a mixed research design, incorporating both descriptive survey and experimental research designs. According to (Mugenda, 2003), a descriptive survey design describes the state of affairs as they exist. This approach was appropriate for the study as it enabled the researcher to collect data on the availability, utilization, and impact of laboratory resources on learners' academic achievement in Biology in secondary schools in Webuye West Sub County.

As noted by (Gopalan, 2020), experimental research design provides more definitive conclusions about causal relationships than correlation studies. This design was incorporated to examine the impact of laboratory resource utilization on improving learners' Biology achievement in Webuye West Sub County.

In line with (Kerlinger, 2014), the researcher used a sampling size between 10% and 30% to determine the sample size, as shown in the table below, which was deemed suitable for this study.

Table 1: Sample size analysis

RESPONDENTS	POPULATION (N)	SAMPLE SIZE (n)	% USED	TECHNIQUE
Form 4 students	4200	420	10	Simple random
Teachers of biology	80	24	30	Simple random
Principals	36	11	30	Purposive
Total	4316	455		

Source: Researcher, 2024

The study employed a stratified sampling technique to determine the sample size from schools in 3 clusters of Webuye West Sub-County: Webuye, Matulo, and Bokoli. Stratified sampling, as described by (Liu & Cheng, 2022) is a probability sampling method that divides a population into distinct strata and selects samples from each stratum in proportion to their representation.

Cochran's (1977) formula was used to obtain proportionate Form 4 candidature respondents

$$n_h = \frac{N_h}{N} \text{ x } n$$

key

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where n_h=sample size of h^{th} stratum.

Nh=population size for h^{th} stratum

N=Size of entire population

n=Size of entire sample

Table 2: Selection of Students Samples from Strata

STRATA	N	n_h	STRATA	N	n_h	CONTROL	EXPERIMENTAL
Z1	1969	197	S1	230	37	18	19
			S2	670	109	55	54
			S3	80	13	6	7
			S4	180	30	15	15
			S5	50	8	5	5
Z2	1670	167	S6	60	34	17	17
			S7	80	45	23	22
			S8	120	68	34	34
			S9	36	20	10	10
Z3	561	56	S10	68	26	13	13
			S11	80	30	15	15
TOTAL	4200	420	11 schools	1654	420	210	210

Source: Researcher, 2025

Educational research involves privacy concerns; therefore, participation in this study was strictly voluntary. Respondents provided express consent before participating, ensuring informed consent, where they agreed on the type of information disclosed to the researcher. They were also assured that any personal data collected would remain confidential and be used solely for the intended research purpose.

According to (Akakulubelwa, 2024) research instruments are tools for gathering data. As a result, three distinct research instruments were utilized in this study to collect data.

A questionnaire is a list of questions with recorded responses from respondents (Kumar, 2011). It also provides answers to questions or statements that evaluates attitudes, opinions, beliefs, and biographical data (Mac Millan, 2004). The questionnaire offers a clear advantage over other data collection techniques, as it gathers data from larger samples, its a more cost-effective, and more efficient. These research questionnaires are designed based on the study's objectives, aiming to determine respondents' opinions regarding the impact of laboratory resources on secondary biology students' academic performance. Questionnaires were administered on teachers of Biology.

Qualitative data was collected through interviews with school principals, guided by interview schedules. A personal interview, conducted in a semi-structured manner by the researcher served as a form of personal

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investigation. Raw data from the recorded interviews underwent coding and classification, followed by tabulation of responses. Verbal quotations were also included to emphasize key points made during the interviews. The results were then summarized using percentages.

A checklist was used to confirm the availability of laboratory resources. The researcher administered it by physically inspecting the laboratory preparatory room and inventory books while recording the levels of available resources. Additionally, the checklist and laboratory practical activities inventory book provided insights into the frequency of access and utilization of various laboratory resources.

