EFFECT OF USE OF PRACTICAL APPROACH ON LEARNERS' ACADEMIC PERFORMANCE IN SELECTED TOPICS IN BIOLOGY IN SECONDARY SCHOOLS IN TURBO SUB-COUNTY, UASIN GISHU-COUNTY, KENYA

BY

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DECLARATION

Declaration by the Candidate

This thesis is my original work and has not been presented for a degree in any other university.

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This thesis is dedicated to my wife, my sons, relatives, friends, and colleagues.

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ABSTRACT

Biology is a practical-oriented subject that aims to develop learners' scientific inquiry and problem-solving skills. However, persistent low performance in Biology among secondary school students have been partly attributed to the continued use of conventional teaching methods that offer limited emphasis on hands-on practical activities. This study sought to investigate the effect of using practical approaches on learners' academic performance in Biology in secondary schools in Turbo Sub-County, Uasin Gishu County, Kenya. The objectives of the study were to determine the pretest performance of Form 2 students in selected Biology topics before the use of the practical approach,to determine the post-test performance of Form 2 students in selected Biology topics after the use of the practical approach,compare the pretest and post-test performance of Form 2 students in selected Biology topics to establish the effect of the practical approach and to asses teachers' perceptions on the use of the practical approach in teaching selected Biology topics in Form 2. The study was grounded in Vygotsky's socio-cultural theory and Dewey's constructivist theory. A quantitative research approach was employed using a quasi-experimental design. The study involved 316 respondents, including 306 Form 2 students and 10 Biology teachers drawn from a target population of 1,817 in 22 secondary schools, which were selected through stratified random sampling. The students were purposively assigned into experimental and control groups. Data were analysed using both descriptive and inferential statistics. Specifically, independent samples t-tests were used to compare mean scores between groups, and Turkey's HSD test was used to assess post-hoc differences. Pre-test results showed no statistically significant difference between the groups. In Group A, the control group had a mean score of 42.56 (SD= 10.34), while the experimental group had a mean of 42.12 (SD = 9.89), with $t(108) = 0.405$, $p = 0.686$. In Group B, the control group scored a mean of 40.78 (SD = 8.76) and the experimental group 40.91 (SD = 9.04), with $t(108) = -0.043$, $p = 0.966$. After the intervention, the experimental groups showed significantly higher mean performance than the control groups. In Group A, the experimental group recorded a mean of 58.24 (SD =8.47) compared to the control group's 47.10 (SD = 9.26), with $t(108) = 4.588$, $p = 0.000$.Similarly, in Group B, the experimental group had a mean score of 54.38 (SD = 7.92) while the control group scored 48.06 (SD = 8.14), with $t(108) = 2.548$, $p = 0.012$. Results from Turkey's HSD test supported these findings, revealing statistically significant differences in performance between the experimental and control groups in the post-test, particularly between Experimental A and Control A ($p = 0.000$). These findings indicate that the practical approach significantly enhances learners' academic performance in Biology. Furthermore, teachers expressed positive perceptions toward the practical approach, noting its benefits in improving students' engagement, comprehension, and retention of Biology concepts. The study concludes that the use of practical teaching methods is effective in improving academic performance and recommends that school managements provide the necessary resources and support to enable teachers to implement more practical-based lessons. The findings contribute to a growing body of evidence supporting the integration of practical approaches in Biology instruction and offer guidance for educators and policymakers in improving science education outcomes.

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ABBREVIATIONS AND ACRONYMS

ASEI	Activity, Student Experimentation, and Improvisation
CEMASTEA	Centre for Mathematics, Science and Technology Education in Africa
KNEC	Kenya National Examination Council
PDSI	Plan, Do, See, Improve
SDG	Sustainable Development Goals
SMASSE	Strengthening of Mathematics and Science in Secondary Education
UK	United Kingdom
ZPD	Zone of Proximal Development

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.0 Introduction

This chapter provides the background of the study, problem statement, study's purpose, research objectives and research questions, significance of the study, assumptions of the study, scope and limitations, theoretical and conceptual framework, and the operational definition of terms.

1.1 Background of the Study

Biology is one of the fundamental branches of science that underpin human understanding of life processes and the environment. Across the world, Biology plays a crucial role in addressing global challenges related to health, food production, biodiversity, and sustainable resource use. As a scientific discipline, it provides foundational knowledge that supports numerous professional fields, including medicine, biotechnology, agriculture, environmental management, nursing, food science, pharmacology, and other applied life sciences. Globally, the teaching and learning of Biology have attracted significant scholarly attention, primarily because of the continued concern over students' performance and the persistent gaps between the intended curriculum and the actual learning outcomes achieved in classrooms. According to Allen et al. (2015), Biology equips learners with conceptual frameworks needed to understand living organisms and to apply that knowledge to real-world problems. It is a subject that is indispensable for the achievement of national and global goals related to sustainable development, health promotion, and technological advancement. As countries strive to produce scientifically literate citizens capable of supporting innovation, Biology education has become central to many national development agendas.

Globally, science education is understood as an active process in which learners must participate meaningfully for learning to occur. Trowbridge et al. (2014) emphasize that science should not be taught as a static body of facts but as a dynamic, investigative field that requires learners to engage in hands-on and minds-on experiences. Effective science education, therefore, demands teaching approaches that encourage inquiry, problem-solving, experimentation, and critical thinking.

Modern global pedagogical trends advocate for learner-centered methods such as inquiry-based learning, cooperative learning, project-based learning, and laboratory-based instruction. Yet despite these global recommendations, many countries continue to grapple with challenges in effectively teaching the subject. In several contexts worldwide—including both developed and developing nations—teachers often resort to traditional, lecture-centered approaches that limit students' active participation. This mismatch between recommended practice and actual classroom methods has been identified as a major contributor to students' low achievement in science subjects, Biology included.

Furthermore, global transformations in technology, biotechnology, medicine, and environmental science have created a heightened need for educators to adopt more interactive, up-to-date instructional strategies. As scientific knowledge continues to expand, the need for practical, experiment-based learning grows even more crucial. Scientists globally develop knowledge by raising questions, designing investigations, collecting data, analyzing outcomes, and relating new evidence to existing theories. Teaching biology should mirror this scientific process.

The global need for improved Biology instruction is also connected to the Sustainable Development Goals (SDGs). Biology forms the foundation for SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land). Knowledge in Biology helps societies understand how to preserve biodiversity, enhance agricultural productivity, promote public health, and sustainably manage natural ecosystems. As Mochama et al. (2020) note, without strong Biology education, achieving these global goals becomes difficult.

Given this global context, it becomes clear that how Biology is taught significantly affects students' understanding, academic performance, and subsequent participation in scientific careers. The worldwide demand for better teaching practices forms the basis for examining how specific approaches such as practical, activity-based learning affect students' performance in different countries, including Kenya.

In Africa, questions of quality, equity, and effectiveness in science education continue to dominate research and policy discussions. African countries generally recognize the crucial role that science plays in economic development, industrialization, and technological growth. Yet, research indicates that instructional strategies used in schools across the continent often fail to meet global standards for effective science teaching. Wieman and Gilbert (2014) argue that African educational institutions rarely collect comprehensive data on teaching practices, making it difficult to improve instructional quality. Most institutions rely heavily on student evaluations, which provide minimal insight into the real practices happening in classrooms. This limitation hampers efforts to reform teaching and improve students' mastery of scientific concepts.

Studies across the continent reveal that many science teachers depend on traditional instructional methods such as lecturing, dictation, and demonstration while giving limited attention to hands-on learning, inquiry, or investigative experiments. As a result, science learning in Africa is often theoretical, with minimal opportunities for learners to engage in practical activities. This disconnect contributes to low academic achievement and poor development of scientific skills among students.

For example, Atilla (2012), in a study conducted in Turkey but noted widely in African comparative research, found that Biology lessons often remain teacher-centered, with very few hands-on activities. In such environments, students learn abstract concepts without understanding how they relate to real life. The inability to link classroom knowledge to daily experiences leads to shallow understanding and poor academic performance.

African countries, therefore, share a common concern over the need to adopt newer, more effective instructional strategies. The emphasis on STEM (Science, Technology, Engineering, and Mathematics) education across Africa highlights the recognition that scientific literacy is essential for addressing challenges such as food insecurity, disease outbreaks, biodiversity loss, and climate change. Given these continental concerns, research focusing on improving Biology instruction especially through practical and student-centered approaches has become increasingly important. Africa’s education systems require teaching strategies that not only improve students’ academic performance but also equip them with the higher-order skills needed for participation in a knowledge-driven global economy.

In East Africa, the need to strengthen science education has long been recognized. Countries in the region, including Kenya, Uganda, Tanzania, and Rwanda, have made efforts to improve science teaching at secondary school levels. According to Ndayambaje (2021) a lecturer at the University of Rwanda cited a case of Agriculture where biology has been instrumental in mitigating the low agricultural yields by increasing plant immunity to high output diseases. Health systems are subject to competing and conflicting goals and information asymmetry between different actors, resulting in resistance to systems change. Hence, implementing policies or priorities in the context of health systems is difficult. However, despite curriculum reforms and teacher training initiatives, performance in science subjects remains below expectations in many schools. Biology, being one of the most widely selected science subjects at secondary level, consistently shows fluctuating performance in regional examinations. Factors such as inadequate resources, limited laboratory facilities, large class sizes, and limited teacher capacity continue to hinder effective curriculum delivery.

In Kenya, Biology is a core subject in secondary schools due to its relevance to national development goals, including Vision 2030. It prepares learners for careers in health, agriculture, medicine, biotechnology, and environmental management. According to the Kenya Institute of Education (2016), effective Biology teaching requires the use of several instructional methods such as; practical work, demonstrations, class discussions, field excursions and project-based learning.

These methods enable learners to develop scientific skills such as observation, experimentation, analysis, and problem-solving.

Despite these well-defined curriculum expectations, students' performance in Biology at the Kenya Certificate of Secondary Education (KCSE) level has been unsatisfactory for many years. Numerous studies provide reasons for the persistent low performance.

According to Dinah (2013), student achievement in Kenya's national examinations remains unsatisfactory, especially in science subjects. Several factors contribute to the low performance:

- Conventional Teaching Methods: Florien et al. (2021) attribute low performance to teacher-centered instructional methods that fail to engage learners in active learning. These methods limit opportunities for practical engagement, inquiry, and critical thinking.
- Lack of Practical Experience: Ndirangu (2020) reports that inadequate practical exposure prevents learners from developing scientific skills necessary for understanding Biological concepts.
- Lack of Motivation and Interest: Filgona et al. (2020) note that students often lack motivation, creativity, and self-drive due to uninspiring teaching approaches.
- Teacher Preparedness: Owiti (2017) found that insufficiently trained teachers are more likely to pass misconceptions to learners and rely heavily on outdated instructional tools.
- Gender Gap and Low Achievement Among Girls: Studies such as Sikolia et al. (2016) highlight persistent underperformance among female students in science subjects, including Biology.
- Misalignment Between Curriculum and Instructional Practices: Despite curriculum recommendations, many teachers continue using traditional lecture methods.

The Kenyan government, through the Strengthening Mathematics and Science in Secondary Education (SMASSE) initiative, has attempted to improve science teaching by introducing inquiry-based and practical instructional methods.

SMASSE emphasizes on; activity-based learning, experiments and demonstrations, learner-centered approaches, problem-solving and application of learned concepts to real-world situations. Sikolia et al. (2016) found that the more teachers engage in SMASSE training over the years, the more student performance improves. However, the impact of SMASSE has been inconsistent across different schools and counties.

The role of Biology in Kenya goes beyond academic achievement. The subject supports:

- Industrial development (through biotechnology)
- Agricultural innovation
- Community health interventions
- Environmental conservation
- climate resilience
- Biodiversity protection

The Vision 2030 agenda identifies science education as a crucial pillar for producing the skilled workforce needed for technological and industrial growth. For Kenya to achieve these goals, improving the teaching and learning of Biology at secondary level is essential.

Turbo Sub-County, located in Uasin Gishu County, mirrors the national challenges facing Biology education. Most secondary schools in the sub-county have made Biology a compulsory science subject because it is widely perceived as more approachable than Chemistry and Physics. However, despite high enrollment in Biology, performance remains consistently low. According to Kenya National Examinations Council (KNEC) reports from 2016 to 2024, Turbo Sub-County has witnessed:

- Declining performance in Biology

- Few students scoring quality grades (A to B-)
- Consistently lower mean scores compared to Chemistry and Physics
- Particularly poor performance in Paper 3 (the practical exam)

See table 1.1 below on the performance of the students

Table 1.1: Performance of Biology (2016-2024)

Year	Paper	Candidature	Max Score	Mean Score	Standard Deviation
2016	1		80	23.91	14.49
	2		80	18.92	11.83
	3		40	20.82	8.39
	Overall	**432,977**	**200**	**63.65**	**32.57**
2017	1		80	27.42	14.46
	2		80	19.56	11.86
	3		40	22.62	9.15
	Overall	**465,584**	**200**	**69.59**	**31.55**
2018	1		80	27.30	16.40
	2		80	20.11	14.14
	3		40	18.99	6.76
	Overall	**509,982**	**200**	**58.37**	**35.16**
2019	1		80	13.74	10.24
	2		80	16.43	10.37
	3		40	7.68	5.05
	Overall	**545,663**	**200**	**37.85**	**23.45**
2020	1		80	15.81	9.26
	2		80	11.92	8.67
	3		40	13.65	7.38
	Overall	**589,900**	**200**	**51.38**	**23.26**
2021	1		80	18.00	11.210
	2		80	18.00	10.036
	3		40	16.00	6.484
	Overall	**618,730**	**200**	**49.87**	**25.50**
2022	1		80	16.03	11.70
	2		80	19.83	11.75
	3		40	16.59	8.48
	Overall	**651,236**	**200**	53.03	29.50
2023	1		80	19.58	14.88
	2		80	21.73	13.87
	3		40	15.72	7.05
	Overall	**710,533**	**200**	**57.01**	**32.98**
2024	1		80	24.04	15.29
	2		80	19.87	12.83
	3		40	13.47	7.32
	Overall	**752,154**	**200**	**57.37**	**32.39**

Source MOE, KNEC Report, 2024

This low performance in Paper 3 highlights a major instructional gap, students are not receiving adequate practical training during classroom learning, hence dismal results

Muraya and Kimamo (2011), in a study conducted in Kenya, demonstrated that cooperative and practical-oriented instructional strategies significantly improve Biology achievement scores. Their findings showed:

- Students taught using cooperative and practical methods performed better
- Gender did not significantly influence outcomes

Wamukota & Masibo (2017) found that most Biology teachers rely on lecture-based methods that deny learners opportunities for active engagement.

Filgona et al. (2020) noted that "Low performance has been attributed to lack of motivation, creativity, interest, practice, confidence, and self- drive towards sciences, among students. Ndirangu (2020) decried the lack of practical experience in the teaching and learning of science leading to poor mastery of important scientific skills and concepts.

As a field of science, Biology has produced an interrelated set of concepts and conceptual frameworks because of experimentation and observation. To comprehend Biology, the difficulty of understanding facts and concepts must be viewed within the perspective of associated laboratory experiments. The tactics used by science teachers in teaching have become obsolete nowadays due to the continually changing nature of science, of which Biology is a field (Ong'amo et al., 2017). Biology remains at delivery with the crucial information, competencies, and opinions to control and safeguard the environment to learners. The subject's significance cannot be overemphasized. The subject helps the students to enter professions like health, agriculture, environment, and education. Biology is the basis for an industrial and technical growth resource for biotechnology (Wamukota & Masibo, 2017). Biology is an important subject as it helps us to grasp the natural world. Biology expertise is applicable in many areas such as medicine, pharmacy, nursing, dentistry, and agriculture (Allen et al., 2015).

The study of Biology aims at facilitating the learners with knowledge, skills, and attitudes necessary for controlling and preserving the environment. The subject enables the learners to enter careers such as health, agriculture, environment, and education. Biology is the precursor for biotechnology which is a tool for industrial and technological development.

According to the secondary education syllabus, the objectives of Biology are as follows: communication of biological information in a precise, clear, and logical manner; application of the knowledge gained to improve and maintain the health of the individual and the community; observation and identification of features of familiar and unfamiliar organisms, recording of observations and making deductions about the functions of parts of organisms; developing positive attitudes and interests towards Biology and the relevant practical skills; demonstrating resourcefulness, relevant technical skills and scientific thinking necessary for economic development; and acquisition of a firm foundation of relevant knowledge, skills and attitudes for further education and training in related scientific fields among other objectives (Wamukota & Masibo, 2017).

Despite its enormous practical value, the general trend in Biology performance in the Kenya Certificate of Secondary Education Examination (K.C.S.E) has been low especially for girls (Sikolia et al., 2016). The generally low performance by students in K.C.S.E science exams (including Biology) indicates that students lack adequate scientific skills. These skills are meant to be obtained through the learning of these subjects at the secondary school level. Therefore, Sikolia et al. (2016) noted that most school leavers at this level do not possess the knowledge and skills to be able to benefit from the opportunities for further training and education. Such skills could be applicable in the labour industries and other critical sectors of the economy.

Closely related to this is the difficulty students face in handling experimental design questions. According to KNEC (2016) exam reports, many candidates struggle with tasks that require them to design experiments, interpret results, or draw valid scientific conclusions. This weakness highlights the need for consistent practice, exposure to investigative science, and improved instructional approaches that emphasize inquiry-based learning.

Another significant contributor to poor performance is the limited availability of resources and inadequate infrastructure in many schools. Some institutions lack fully equipped laboratories, modern apparatus, and essential materials required to facilitate effective practical learning. Without these resources, teachers find it challenging to implement hands-on activities, and students miss out on opportunities to develop practical competencies that are essential for success in Biology.

Finally, high dropout rates and socioeconomic challenges within the Turbo constituency further affect academic performance. Many families face financial constraints that limit their ability to support students throughout their education. Additionally, the region's limited infrastructural development impacts access to quality learning environments. These socioeconomic factors indirectly undermine learners' consistency, concentration, and performance in subjects like Biology, where continuous engagement and practical exposure are crucial.

As noted by Owiti (2017), teachers who lack adequate training may pass misunderstandings to students or rely on outdated teaching tools.

These findings underscore the importance of integrating diverse teaching strategies including practical approaches to improve Biology performance in Turbo Sub-County.

Despite the availability of curriculum guidelines, national programs, and local awareness of the challenges, Biology performance in Turbo Sub-County remains low. Discussions with teachers and school administrators indicate that:

- Practical work is minimal or inconsistently conducted
- Most lessons remain teacher-centered
- Learners often memorize rather than understand biological concepts
- Students struggle to answer practical-based questions in examinations
- Inadequate lab facilities hinder effective learning

These challenges point to a need for research that specifically investigates how practical instructional approaches influence learners' academic performance in Biology, particularly in selected topics that students commonly find difficult.

The combined evidence from global, continental, national, and local literature demonstrates a clear pattern: the use of practical, learner-centered instructional approaches results in better learning outcomes compared to traditional methods. However, despite this knowledge, many teachers in Turbo Sub-County continue to rely on lecture-based, teacher-centered strategies. This mismatch contributes significantly to students' persistent low performance in Biology.

Poor performance in Biology has far-reaching consequences for the community, including:

- Reduced career opportunities in science-related fields
- Limited capacity for technological advancement
- Compromised ability to address health and environmental challenges
- Negative impact on national development goals

Given the centrality of Biology to Kenya's Vision 2030 goals and the global Sustainable Development Goals, improving Biology education in Turbo Sub-County is both urgent and necessary.

The present study therefore responds to a documented educational need by investigating the effect of practical instructional approaches on learners' academic performance in selected Biology topics in Turbo Sub-County. Its findings are expected to contribute to better teaching strategies, improved student outcomes, and enhanced alignment between curriculum goals and classroom practice.

From a global to a local perspective, the teaching and learning of Biology face numerous challenges that directly influence student performance. Across the world, there is a strong call for more active, practical, and inquiry-based instructional approaches. In Africa, the need for improved teaching practices is particularly urgent due to ongoing struggles with teacher preparedness, resource limitations, and ineffective instructional strategies.

In Kenya, despite curriculum reforms and national initiatives such as SMASSE, student performance in Biology remains below expectations, largely due to minimal use of practical approaches and continued reliance on traditional teaching methods. At the local level, Turbo Sub-County experiences persistent low performance in Biology despite high student enrollment in the subject. This underscores the need for research that specifically examines how practical approaches can improve academic outcomes in the region.

This study therefore seeks to examine the effects of using practical approaches on learners' academic performance in selected Biology topics in secondary schools in Turbo Sub-County, Uasin Gishu County, Kenya. By focusing on practical approaches, the study aims to determine whether hands-on learning can address the persistent gaps in conceptual understanding, improve students' performance in both theory and practical examinations, and contribute to the long-term quality of science education in the region.