A practical test is a replicated work situation designed to assess a candidate's ability and skill in performing critical and frequently performed tasks. Practical test was administered to both a control group, labeled A, consisting of 210 students, and an experimental group, labeled B, also comprising 210 students. The experimental group was exposed to specific laboratory resources that the researcher utilized in constructing the practical test. Pilot study was conducted in Webuye East in four schools. Researcher used 42 Form4 respondents who were selected randomly in 4 schools. Researcher administered questionnaires of student to selected students. Practical test was administered to 11control group and 11 experimental group. This is 10% of 420 respondents to be used in the study.8 teachers were purposeful selected and researcher administered questionnaires of teachers, 4 principals were interviewed. The split-half test technique was used to assess the reliability of the practical test. Face and content validity were used to validate questionnaires of teachers of Biology and Form 4 students' as well as the practical test. The face validity of these research instruments involved reviewing them with the help of my supervisors after pilot study to ensure they were admissible, meaningful, and appropriate for the study location (Mugenda, 2023) defined reliability as the extent to which research instruments produce consistent data or results after repeated tests. The results indicated a high reliability coefficient of Cronbach's alpha value(α) of 0.76 confirming that the tools were reliable in pilot study. The reliability of the the scale varied between α= 0.81-0.90 in several samples.

RESULTS AND DISCUSSION

The objective sought the views of teachers to establish the types of laboratory resources and their effect on learners' achievement in Biology in Secondary schools in Webuye West Sub-County.Using a four-point Likert scale (1 – Strongly Disagree, 2 – Disagree, 3 – Agree, 4 – Strongly Agree). Findings were summarized in Table 4

Table 3: Teachers response on types, availability and adequacy of Laboratory Resources

Statements (n=24)	SD		Disagree		Agree		SA			
	F	%	F	%	F	%	F	%	M	SD
We have adequate science laboratory for conducting practical lessons: in Biology	2	8.3	4	16.7	10	41.7	8	33.3	3.25	0.812
The laboratory is adequately equipped with reagents and materials for practical lessons in Biology	6	25	8	33.3	6	25	4	16.7	2.10	0.954
We have adequate textbooks for teaching Biology practicals	1	4.2	1	4.2	11	45.8	11	45.8	3.50	0.441
I access ICT resources in the laboratory for teaching Biology practicals	7	29.2	8	33.3	5	20.8	4	16.7	2.18	0.948

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We have adequate tables in the laboratory	4	16.7	5	20.8	10	41.7	5	20.8	3.22	0.718
We have laboratory technician(s)	2	8.3	2	8.3	8	33.3	12	50	3.44	0.512
We have adequate Teachers of biology	6	25	8	33.3	6	25	4	16.7	2.13	0.958
Composite M and SD									**3.08**	**0.733**

Key: SD=strongly disagree; SA=strongly agree; F=frequency; M=Mean; SD=Standard deviation

Source: Researcher, 2025

Findings from Table 3 indicate varying levels of availability and adequacy of laboratory resources in secondary schools in Webuye West Sub-County. The data highlights disparities in the provision of essential learning materials, laboratory equipment, and support systems, which are critical in enhancing learners' achievement in Biology. Each construct was analyzed to understand its contribution to practical learning outcomes.

On the availability of biology practical textbooks for teaching (M=3.50, SD = 0.441), the findings revealed that most schools had sufficient biology practical textbooks, likely due to government supply programme.

The majority of teachers agreed that their schools had adequate science laboratories for conducting practical lessons (M = 3.25, SD = 0.812). This suggests that while the physical presence of laboratories was satisfactory, their adequacy in meeting the practical learning needs of students remained moderate. However, the availability of reagents and materials (M = 2.10, SD = 0.954) was rated low, indicating that most laboratories lacked sufficient supplies to support consistent practical lessons.

The presence of laboratory technicians (M = 3.44, SD = 0.512) further indicated that technical support was available to facilitate practical lessons, enhancing the overall learning experience. In contrast, the study found that ICT resources for teaching Biology (M = 2.18, SD = 0.948) and revision materials (M = 2.20, SD = 0.960) were inadequately provided. This highlights a gap in the integration of technology and supplementary learning resources, which are essential for enriching students' understanding of Biology concepts. Furthermore, the availability of Teachers of biology (M = 2.13, SD = 0.958) was rated low, reflecting a staffing challenge that could significantly impact the delivery of quality instruction.