1.2 Statement of the Problem

The performance of students in Biology at the Kenya Certificate of Secondary Education (KCSE 2016-2024) has remained consistently low, particularly in topics such as Classification, Ecology, Support and Movement, and Evolution. Despite periodic advisories from the Ministry of Education encouraging teachers to adopt practical, activity-based approaches, learners continue to demonstrate weaknesses in key scientific skills, including observation, interpretation of data, drawing and labeling, and the correct use of biological terminology. These weaknesses are highly consequential because success in the practical paper significantly influences overall performance in Biology at KCSE.

Although the Biology syllabus outlines numerous practical activities to be implemented from Form One through Form Four, it is unclear whether teachers actually conduct these practicals as required. The persistent underperformance raises concern that many students may be progressing through secondary school with minimal exposure to hands-on scientific experiences. This lack of practical engagement may contribute to poor mastery of biological concepts and, ultimately, low achievement in examinations. The analysis also showed that learners displayed weaknesses in spelling of technical terms, relating structure to their functions, interpreting data and graphical information, making correct observations on provided specimens following experimental procedures and giving unsolicited information.

In Turbo Sub-County, the situation mirrors national trends. Students continue to record unsatisfactory results in Biology, limiting their eligibility for science-related courses at higher levels of education. What remains unknown is the extent to which teachers implement biology practicals in lower secondary classes, particularly in Forms One and Two, where foundational scientific skills are expected to be developed.

The core problem, therefore, is that there is insufficient evidence on whether learners in Turbo Sub-County are adequately exposed to practical work in Biology, despite the curriculum's emphasis on it and even after Introduction of SMASSE in-service training. This gap makes it difficult to determine whether the low academic performance observed is a result of limited practical instruction, inadequate resources, teacher-related factors, or other classroom practices. This has raised fears that many students continue to be locked out of courses that require decent grades in the subject, especially medicine courses. Scholars have been trying to unearth this menace. Haambokoma (2007) stated that science teachers are shunning from performing biology practicals in most schools in Zambia. Consequently, Teachers still rely on the old-fashioned way of teaching (Ezeliora, 2004) as such lecturing, teacher disposition and dictation. In some cases, teachers may prefer these ineffective conventional teaching approach owning to the absence of laboratories facilitates or necessary skills to conduct practical (Kibirige & Tsamago, 2013). Traditional learning techniques only results in teachers relying highly on textbooks depriving learners' stimulation of higher-order thinking and conceptual understanding of biology concepts taught through practical work and experience. In this case, learners are exposed to learning disposition without an appreciation of practical work during experiments, i.e. as cookery books approach. The practical learning approach is an efficient way of teaching biology. However, the practical approach is most likely not being performed in two in secondary schools in Kenya, which is the reason for low performance. Therefore, this research is designed to study the effect of use of practical approach on learners' academic performance in selected topics in Biology in form two in secondary schools in Turbo Sub-County, Uasin Gishu County.

1.3 Purpose of the study

The purpose of this study is to explore the effect of use of practical approach on learner's academic performance in selected topics in Biology in secondary schools in Turbo Sub-county, Uasin Gishu County, Kenya.

1.4 Objectives of the Study

The purpose of this study was to investigate the effect of use of practical approach on learners' academic performance in selected topics in Biology in secondary schools in Turbo Sub-County, Uasin Gishu County.

The study was guided by the following research objectives:

i. To determine the pretest performance of Form 2 students in selected Biology topics before the use of the practical approach.

ii. To determine the posttest performance of Form 2 students in selected Biology topics after the use of the practical approach.

iii. To compare the pretest and posttest performance of Form 2 students in selected Biology topics to establish the effect of the practical approach.

iv. To determine teachers' perceptions towards the use of the practical approach in teaching selected Biology topics in Form 2.

1.5 Research Questions

i. How is the pretest performance of form 2 students in selected topics in Biology before using the practical approach?

ii. What is the posttest performance of form 2 students in selected topics in Biology after using the practical approach?

iii. What is the difference between Pretest and posttest performance of students in selected topics in Biology before and after the use of practical approach?

iv. What are the teacher perceptions on the use of practical approach in teaching selected topics in Biology in form 2?

1.6 Research Hypotheses

H_{01} : There is no significant difference in the pretest performance of form 2 students in Biology before using the practical approach.

H_{02} : There is no significant difference posttest performance of form 2 students in Biology after using the practical approach.

H_{03} : There is no significant difference between the pretest and posttest performance of students in Biology before and after the use of practical approach

H_{04} : There is no significant effect of teacher perceptions on the use of practical approach in teaching Biology in form 2

1.7 Justification of the Study

Over the last five years, it has been observed that there is a drastic decline in the performance of Biology subject during Kenya Certification of Secondary Education Examinations (2016),and also regular circular from the Director of Quality Assurance and Standards in the Ministry of Education Science and Technology (MOEST) in Kenya to all principals of secondary schools highlighted the key areas where low performance of biology in KCSE examinations over last five years, was specifically reported in the topics of classification, ecology, support and movement and evolution.

Therefore, there was need to undertake this study so as establish the salient factors that can be attributed to the low performance of Biology, notably in the aforementioned topics in KCSE examinations.

1.8 Significance of the Study

The research data is useful both in theory and in practical biology. Regarding theoretical value, the data sheds more light on the long-standing concepts and variables in the dynamic in-service process. In particular, the applicability of practical instructional strategies in Biology within limits of the traditional orientation of teachers is critically examined. In terms of practice, the research data is useful in several ways: the Ministry of Education may realize the impact of practical instructional strategies adopted if any on schools where resources and facilities are inadequate, and may develop policies to help such schools excel in performance; the ministry may also realize the role played by the practical instructional strategies adopted in academic achievement and thus streamline its policies in light of practical instructional strategies adopted objectives and principles; the Biology teachers may plan and prepare their teaching and learning activities using strategies that promote high achievement in the subject and performance of Biology in teaching selected topics in secondary schools in Kenya ; the pre-tests and post-test research was conducted in form two class of Biology between May - August 2022.

Academicians and other researchers may find this study useful as a point of reference. The findings may increase stock on the existing pool of theoretical knowledge and empirical knowledge on use of practical approach on learners' performance in selected topics in Biology in form two in secondary schools in Turbo Sub-County, Uasin Gishu county, Kenya. Further, the study is important to scholars, as it contributes to the pool of knowledge thereby forming a reference material in increased use of practical approach on learners' academic performance in selected topics in Biology in form two in secondary schools in Turbo Sub-County Uasin Gishu county, Kenya.

1.9 Assumptions of the Study

The study made the following assumptions;

i. That the respondents will give accurate and honest responses to the study questions.
ii. That all the schools sampled for study have laboratory equipment that will aid in the study.
iii. That all the schools sampled for the study will have two streams.
iv. That all schools sampled for the study will have forty students in each stream.

1.10 Scope and Limitation of the Study

This study established the effect of use of practical approach on learners' academic performance in selected topics in Biology in form two in secondary schools. It was conducted through quasi experimental research design. Specifically, the study sought to find out the performance of form 2 students in selected topics in Biology before using the practical approach; investigate the performance of form 2 students in selected topics in Biology after using the practical approach; compare the performance of students in selected topics in Biology before and after the use of practical approach and to establish teacher perceptions on the use of practical approach in teaching selected topics in Biology in form 2. Hence the participants in the study was form 2 students as well as biology teachers. The study covered 22 secondary schools in in Turbo Sub-County, Uasin Gishu County.

This study faced several limitations. The study was limited by the respondent's withholding information during the data collection process; however, the researcher assured them that the study was conducted purposely for academic purposes. Additionally, use of tests as a research instrument had some limitations. For instance, the learners had different cognitive levels and school environment is different across schools. Validity and reliability of the tests affected the results. However, this was countered by peer review in form of test moderation.

1.11 Theoretical Framework

This study was guided by two theories. The theories are Vygotsky's Theory (1978) and Dewey's constructivist theory (1930).

1.11.1 Sociocultural Cognitive Development Theory

Vygotsky's Theory of Sociocultural Cognitive Development developed by Lev Vygotsky (1978) revolves around how our social interactions influence our cognitive development. This is known as Lev Vygotsky's Sociocultural Theory of Cognitive Development. His theory highlights the role of culture in a child's development of cognitive abilities such as reasoning and communication. According to Vygotsky's theory, in society adults foster cognitive development in children by engaging them in meaningful and challenging activities. Vygotsky was a key figure in Soviet Psychology who studied children and developed his own theories about how learning occurs. He believed that learning happens in three different stages: cognitive, motoric, and sociocultural. Cognitive learning involves thinking about concepts and ideas; motoric learning involves doing things; and sociocultural learning involves interacting with others. Although the theory is socio-cultural in nature, its relevance to this scientific study is grounded in how learning Biology especially laboratory-based Biology depends on guided interaction**.** Scientific concepts often require teacher scaffolding, peer collaboration, and hands-on engagement, all of which align with the sociocultural principles of learning.

Vygotsky’s social development theory asserts that a child's cognitive development and learning ability can be guided and mediated by their social interactions. His theory asserts that learning is a crucially social process as opposed to an independent journey of discovery. Vygotsky's theory places importance on guiding children's learning through their interaction with a more knowledgeable other (MKO). Vygotsky promoted the development of higher level thinking and problem solving in education. Vygotsky argued that teaching methods must be adapted to fit the individual student. His goal was to develop ways in which teachers could enhance students' abilities to learn. If situations are designed to have students utilize critical thinking skills, their thought processes are being challenged and new knowledge gained. Essentially, the knowledge gained through experience such as in the practical approach enhances academic performance (Fosnot, 2013).

This theory is not limited to academic or subject learning, it can also be applied to studying or teaching of Biology by looking at the performance of the students before and after exposure to laboratory practicals and the perception of teachers in the use of practical's approach in teaching selected topics in biology. However, the theory has been criticized on the argument that the emphasis on interaction between teacher and learner is too simplistic, and that the focus on external factors rather than internal ones is misguided. Criticisms infer that whereas social interaction is conducive to learning, other factors such as socio-economic background and culture influence educational attainment (DfE, 2011).

1.11.2 Constructivist Theory

The second theory employed by the researcher in this study is the Constructivist Theory. Develop by John Dewey in 1930's, the theory emphasizes inquiry and the integration of real world and classroom activities. It relies on the learners to be in control of their own acquisition of knowledge and encourages the instructor to serve as a facilitator. Constructivist theory is based around the idea that learners are active participants in their learning journey; knowledge is constructed based on experiences. As events occur, each person reflects on their experience and incorporates the new ideas with their prior knowledge.

The theory of constructivist in teaching and learning applies to understanding how students learn. In the context of this study, the supposition is that it is crucial to understand the theory of constructivist learning so as to apply it in practical simulations as basis where a learner construct new knowledge on what they have already had, the seen and heard. This is because Dewey's theory underscores facets like knowledge is constructed, learning is a social activity, learning is active process and that learning is contextual. This concurs with the fact that people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences.

The goal of educators is to create a welcoming environment that promotes active engagement in learning. In the theory of constructivist learning, educators act as facilitators. Hence, they must promote collaboration and adjust their lessons based on the prior level of understanding of the class. Once they identify students' existing knowledge, instructors must work to grow the understanding in those areas. Constructivist classrooms are more student-centered and the learning revolves around their interests and questions. Students build on their prior knowledge and construct new understanding based on the lessons taught. Dialogue and negotiation are also key components to successful learning and enhanced performance. Teachers guide learning by implementing group activities, creating collaborative dialogue, and facilitating interactive experiences which may include practicals to improve their understanding of lesson concepts.

1.12 Conceptual Framework

The conceptual framework shows the association between the independent and the dependent variable. The independent variable is practical instructional strategies, and the dependent variable is performance of Biology. The conceptual framework adopted in the study is as shown in figure 1.1.

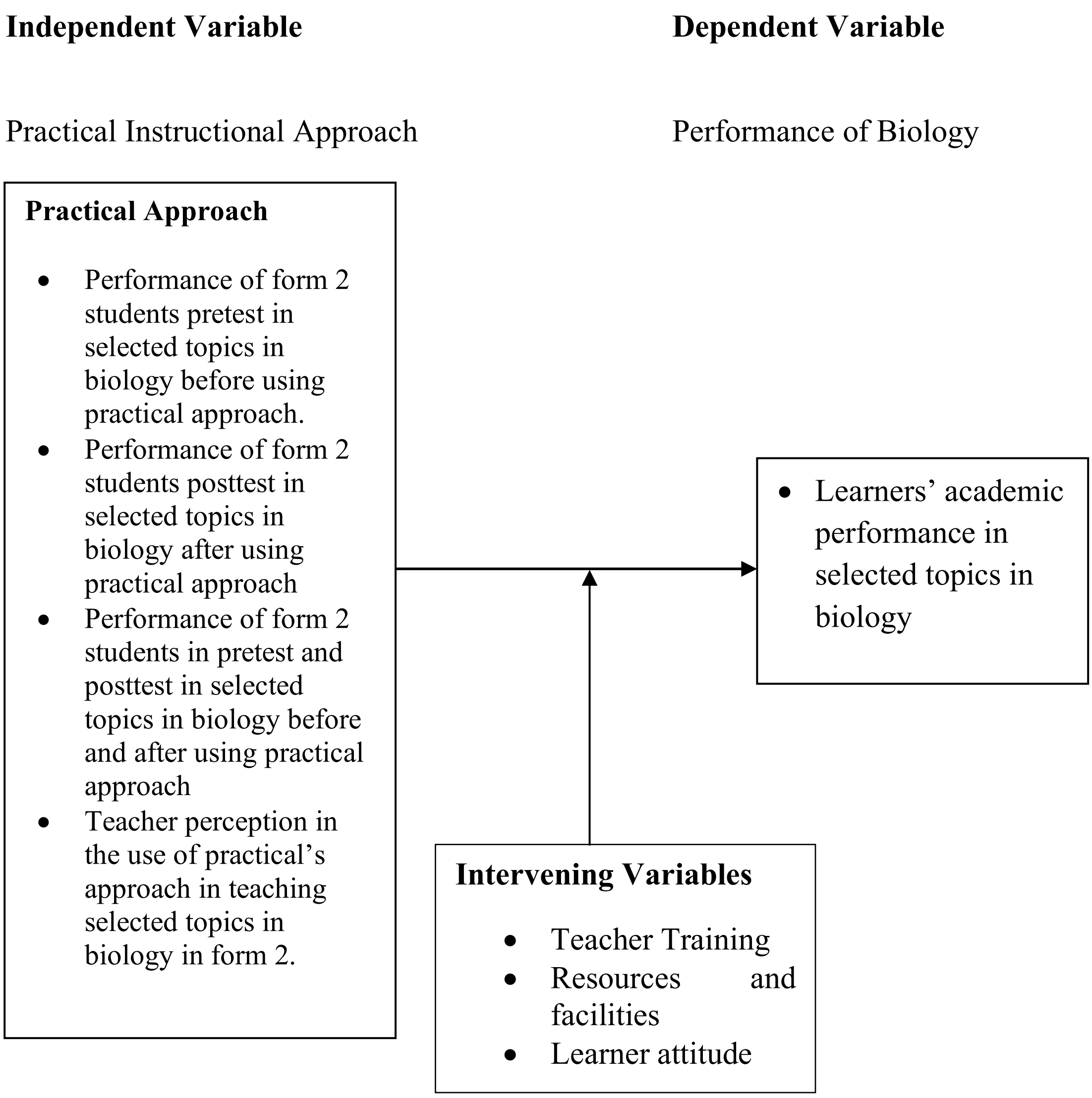

Figure 1.1 Conceptual Framework

Source: Author (2023)

1.13 Operational Definition of Terms

Academic Performance in Biology: Refers to improved mean score, pass rate and mastery of biology concepts.

ASEI: Activity, student experimentation and improvisation.

Effect of use: refers to the impact or outcome of utilizing something, in this context, practical approaches in Biology teaching

Learner Achievement: The amount of academic content a student learns in a determined time, it includes the test score and grade the learner attains in a given subject.

Lecture Method: This is teacher controlled and information-centered approach in which the teacher works as a role resource in classroom instruction.

PDSI: Plan, do and improve.

Post-test: This is an educational term which refers to a battery of tests given after a treatment process. In this study, it refers to biology tests from area covered by regular teachers given to experimental group after treatment.

Practical Approach: Is termed as a teaching approach where teachers teach the students by combining theory and practical work experience.

Practical Assessment: Practical task that involves an experimental test of prediction provided by the teacher.

Pre-test: This is an educational term which refers to a battery of tests given before a treatment process. In this study it refers to biology tests from area covered by regular teachers given to experimental group and control group before treatment.

Teaching style: Refers to those enduring personal qualities and behaviours that appear in how teachers conduct their classes. In this study, it refers to traditional/common personal qualities and behaviours of teachers that appear in how teachers conduct their classes regardless of the preferred learning styles of their learners.

Use of Teaching Aids: Involves the use of apparatus in teaching selected topics in Biology, i.e. teaching and learning activities are based on 'real-life experience' to help learners to transform knowledge or information into their knowledge which they can apply in different situations.

use: more frequent.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This section critically reviews the available literature on the effect of use of practical approach on learners' performance in selected topics in Biology in teaching selected topics from a global, African, and Kenyan perspective. It also gives literature on of increased use of practical approach on learners' academic performance in selected topics in Biology in teaching selected topics in secondary schools in Kenya. In addition, the theoretical literature, related studies, research gap and chapter summary of the literature review.

2.1 The Place of Biology

2.1.1 The Place of Biology Globally

Across the world, education is a vital process in human development and environmental management and a process of refining and preserving the collective values embedded in the culture of the society (Nja, Cornelius-Ukpepi, & Orim (2019), Oyekan, (2000)). By education, a network of worthwhile knowledge, skills and habits is passed on from one generation to the other for effective citizenship and collective benefits of the society. Education is a systematic, intellectual and moral training, development, geared towards obtaining knowledge, development of character and also mental development that will ensure human survival (Nja, Cornelius-Ukpepi, Edoho & Orim (2019) Nja, Idiege & Obi (2017) Nja and Idiege (2019)). Nja, Cornelius-Ukpepi, Edoho, Neji,(2020). This becomes a reality through effective teaching and learning. Education is often conceived as a systematic action of imparting relevant knowledge, skills and habits to the learners in their preparation for meaningful life and contribution to better society (Oloyede, 2006). This action is however usually delivered through skillful exposure to a number of academic disciplines. Science education is a part of education which makes a man rational, develops his independent thinking and helps in removing the superstitions, prevalent in the society in various forms (Nja, Kalu, & Neji. (2015)).

In view of the modern developments in science and its importance to today's world, science education and scientific outlook have assumed a significant place. Science education is most commonly broken down into; Biology, Chemistry, Physics and Mathematics (Nja, Cornelius-Ukpepi, Edoho & Orim (2019) Nja, Idiege & Obi (2017) Nja and Idiege (2019)). Nja, Cornelius-Ukpepi, Edoho, Neji,(2020). Don-philips (1975) stated that science education or indeed all education, must develop in students both an awareness to the problems facing the society and the capacity to contribute towards their solution. Science has become a substantial and integral part of organized society. There is a close interaction between science and the economic, social, political and educational system of the society. Never before in the history of mankind has society been so dependent upon scientific knowledge as it is today. Science education cultivates students' curiosity about the world and enhances scientific thinking. Through the inquiry process, students will recognize the nature of science with the aid of biological studies and develop scientific knowledge and science process skills to help them evaluate the impacts of scientific and technological developments. The emphasis of science education is to enhance students' scientific literacy through investigative activities that involves planning, measuring, observing, analyzing data, designing and evaluating procedures, and examining evidence. Biology is the natural science that studies life and living organisms including their physical structure, chemical processes, molecular interaction, physiological mechanisms, development and evolution (Uba, Udumo, Emmanuel, Addo (2019) and, Monty, Udumo & Igwebulke (2019)). The basis of our very origin and existence on earth lies within the depths of biological sciences.

Biology has an endless array of species. Biology plays an important role in the understanding of complex forms of life involving humans, animals and plants. Biology helps individuals understand the interaction between humanity and the world. It also develops interests in the lives of living organisms in an effort to preserve them. Studying biology is the foundation of all characteristics of life on earth (Idika, Ovat, Achighe, & Udumo, 2019). Apart from creating solutions to the challenges many living organisms face, it paves the way for inventions and discoveries that improve the quality of life. Biology can also be appreciated by the advances in the improvement of food supply and elimination of hereditary diseases. Biology is a science-oriented course; thus, it has developed advancement as it concerns the field of forensic science, genetic engineering and machines. In spite of its importance, however, the performance of students has degenerated at higher level of secondary schools (2008). In recent years, students' academic performance or achievements in senior secondary certificate examination (SSCE), the decline in academic accomplishments of students in Biology is reflected yearly in students' results published by the examination bodies. Dinah (2013) concluded that, availability of text books, laboratory apparatus and other learning resources contribute significantly to the performance of students in Biology Examination. He added that, students with positive attitude towards the subject, register better performance than those who had a negative attitude. Those with positive attitude are motivated to work hard and this is reflected in the good marks scored in the examination. The search for a more effective approach for the acquisition of process skills has persisted over the years. This is because, the acquisition of science process skills are the bases for scientific inquiry and the development of intellectual skills and attitudes that are needed to learn concepts (Udumo, Uba, Nwabiuke, Elemi, Emmanuel, Eze, Odumegwu 2020). Nwosu in Ibe (2004) asserted that science process skills are abilities which can be developed by experience and used in carrying out mental and physical operations.