These results are supported by findings from the researcher's checklist data regarding the availability of laboratory resources. Only 5 out of 11 schools (45.5%) had sufficient laboratory stools, meaning many students had to stand during practical sessions, potentially affecting concentration and comfort. Laboratory space was also a concern, with only 4 schools (36.4%) reporting that their laboratory size adequately accommodated students during practicals.58% of students disagreed that there were enough stools to sit on during practicals.highlighting inadequacies in laboratory infrastructure. Researcher's checklist established that only 7 schools out of 11 schools (63.6%) had microscopes, Benedict's solution and DCPIP are found in 9 schools (81.8%), visking tubing and potassium per manganate are only available in 6 schools out of 11 schools (54.5%), indicating inconsistencies in provision of essential materials. This shortage could hinder the effective implementation of practical-based learning in Biology, affecting students' mastery of scientific concepts in biology.

Similarly, principals opinions were in agreement with the foregoing findings. Typically, their answers on the availability and adequacy of laboratory resources included the following:

"We have only one laboratory which is not enough because it has to be shared between Biology, Chemistry and Physics lessons". (g,1)

Other principals reported a severe shortage of essential materials.

"Our school laboratory lacks modern equipment and we often have to improvise during practical lessons". (h,3)

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Findings on shortage of teachers students questionnaire is in agreement from principals interview:

"Our school lacks enough Teachers of biology who can handle the biology workload". (e,3)

Principal's interview also examined the role of laboratory resources availability in students achievement in biology:

"Students who actively participate in practical lessons tend to grasp concept better and perform well in examinations". (d,4)

However, schools with limited resources struggled to achieve high scores, with another principal admitting:

"Our students fear practical Questions in KCSE because they lack exposure to real experiments". (i,3)

This implies that dry practicals in most Secondary schools were done to some level where students answer practical questions without doing the real practicals and these practice demotivates students in performing better in biology during KCSE.

Jerome Bruner's constructivist theory (1962) rooted on concept organization and learning by doing. The objective intends to achieve this by provision of various types of laboratory resources to enhance achievement in Biology, so findings from principals and teachers, are of view that availability, adequacy of laboratory resources results in better performance in Biology.

The composite mean of 3.08 and a standard deviation of 0.733 suggest a moderate level of adequacy in laboratory resources across the sampled schools. However, the relatively high standard deviation indicates inconsistencies in resource distribution. A chi-square (χ^2) cross tabulation was conducted to test if there was any significant relationship between the category of school and availability and adequacy of laboratory resources. Laboratory resources were considered adequate if the overall mean on the availability of resources in Table 4.5 was above 2 (two), otherwise it was considered inadequate if it was 2 or below. Because there was only one national school, it was combined with the two county schools to ensure that the minimum expected count in every cell in the table was above the required threshold.

Table 4: Relationship between category of school and adequacy of laboratory resources

			Category of school		
			National/Extra-County/County	Sub county	
Adequate laboratory resources	No	Frequency	1	6	7
		%	15.0	85.0	100.0
	Yes	Frequency	3	1	4
		%	75.0	25.0	100.0
Total		Frequency	3	8	11
		%	36.3	63.7	100.0

Key: χ^2 (1) = 5.185, p=0.0228. The result is significant at p<0.05

Source: Researcher, 2025

The results showed a significant correlation between the category of school and adequacy of laboratory resources, χ^2 (1) = 5,185, p=0.0228 National, Extra-county and County schools had significantly greater

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laboratory resources relative to sub -county schools who had mainly inadequate resources. Consequently, while some schools were adequately equipped, notably national schools and county schools, which could contribute to better performance in KCSE Biology subject. Others faced significant shortages, especially in laboratory reagents, ICT resources and teaching personnel. These findings underscore the need for targeted interventions to bridge the resource gap an d promote equity in the provision of laboratory resources to enhance learners' achievement in Biology.

The findings of this study align with previous research on laboratory resource availability and its impact on Biology achievement. (Wekwe et al, 2024) found that laboratory technicians play a crucial role in enhancing practical learning experiences in public secondary schools in Dar es Salaam, Tanzania. The present study supports this finding, as it revealed that most schools in Webuye West Sub-County had laboratory technicians (M = 3.44), suggesting that technical support for practical sessions was relatively sufficient. However, similar to (Sani et al, 2024), who reported inadequate laboratory equipment in Federal College of Education, Zaria, this study also identified a significant shortage of reagents and laboratory materials (M = 2.10). This scarcity could limit students' ability to engage in hands-on activities during learning, reinforcing concerns about the impact of under-resourced laboratories on practical-based instruction.