According to Ibe (2004), the American Association for the Advancement of Science (AAAS) developed a program known as ‘Science A Process Approach’ (SAPA). This program sees science processes as the essence of science. The problem of poor performance in science subjects is global as indicated by studies done by Valverde and Schmidt (1997) in USA, Landry (1998) in Canada, Fonseca and Conboy (2006) in Portugal, indicates that the root causes of the students’ poor performance in Biology are namely: English language as medium of instruction, insufficient laboratory equipment, insufficient teaching and learning materials, inappropriate teaching methodology, amount of content and time allocated, inadequate involvement of parents in learners’ education, poverty, students’ absenteeism and school environment. This research therefore seeks to elaborate more on these low performance of biology through this topic: “effect of use of practical approach on learners’ academic performance in selected topics of biology in secondary schools in Turbo Sub-County Uasin Gishu county, Kenya.”

The critical role of science education, particularly Biology, in fostering informed citizens and driving national development cannot be overstated (Organisation for Economic Co-operation and Development [OECD], 2018). Globally, there's a growing recognition that effective science education goes beyond rote memorization of facts; it emphasizes the development of scientific literacy, critical thinking, and problem-solving skills (National Research Council [NRC], 2012). This shift is driven by the increasing complexity of global challenges, such as climate change, pandemics, and food security, all of which require a scientifically literate populace to address effectively.

However, despite this universal acknowledgment of science's importance, consistent challenges persist in biology education worldwide. One recurring issue is the perceived abstract nature of many biological concepts, which can make it difficult for students to connect theoretical knowledge to real-world phenomena (Osborne & Dillon, 2008). This abstractness is often compounded by traditional teaching methods that heavily rely on lectures and textbooks, limiting opportunities for hands-on engagement and experiential learning (Anderson, 2007). The result is often a lack of conceptual understanding, disengagement among students, and ultimately, poor academic performance.

The Programme for International Student Assessment (PISA) reports, conducted by the OECD, consistently highlight disparities in science performance across different countries and educational systems (OECD, 2018). While some high-performing nations demonstrate robust science education systems, many others struggle to equip their students with the necessary scientific competencies. These reports often point to factors such as teacher quality, curriculum design, and the availability of resources, including laboratory facilities and practical equipment, as significant determinants of student achievement in science.

Furthermore, a significant body of research globally underscores the importance of practical work in science education. Practical activities are widely recognized for their potential to enhance conceptual understanding, develop scientific process skills, foster positive attitudes towards science, and stimulate critical thinking (Abrahams & Millar, 2008; Hofstein & Lunetta, 2004). When students are actively involved in experiments, observations, and data analysis, they move beyond passive reception of information to active construction of knowledge. This constructivist approach to learning is particularly relevant in biology, where understanding complex biological processes often requires direct manipulation of materials, observation of living organisms, and interpretation of experimental results.

However, the effective implementation of practical work remains a challenge in many educational contexts. Resource constraints, including inadequate laboratory infrastructure, insufficient equipment, and a lack of consumable materials, frequently hinder the ability of schools to provide meaningful practical experiences (National Academies of Sciences, Engineering, and Medicine [NASEM], 2019). Additionally, teacher competency in designing, facilitating, and assessing practical activities is crucial. Many teachers, particularly in resource-limited settings, may lack the training or confidence to move beyond cookbook-style experiments to more inquiry-based approaches that genuinely foster scientific thinking (Tytler, 2007).

The language of instruction also plays a critical role, particularly in contexts where English is not the students' first language but is used as the medium for science instruction (Brock-Utne, 2007). This linguistic barrier can impede comprehension of complex scientific terminology and concepts, further exacerbating learning difficulties. Students may struggle to articulate their understanding or engage effectively in discussions and practical activities if they are simultaneously grappling with language acquisition.

Moreover, the sheer volume of content in biology curricula in many countries often pressures teachers to rush through topics, leaving little time for in-depth practical investigations or extended inquiry-based projects (Supovitz & Turner, 2000). This emphasis on content coverage over conceptual understanding can lead to superficial learning and an inability to apply biological knowledge to novel situations.

In response to these global challenges, educational reforms worldwide have increasingly emphasized the need for more student-centered and inquiry-based approaches to science education (Bybee, 2014). Many curricula are being redesigned to integrate practical work more effectively, moving away from isolated experiments towards more coherent sequences of investigations that build upon students' prior knowledge and skills. The aim is to cultivate not just knowledge, but also the skills and attitudes necessary for lifelong learning and scientific engagement. This global trend towards practical and inquiry-based learning serves as a foundational context for understanding the specific challenges and opportunities within African and Kenyan biology education.

2.1.2 Biology Education in Africa: A Continental and West African Perspective

Biology education in Africa faces numerous historical, systemic, and socio-economic challenges that impede effective teaching and learning. Although the continent is endowed with vast biodiversity and depends heavily on biological knowledge for addressing public health, agricultural productivity, and environmental sustainability, the quality of biology education remains inconsistent across many African countries (UNESCO, 2015).

A recurring challenge is the acute shortage of qualified science teachers across the continent, particularly in rural areas. Many teachers lack specialized pedagogical skills needed to effectively deliver practical biology lessons (Ogunleye, 2002). Consequently, teaching is often theoretical, heavily lecture-based, and limited in hands-on experiences.

It has been observed that poor performance in the field of science is caused by the poor quality of science teachers, overcrowded classrooms and lack of suitable and adequate science equipment among others. Students perform poorly in biology because; the biology classes are usually too large and heterogeneous in terms of ability level. Snezana et al. (2011) outlined in his study that academic achievement in lessons began with experiment or slide demonstration was higher than lessons beginning with lecture method. In addition, the laboratories are ill-equipped and the Biology syllabus is over loaded (Ajayi, 1988).

Furthermore, the problem of inadequate infrastructure and resources is widespread across many African secondary schools. Laboratories are often non-existent, poorly equipped, or lack essential consumables (Sifuna & Otiende, 2009). This dearth of resources severely restricts opportunities for practical work, forcing teachers to resort to chalk-and-talk methods or simulated experiments that do not provide the same experiential learning benefits. The limited availability of textbooks and other learning materials further compounds the challenge, as students have limited access to supplementary resources that could enhance their understanding.

Teaching Biology in West Africa: Insights from Nigeria

The Federal Republic of Nigeria (1998) refers to secondary education as the education given in institutions for children aged 11 to 16 years old. It further stresses that since the tertiary education system is built upon it; the secondary level is the key to the success or failure of the whole national educational system. In other words, the secondary education is the second tier of the 6-3-3-4 educational system which is for six years duration in Nigeria. According to Adepoju (1998) secondary education in the type of education, which is exposed to children in secondary institution, where the students acquire fundamental knowledge, skills, thought, feelings and actions, which are considered necessary for all citizens, regardless of social status, vocation or sex. It should be noted that secondary education has direct impact on development because of the cognitive skills of literacy. As from 1960, the country witnessed a considerable expansion in secondary education and major reorganization. In northern Nigeria, middle schools were dissolved, and sixth forms were introduced. Schools of basic and preliminary studies were also introduced. By year 1980/81, the first graduates of UPE scheme were turned out but these increased the number of candidates for secondary school. This facilities equipment and teaching aids were heavily expanded to cater for the population. For example, there are 161 secondary schools in 1955, 275 in 1956, 297 in 1957, 303 in 1958, 305 in 1959 and 311 in 1960. Immediately after independence, the various regional governments addressed this issue by establishing more secondary schools. Thus, some of two decades after independence, the figures of secondary schools in the country had risen to 1928 in 1977/78, 2,249 in 1978/79, 2,778 in 1979/80 (Osokoya, 1989). The sharp rise in the figures is the result following by in adequate and in proper planning. This oversight is by the large one of the major contributing factors to the still ensuring deterioration in quality and efficiency of secondary education delivery.

Despite the prime position Biology occupies in the Rwandan education system, and numerous advantages derivable from the study of Biology for both individuals and nation, it is worthless to note that students are still performing poorly in Biology compared to the other science subjects especially in National Examinations (MINEDUC, 2012). Besides, this poor performance cuts across almost all districts in Rwanda. This is attested by the results of the Ordinary Level National Examinations over the past years. For instance, Ntawiha (2016) found that Biology (mean=3.8) was less performed in S3NE compared to Chemistry (mean=4.9) and Physics (mean=5.6) among public secondary schools in the Nyarugenge and Nyamasheke districts of Rwanda. The low students' academic performance in Biology Ordinary Level National Examination has prevented the majority of students to be admitted into the most desirable boarding schools. It has also aborted their ambition to study biology-related combinations at the advanced secondary level. This ends up by reducing the number of students to be enrolled in tertiary education in science-related courses. This situation has raised problems with much attention from different educational stakeholders as they agree that the input in education has not yielded the desired outcomes. This is so because, the academic performance at all levels of education in Rwanda is regarded in terms of the passes in the National Examinations; the number of students who obtained certificates as well as the number of students who got admission to the further educational levels (Harerimana et al., 2017). Various studies have attached poor students' academic performance in Rwanda to several factors. For instance, Ndihokubwayo (2017) concluded that the inadequacy of laboratory equipment contributes to poor quality teaching and learning. Also, Nzabalirwa and Nkiliye (2012); Nizeyimana and Nkiliye (2015), Rubagiza et al. (2016) postulated that lack of sufficient instructional materials, untrained and demotivated teachers are among the factors that have lowered the quality of teaching and therefore students' performance, especially in most rural 12 Year Basic secondary schools in Rwanda. Moreover, researchers like Lackamp (2016), Bagabe (2015) Pearson (2014), Sibomana (2014) reported the medium of instruction as a driving factor for lower students' performance. Hence this study intends to examine the “effect of use of practical approach on learners’ academic performance in selected topics of biology in secondary schools in Turbo Sub-County Uasin Gishu county, Kenya.”

This often leads to a reliance on theoretical instruction, where concepts are taught without sufficient practical reinforcement, thereby hindering deep understanding.

Overcrowded classrooms are another significant impediment to effective biology teaching in many African countries (Okebukola, 2004). Large class sizes make it difficult for teachers to provide individualized attention, manage practical activities safely, and assess students' practical skills effectively. The heterogeneity of ability levels within these large classes also poses a challenge, as teachers struggle to cater to the diverse learning needs of their students. This often leads to a "one-size-fits-all" approach that fails to engage or adequately support all learners.

Other African Contexts

Curriculum design in some African contexts also contributes to the problem. Syllabi can be overly ambitious, attempting to cover a vast amount of content within limited timeframes, leaving little room for in-depth exploration or practical application (Ogunniyi, 1995). This pressure to complete the syllabus often forces teachers to prioritize content delivery over the development of critical thinking and practical skills. Consequently, students may acquire fragmented knowledge without truly understanding the interconnectedness of biological concepts or their real-world relevance.

The medium of instruction, as highlighted in the Rwandan context, is a recurrent issue across many Anglophone and Francophone African countries. Where English or French is the language of instruction for science subjects, students who have been educated in their local languages at primary level often face a significant linguistic barrier (Probyn, 2009). They struggle to comprehend complex scientific terminology, participate effectively in classroom discussions, and articulate their understanding in the examination setting. This can lead to a misdiagnosis of their conceptual understanding, with language proficiency being mistaken for a lack of scientific ability.

Sociocultural factors also play a role. In some communities, there may be a prevailing perception that science subjects are inherently difficult or only for academically gifted students (Jegede, 2007). This can lead to a lack of motivation among students and disinterest in pursuing biology-related fields. Parental involvement in education, particularly in science, can also be limited due to various socio-economic factors, further impacting student support and engagement.

Despite these challenges, there is a growing recognition across Africa of the need to strengthen science education, including biology, to drive economic development and address continental challenges. Many governments and educational stakeholders are investing in initiatives aimed at improving teacher training, providing more resources for laboratories, and revising curricula to promote more practical and inquiry-based learning (African Union Commission, 2017). The focus is increasingly shifting towards developing critical thinking, problem-solving, and scientific literacy skills that are essential for innovation and sustainable development. However, significant work remains to be done to ensure that all African students have access to high-quality biology education that prepares them for the complexities of the 21st century.

2.1.3 County and Sub-County (Kenya)

The Vision 2030 aims to transform Kenya into a middle-income country offering its citizens a high quality of life in a safe and secure environment. Both the social and economic pillar in the vision 2030 has strong links with Biology subject. The Social Pillar of Vision 2030 aims at investing in the people of Kenya through high quality education and training, water and sanitation, housing, social equity, better care of the environment, poverty reduction, gender equity and support for vulnerable groups in society such as the physically handicapped. The quality of education can only be raised if the teaching and learning of science subjects in schools and colleges is properly done. Most of the tenets in the social pillar are linked to Biology and therefore quality teaching and training in Biology is expected in order to achieve better water and sanitation, care of the environment for instance control of pollution, deforestation, human diseases (GoK, 2017).

Maina (2015) aimed at determining influence of competence in procedure, execution, observation and interpretation skills on performance in practical Biology and subsequently performance in Form Three students in Kiambu County as represented by sample drawn from Thika West Sub-County (TWSC). The findings of the study unearthed a significant relationship between students' competence in practical skills and performance that is ultimately reflected in KCSE results. The findings indicate that competence is highest in observation skills and low in execution, and interpretation skills. This study recommends teachers to use methodology that facilitates competence in these skills.

A study by Mutua (2015) in Machakos - Kathiani Sub-County was done on the relationship between learning styles and academic achievement among secondary school students in Kenya. Mutua found that there was positive and statistically significant relationship between learning styles and academic achievement for the trimodal learners, and among male and female students. However, analysis of specific learning styles and the effect of mismatch of teaching styles to preferred learners' styles have not been done in Kenya. The traditional way of teaching sciences in Kenyan secondary schools is the use of ASEI-PDSI (Activity-focused Student–centred learning

Experiment Improvisation - Plan, Do, See, Improve) approach which continue to yield unsatisfactory performance (Makewa et al., 2011).

The Economic Pillar aims at a rapid growth rate averaging 10 percent annually, driven by flagship projects all over the republic. These projects will be in key sectors like agriculture, manufacturing, tourism, wholesale and retail trade, business processes off-shoring, and the financial sector. Not only will these projects change the economic face of Kenya, but they have been selected on the basis of their ability to provide gainful employment to our people. Biology is also important here because agriculture and tourism involve flora and fauna and therefore provides a base for careers in these fields hence providing employment. Food processing and technology in manufacturing industry has its base from Biology and chemistry. With low performance in sciences and specifically Biology the country will not attain the goals for vision 2030. This calls for quality teaching and learning in our schools in the biology subject (Oyoo, 2010) hence this research the effects of use of practical approach on learners' academic performance in selected topics in biology in form 2 in Turbo sub-county, Uasin Gishu county, Kenya seeks to fill the gap.

Kenya, like many other developing nations, places significant emphasis on science education as a cornerstone for achieving its national development goals, particularly those outlined in Vision 2030. The recognition of Biology's central role in areas such as health, food security, environmental conservation, and biotechnology underscores the urgency of improving its teaching and learning outcomes (Kenya National Examinations Council [KNEC], 2018). However, despite policy pronouncements and curriculum reforms, persistent challenges continue to plague biology education in Kenyan secondary schools, contributing to a cycle of low academic performance.

One of the primary concerns is the consistent poor performance of students in national examinations, particularly the Kenya Certificate of Secondary Education (KCSE) Biology paper (KNEC, 2018). Analysis of these results often reveals widespread difficulties in answering questions that require higher-order thinking skills, application of knowledge, and interpretation of experimental data, pointing to a fundamental weakness in conceptual understanding rather than just rote memorization. This deficiency is often attributed to the prevalent teaching methodologies employed in classrooms.

Traditional teaching methods, largely teacher-centered and didactic, remain dominant in many Kenyan secondary schools (Orodho, 2014). Lectures, note-taking, and textbook reliance are common, with limited opportunities for students to actively engage with biological concepts through hands-on activities, experiments, or inquiry-based learning. While the Kenyan curriculum, particularly through the ASEI-PDSI approach, advocates for practical and student-centered learning, its effective implementation often falls short (Makewa et al., 2011). This gap between policy and practice contributes significantly to students' disengagement and a superficial understanding of biology.

The issue of inadequate laboratory facilities and resources is particularly acute in public secondary schools, especially in rural and marginalized areas (Indimuli, 2016). Many schools lack well-equipped laboratories, essential chemicals, apparatus, and even basic biological specimens. This forces teachers to either forgo practical sessions entirely or resort to theoretical explanations of experiments, which deprives students of crucial experiential learning. Even in schools with some facilities, the equipment may be outdated, insufficient for large class sizes, or poorly maintained. This resource scarcity directly impacts the quality of practical work and, consequently, students' ability to develop practical skills.

Teacher competency and professional development also emerge as critical factors. While teachers are trained in pedagogy, continuous professional development specifically in practical biology skills and innovative teaching methodologies is often limited (Republic of Kenya, 2018). Some teachers may lack confidence in conducting certain practicals, or they may not be adequately trained in facilitating inquiry-based learning, leading them to revert to familiar, less effective methods. This underscores the need for targeted training programs that equip teachers with the necessary skills to implement practical approaches effectively, even with limited resources.

Overcrowding in classrooms, a characteristic of many Kenyan public schools, further complicates the delivery of practical biology (Mwiria & Ng'ethe, 2002). Managing a large number of students during practical sessions, ensuring safety, and providing individual guidance become logistical nightmares for teachers. This often leads to a reduction in the frequency and complexity of practical activities, impacting the quality of learning.

Moreover, the emphasis on national examinations often inadvertently encourages teaching to the test, where the focus shifts from genuine understanding and skill development to memorizing facts for examination purposes (Wamari, 2013). This examination-driven culture can de-emphasize the importance of practical work, as its direct contribution to examination scores might not be immediately apparent to students or teachers, leading to its neglect.

Regional disparities in educational outcomes in Kenya are also a concern. Students in urban areas and well-resourced private schools often have better access to qualified teachers, modern facilities, and a wider range of learning resources, which contribute to their higher performance in biology compared to their counterparts in rural or less privileged schools (Koech, 2002). This creates an inequitable playing field and perpetuates educational disparities.

Despite these challenges, various stakeholders, including the Ministry of Education, Kenya Institute of Curriculum Development (KICD), and non-governmental organizations, are actively working towards improving science education. Initiatives promoting teacher training, provision of teaching and learning materials, and encouraging innovative teaching methods are underway. The ongoing curriculum reforms, particularly the Competency-Based Curriculum (CBC), aim to shift towards more practical, experiential, and learner-centered approaches, which holds promise for transforming biology education in the country (KICD, 2017).

However, the success of these reforms hinges on addressing the fundamental issues of resource allocation, teacher capacity building, and a cultural shift towards valuing practical skills and conceptual understanding over mere rote learning. The current research focuses on Turbo Sub-County, Uasin Gishu County, which, like many other regions in Kenya, is likely to face similar challenges in implementing practical approaches in biology education. By examining the "effect of use of practical approach on learners' academic performance in selected topics of biology in secondary schools in Turbo Sub-County Uasin Gishu county, Kenya," this study aims to contribute to a deeper understanding of these localized challenges and provide evidence-based recommendations for improvement, ultimately contributing to the broader goal of achieving Vision 2030 through enhanced science education.

2.2 Theoretical Literature

The theoretical underpinnings of this study are largely rooted in constructivist learning theories, particularly those advanced by Jean Piaget and Lev Vygotsky, and further supported by experiential learning theory by David Kolb. These theories emphasize the active role of the learner in constructing knowledge, rather than passively receiving it.

2.2.1 Constructivism

Constructivism posits that learners actively construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences (Piaget, 1954). Instead of passively absorbing information, individuals build knowledge and meaning from their experiences. In the context of biology education, this means that students learn best when they are actively engaged in hands-on activities, experiments, and problem-solving, rather than merely listening to lectures or reading textbooks.