Additionally, the findings resonate with those of (Chepkirui & Njoroge, 2024), who highlighted that adequate biology practicals text book supply through government initiatives contributed to improved student performance in Kuresoi South Sub-County, Kenya. Similarly, this study found that Biology practicals textbooks were widely available (M = 3.50), indicating that access to instructional materials was not a major challenge. However, (Makokha et al, 2024) linked poor school working conditions and inadequate staffing to low learning achievement in Biology in Garissa County. This aligns with the present study, which found that Biology teacher availability was rated low (M = 2.13), highlighting staffing shortages that could negatively impact student performance. These findings underscore the need for policy interventions to address disparities in laboratory resource allocation and teaching staff distribution to enhance Biology education outcomes.

An Independent Samples **z**-test was conducted to determine whether the difference in performance between the unpaired control and experimental groups was significant. The test was appropriate because sample proportion was 210 > 30.When the test was marked as per the marking scheme by the researcher ,experimental group proportion was 210 with a mean of 10.6 and Control group proportion was 210 with a mean of 5.4.The test maximum score was 12.The test revealed a significant difference in performance between the two groups, $z(1)=-7.5493$, $p<0.00001$ thus, students in experimental group performed significantly better than those in the control group in the practical test. It was observed that many in the control group skipped critical steps in the procedure that include heating the mixture without adding Benedict's solution, use of excessive solutions. This control group recorded inaccurate observations, indicating a lack of familiarity with practical applications.

Further analysis of individual tasks showed that students in the experimental group demonstrated better accuracy in observations. For instance, when testing for reducing sugars in solution B using Benedict's solution, 85% of experimental group students correctly recorded the color change from blue to green to yellow finally to orange while heating, leading to the correct conclusion that solution B contained reducing sugar(s). Conversely, only 52% of control group students noted the correct color change, with many reporting partial or no change, suggesting uncertainty in the procedure,

These findings underscore the impact of laboratory resource availability on students' practical skills. The experimental group, with prior hands-on exposure, demonstrated greater confidence, precision, and ability to follow scientific procedures correctly. This suggests that frequent and structured laboratory experiences enhance students' competency in executing biological experiments, reinforcing the importance of investing in laboratory resources to improve practical learning outcomes.

CONLUSION

The findings on laboratory resources in 11 schools in Webuye West Sub-county revealed disparities in availability and usage. While 72.7% of schools had laboratory workbooks, essential materials like salt and iodine solution were available in all schools, but vising tubing and potassium permanganate were only in 54.5%. Test

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tubes and beakers were in all schools, but microscopes were limited (63.6%). Only 27.3% had projectors. Laboratory space and stools were inadequate in most schools, shortage of teachers of biology was witnessed. Despite regular use of available resources, shortages of biology equipment and modern tools hindered effective practical learning, especially for senior students.

The study concludes that the availability and adequacy of laboratory resources play a crucial role in shaping the quality of Biology instruction in secondary schools in Webuye West Sub-County. While most schools have basic laboratory infrastructure, there are notable shortages in essential supplies such as reagents and ICT resources, which hinder the effectiveness of practical learning. The inadequacy of laboratory technicians and limited access to digital learning tools further exacerbate these challenges. These findings highlight the urgent need for policy interventions to improve resource distribution and ensure equitable access to laboratory materials across schools.

RECOMMENDATIONS

The following recommendations were made by the study:

The Ministry of Education and School Administrators should increase funding for laboratory resources to ensure all secondary schools are adequately equipped with essential reagents, modern laboratory equipment, and ICT tools.

School Administrators and Boards of Management should prioritize the recruitment and training of laboratory technicians to support Biology practical sessions.

Teachers of biology and Curriculum Developers should integrate frequent and structured practical sessions into the Biology syllabus to allow students to actively participate in experiments.

The Government and Education Stakeholders should address staffing shortages by recruiting more qualified Teachers of biology and providing ongoing professional development programs.

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