Piaget's Theory of Cognitive Development focuses on how individuals build cognitive structures (schemas) through processes of assimilation and accommodation (Piaget, 1954). Assimilation involves fitting new information into existing schemas, while accommodation involves modifying existing schemas or creating new ones to incorporate new information. Practical work in biology provides concrete experiences that can challenge existing schemas and necessitate accommodation, leading to deeper and more robust understanding. For instance, dissecting an organ allows students to move beyond a two-dimensional diagram and construct a more accurate and detailed mental model of its structure and function. The discrepancies between their initial assumptions and actual observations drive cognitive disequilibrium, which motivates learning.

Vygotsky's Sociocultural Theory emphasizes the role of social interaction and culture in cognitive development (Vygotsky, 1978). He introduced the concept of the Zone of Proximal Development (ZPD), which refers to the difference between what a learner can do independently and what they can achieve with the guidance and collaboration of more knowledgeable others (e.g., teachers or peers). Practical activities in biology often involve collaboration, discussion, and peer learning, allowing students to learn from each other and from the teacher's scaffolding within their ZPD. For example, working in groups on a dissection or an ecological field study encourages discussion, negotiation of ideas, and shared problem-solving, all of which contribute to the co-construction of knowledge. The teacher's role becomes that of a facilitator and guide, providing support and posing challenging questions rather than simply delivering information. This collaborative aspect of practical work is crucial, as it transforms learning into a social endeavor, mirroring the collaborative nature of scientific inquiry itself. Vygotsky's emphasis on tools and signs (including language and scientific instruments) also aligns with the use of laboratory equipment and scientific vocabulary in practical biology, which serve as mediating tools for understanding complex biological phenomena.

2.2.2 Experiential Learning Theory

Kolb's Experiential Learning Theory (ELT) provides a framework for understanding how individuals learn from experience. It proposes a four-stage learning cycle: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation (Kolb, 1984).

- ✓ **Concrete experience:** This is the initial stage where the learner encounters a new experience or reinterprets an existing one. In biology, this could be performing a dissection, observing cells under a microscope, or conducting a field study.

- ✓ **Reflective observation:** In this stage, the learner reflects on the experience, considering what happened, why it happened, and what it means. This involves critical thinking and analysis of the observations made during the practical activity.

- ✓ **Abstract conceptualization:** Here, the learner forms new ideas or modifies existing abstract concepts based on their reflections. They try to make sense of their experience by connecting it to existing theoretical frameworks or developing new ones. For example, after observing plant cells, students might abstract the concept of photosynthesis and how it relates to chloroplasts.

- ✓ **Active experimentation:** Finally, the learner applies these new ideas to new situations, testing their hypotheses and further refining their understanding. This could involve designing new experiments, solving related problems, or applying the learned concepts to real-world scenarios.

The practical approach in biology aligns perfectly with Kolb's model. Practical activities provide the concrete experience, while post-practical discussions, lab reports, and teacher feedback facilitate reflective observation. The process of drawing conclusions and connecting observations to biological principles leads to abstract conceptualization, and the application of these concepts in new problems or further investigations completes the cycle through active experimentation. Therefore, a well-designed practical biology lesson should guide students through all these stages, ensuring a holistic learning experience. The iterative nature of this cycle suggests that learning is not a linear process but rather a continuous spiral of experience, reflection, conceptualization, and experimentation. This cyclical process promotes deep learning and the development of transferable skills, which are crucial for scientific inquiry.

2.2.3 Theory of Meaningful Learning

While often seen as contrasting with constructivism, Ausubel's Theory of Meaningful Learning (Ausubel, 1968) provides another relevant theoretical lens, particularly when considering the role of prior knowledge in practical learning. Ausubel argued that meaningful learning occurs when new information is related to existing knowledge in a non-arbitrary, substantive way. He emphasized the importance of "advance organizers" – introductory materials that help learners connect new information to what they already know.

In the context of practical biology, meaningful learning is enhanced when practical activities are not isolated events but are explicitly linked to theoretical concepts and students' prior knowledge. Teachers can use pre-lab discussions or theoretical introductions as advance organizers to activate relevant prior knowledge and provide a conceptual framework for the practical experience. This helps students to integrate their observations and experimental data into a broader understanding of biological principles, rather than just performing isolated tasks. When practical work is seen as a way to verify, illustrate, or extend theoretical knowledge, it becomes more meaningful and impactful. Without this connection, practical activities can devolve into mere "cookbook" exercises that offer little cognitive benefit. Ausubel's theory thus highlights the importance of instructional design that bridges the gap between concrete practical experiences and abstract biological concepts, ensuring that students can integrate new information into their existing cognitive structures.

2.2.4 Cognitive Load Theory

Cognitive Load Theory (Sweller, 1988) offers insights into how the design of instruction and learning activities can impact cognitive processing and learning effectiveness. It posits that working memory has limited capacity, and excessive cognitive load can impede learning. Cognitive load can be intrinsic (related to the inherent complexity of the material), extraneous (due to poor instructional design), or germane (related to schema construction and automation).

In practical biology, the complexity of procedures, unfamiliar equipment, and the need to observe and record data simultaneously can impose significant intrinsic and extraneous cognitive load. If practical tasks are overly complex or poorly structured, students might be overwhelmed, leading to superficial learning or frustration. A practical approach, when designed effectively, can reduce extraneous cognitive load by making abstract concepts concrete and providing clear, step-by-step guidance. However, if poorly implemented (e.g., complex instructions, disorganized lab spaces, lack of clear objectives), practical work can increase extraneous load, diverting cognitive resources away from germane processing (the actual learning of biological concepts). Therefore, designing practical activities with manageable steps, clear instructions, and appropriate scaffolding (e.g., demonstrations, pre-lab activities, guided questions) is crucial to optimize learning and prevent cognitive overload. The goal is to maximize germane load, encouraging deep processing and schema formation, while minimizing intrinsic and extraneous load through careful instructional design.

2.2.5 Self-Efficacy Theory

Bandura's Self-Efficacy Theory (Bandura, 1997) proposes that an individual's belief in their ability to succeed in specific situations or accomplish a task plays a significant role in their motivation, behavior, and ultimate performance. High self-efficacy is associated with greater effort, persistence, and resilience in the face of challenges.

In the context of practical biology, successful engagement in hands-on activities can significantly enhance students' self-efficacy. When students successfully manipulate equipment, perform experiments, and observe expected results, they gain a sense of mastery and competence. This positive experience can build their confidence in their ability to learn and perform well in biology. Conversely, if practical activities are poorly structured, lead to repeated failures, or are perceived as overwhelmingly difficult, they can diminish students' self-efficacy, leading to avoidance or disengagement. Therefore, effective practical approaches should be designed to provide opportunities for success, even incremental ones, and to provide constructive feedback that reinforces students' capabilities. Encouraging collaboration and peer support during practical sessions can also contribute to a sense of collective efficacy, where students feel more confident in their ability to achieve goals together. Ultimately, fostering high self-efficacy through well-designed practical experiences can translate into increased motivation and improved academic performance in biology.

These theories collectively highlight the pedagogical advantages of a practical approach in biology education. By actively engaging learners, fostering social interaction, connecting new information to prior knowledge, managing cognitive load, and building self-efficacy, practical work can create a rich and effective learning environment that goes beyond mere factual recall, leading to deeper conceptual understanding and improved academic performance.

2.3 Related Studies

The efficacy of practical approaches in science education, and specifically in biology, has been a subject of extensive research globally, regionally, and locally. This section reviews various studies that shed light on the impact of hands-on activities, laboratory work, and inquiry-based learning on students' academic performance, conceptual understanding, and development of scientific skills.

2.3.1 Global Studies on Practical Approach and Performance

Globally, a substantial body of literature supports the positive impact of practical approaches on learning outcomes in science. Research consistently indicates that direct engagement with scientific phenomena enhances students' understanding, retention, and ability to apply scientific concepts.

For instance, a meta-analysis by Mayer (2009) on multimedia learning principles, while not exclusively focused on practical work, strongly advocates for learning by doing and the integration of visual and verbal information. His findings suggest that active processing, often facilitated by hands-on activities, leads to deeper comprehension and better transfer of knowledge. In the context of biology, seeing and manipulating specimens or conducting experiments allows students to build mental models that are more robust than those formed through passive reception of information.

Hofstein and Lunetta (2004), in their comprehensive review of the role of the laboratory in science teaching, concluded that well-designed laboratory experiences can significantly contribute to students' conceptual understanding, mastery of scientific processes, and development of positive attitudes towards science. They argued that the laboratory is a unique learning environment where students can engage in authentic scientific inquiry, thereby fostering critical thinking and problem-solving skills.

However, they also cautioned that merely performing experiments without explicit instructional guidance and opportunities for reflection may not automatically lead to desired learning outcomes. The effectiveness, they emphasized, lies in the quality of the practical experience, including clear objectives, pre-lab preparation, and post-lab discussions.

A study by Abrahams and Millar (2008), based on observations in UK secondary schools, found that while practical work is highly valued by teachers and students, its effectiveness in achieving learning goals varies. They distinguished between practical work aimed at developing practical skills (e.g., manipulating apparatus) and that aimed at developing conceptual understanding. Their research suggested that for practical work to effectively enhance conceptual understanding, there needs to be a strong cognitive link between the "doing" and the "learning," with clear objectives and structured opportunities for students to make sense of their observations in relation to scientific theories. This highlights the importance of pedagogical design in maximizing the impact of practical activities.

Furthermore, Tamir (1991), drawing on various international studies, emphasized that practical work is essential for developing a wide range of scientific skills, including observation, measurement, interpretation of data, and drawing conclusions. He argued that these process skills are fundamental to scientific literacy and are best acquired through direct, hands-on experience. His work underscored that without practical engagement, students often struggle to grasp the empirical nature of science.

The National Research Council (2012) in the United States, in their report "A Framework for K-12 Science Education," strongly advocates for the integration of scientific practices (which include designing and carrying out investigations, analyzing and interpreting data, and constructing explanations) with disciplinary core ideas and crosscutting concepts. This framework posits that students learn science effectively when they engage in the practices of science, much like scientists do, rather than simply learning about science. This global recommendation underscores the shift towards more inquiry-based and practical approaches as central to modern science education.

Studies in Asia have also echoed these findings. For instance, Cheung (2009), in a review of science education in Hong Kong, noted that incorporating more practical work and inquiry-based learning approaches led to improvements in students' scientific literacy and problem-solving abilities. He highlighted the need for adequate resources and teacher training to support such pedagogical shifts. Similarly, research in Singapore, a high-performing nation in science education, emphasizes the strong integration of practical work and inquiry-based learning in their science curriculum, contributing to their students' strong conceptual understanding and scientific reasoning skills (Tan, 2017).

However, it is important to acknowledge that not all global studies unequivocally report positive impacts, especially if practical work is poorly implemented. For instance, some research points to the challenge of "cookbook" laboratories where students follow instructions without deep understanding, leading to limited cognitive gains (Kirschner & Huisman, 2017). This emphasizes that the *quality* and *pedagogical design* of practical work are more crucial than its mere presence. Effective practical work requires clear learning objectives, opportunities for critical thinking, and structured reflection.

The global consensus, therefore, is that while practical approaches are vital for effective science education, their success is highly dependent on careful planning, adequate resourcing, and skilled instructional delivery. These global perspectives provide a valuable backdrop for understanding the challenges and opportunities within the African and Kenyan contexts, where similar issues of resource constraints and pedagogical approaches often arise.

2.3.2 African Studies on Practical Approach and Performance

Across the African continent, the importance of practical work in science education is widely acknowledged, yet its implementation faces significant challenges. Numerous studies highlight the gap between the perceived value of practical approaches and the reality of classroom practices.

A study by Okebukola (2004) in Nigeria, for instance, extensively reviewed the state of science education in the country. He concluded that despite policy emphasis on practical work, many secondary schools lacked the necessary laboratory facilities, equipment, and qualified personnel to conduct meaningful practical activities. This led to a situation where teachers resorted to theoretical teaching, often using diagrams and verbal descriptions instead of actual experiments, which significantly impacted students' understanding and performance in practical-oriented examination questions. Okebukola stressed that the absence of hands-on experiences left students with a superficial understanding of scientific concepts.

Similarly, Gambari, Olasehinde, and Adewumi (2014), also in Nigeria, investigated the effect of computer-assisted instruction (CAI) on students' performance in biology. While their study focused on technology, their findings implicitly underscored the need for alternative practical methods in contexts where physical laboratories are limited. They found that CAI could improve performance, suggesting that innovative approaches are needed to bridge the gap left by insufficient traditional practical work.

In Ghana, Anamuah-Mensah, Mereku, and Asabere-Ameyaw (2004), in their report on the quality of science education, identified the lack of practical activities as a major contributing factor to poor performance in science subjects. They highlighted overcrowded classrooms, insufficient funding for science equipment, and inadequate teacher training as primary impediments to effective practical instruction. Their recommendations included increased investment in laboratories and continuous professional development for science teachers to enhance their capacity in facilitating hands-on learning.

A study in Uganda by Namubiru (2011) examined the impact of practical work on students' conceptual understanding in biology. The findings revealed that students exposed to more practical activities demonstrated a significantly better understanding of biological concepts compared to those who received predominantly theoretical instruction. However, the study also pointed out that many schools struggled to implement practical work due to limited resources and a curriculum that was often too broad, leaving little time for in-depth practical investigations.

Ntawiha (2016), as cited in the introductory section, found that Biology was less performed in S3NE in Rwanda compared to Chemistry and Physics. This aligns with other studies from Rwanda, such as Ndihokubwayo (2017), who explicitly linked the inadequacy of laboratory equipment to poor quality teaching and learning in science subjects. **N**zabalirwa and Nkiliye (2012), and Nizeyimana and Nkiliye (2015) further corroborated this, highlighting the lack of sufficient instructional materials, untrained and demotivated teachers as critical factors contributing to low student performance. These studies collectively paint a picture of a systemic challenge where the aspiration for practical-based learning is often unmet due to a confluence of resource constraints and pedagogical deficiencies.

The challenge of language as a medium of instruction, as noted by Lackamp (2016), Bagabe (2015), Pearson (2014), and Sibomana (2014) in Rwanda, is also a pervasive issue across Anglophone and Francophone Africa. When students are taught complex biological concepts in a second or third language, their cognitive load increases, making it harder to process new information and engage meaningfully with practical tasks. This linguistic barrier often masks genuine conceptual difficulties and hinders effective communication during practical sessions.

Despite these challenges, there are ongoing efforts and success stories. Some studies explore the use of locally available materials and improvisation to conduct practical work in resource-constrained environments. For example, Ogunleye (2002) discussed the potential of improvisation as a strategy to overcome the lack of conventional laboratory equipment in Nigerian schools. Such initiatives demonstrate the resilience and creativity of African educators in their pursuit of effective science education.

In summary, studies across Africa consistently identify the critical need for increased practical work in biology education to improve student performance and conceptual understanding. However, the consistent barriers remain: inadequate laboratory infrastructure, insufficient teaching and learning materials, overcrowded classrooms, a shortage of qualified and well-trained science teachers, and the pervasive challenge of language of instruction. Addressing these issues systematically is crucial for realizing the full potential of practical approaches in African biology classrooms.

2.3.3 Kenyan Studies on Practical Approach and Performance

In Kenya, the discourse around the effectiveness of practical approaches in biology education is particularly vibrant, driven by persistent concerns over students' performance in national examinations and the country's aspiration to achieve Vision 2030. Kenyan studies mirror many of the challenges observed globally and continentally, while also offering unique insights into the local context.

The Kenya National Examinations Council (KNEC) reports consistently highlight students' weaknesses in biology practical examinations and questions requiring higher-order thinking skills (KNEC, annual reports). This recurring trend suggests that students are not adequately developing the practical and analytical skills necessary for deep understanding.

Maina (2015), as previously cited, conducted a study in Kiambu County, specifically Thika West Sub-County, to investigate the influence of competence in procedural, execution, observation, and interpretation skills on performance in practical Biology. Her findings revealed a significant relationship between students' competence in these practical skills and their overall performance in KCSE Biology. Critically, Maina found that competence was highest in observation skills but significantly lower in execution and interpretation skills. This suggests that while students might be able to *see* what's happening during a practical, they struggle with *doing* it correctly and *making sense* of their observations to draw valid conclusions. This highlights a crucial gap that a more robust practical approach needs to address, moving beyond mere observation to active manipulation, analysis, and interpretation. Maina's recommendation for teachers to use methodologies that facilitate competence in these specific skills directly supports the rationale for this current study.

Mutua (2015), in Machakos - Kathiani Sub-County, explored the relationship between learning styles and academic achievement. While her study did not exclusively focus on practical approach, her finding of a positive and statistically significant relationship between trimodal learning styles (combining visual, auditory, and kinesthetic approaches) and academic achievement is highly relevant. Practical approaches intrinsically incorporate kinesthetic learning, and often visual elements, making them particularly beneficial for a broad range of learners. Mutua's observation that the effect of mismatch of teaching styles to preferred learners' styles had not been fully explored in Kenya further justifies investigations into varied methodologies, including practical ones, to cater to diverse learning needs.

Makewa et al. (2011) critically assessed the ASEI-PDSI (Activity-focused Student–centred learning Experiment Improvisation - Plan, Do, See, Improve) approach, which is the officially endorsed method for teaching sciences in Kenyan secondary schools. Their findings indicate that despite its theoretical soundness, the approach continues to yield unsatisfactory performance. This suggests a significant implementation gap. Reasons for this gap could include insufficient teacher training in fully implementing ASEI-PDSI, lack of resources for activity-based learning, or an examination system that does not adequately reward such approaches. This study thus underscores the need to investigate *how* practical approaches are being implemented and what factors hinder their effectiveness in the Kenyan context.

A study by Ochanda and Indoshi (2011) in Kisumu County investigated factors influencing students' performance in KCSE Biology. They found that teacher factors (qualifications, experience), resource availability (laboratory equipment, textbooks), and student attitudes were significant predictors of performance. Their findings corroborate the idea that resource scarcity directly undermines the ability to conduct effective practical work, leading to poorer outcomes.

Owuor (2012), in a study on teaching methods and students' academic performance in biology in Rachuonyo North Sub-County, Homa Bay County, found that while teachers were aware of student-centered methods, they predominantly used teacher-centered approaches due to factors such as large class sizes and pressure to cover the syllabus. This highlights the practical constraints that prevent teachers from adopting more practical, student-centered pedagogies, even when they recognize their benefits.

The issue of inadequate laboratory facilities and equipment has been consistently highlighted across various Kenyan studies. Indimuli (2016), in a comprehensive review of science education in Kenya, emphasized that many public secondary schools operate without functional laboratories, severely limiting opportunities for hands-on learning in biology. This often forces teachers to use theoretical explanations or simulated practicals, which fail to achieve the same learning outcomes as direct experimentation.

Furthermore, the influence of the examination system on teaching practices is a critical factor in Kenya. The high-stakes nature of the KCSE often pushes teachers to prioritize content coverage over pedagogical approaches that might foster deeper understanding but take more time (Wamari, 2013). This can lead to a reduction or superficialization of practical work, as its direct contribution to final grades might be perceived as less significant than mastering theoretical content.

However, there are also studies that demonstrate positive impacts when practical approaches are well-implemented in Kenya. For instance, some school-based initiatives focusing on improvisation and use of locally available materials have shown promising results in enhancing student engagement and understanding (Ominde, 2008). These localized successes suggest that with targeted interventions, resourcefulness, and effective teacher support, the challenges of implementing practical approaches can be mitigated.

In the context of Turbo Sub-County, Uasin Gishu County, this study aims to build upon these previous findings by specifically investigating the "effect of use of practical approach on learners' academic performance in selected topics of biology." It acknowledges the existing challenges in Kenya regarding resources, teaching methodologies, and examination pressures. By focusing on a specific sub-county, the research can provide more granular insights into the localized factors influencing the implementation and effectiveness of practical approaches, contributing to more targeted interventions for improving biology education in the region and potentially informing national policy. The identification of specific topics within biology further narrows the scope, allowing for a detailed analysis of how practical work influences learning in particular areas of the curriculum that may be inherently challenging for students.

2.4 Research Gap

The preceding literature review highlights a global consensus on the importance of practical approaches in biology education for fostering conceptual understanding, scientific skills, and positive attitudes. Studies from various continents, including Africa and Kenya, consistently identify common challenges such as inadequate laboratory facilities, overcrowded classrooms, insufficient teacher training in practical pedagogy, and the pressure of examination-oriented curricula that often prioritize theoretical content over hands-on experience.

While there is ample literature discussing the *problems* associated with a lack of practical work and general calls for its increased use, a significant research gap exists concerning the *specific effects* of implementing a practical approach on *learners' academic performance in selected topics in Biology* within defined local contexts, particularly in areas like Turbo Sub-County, Uasin Gishu County, Kenya.

Existing studies in Kenya, such as those by Maina (2015) and Makewa et al. (2011), have highlighted weaknesses in practical skills and the unsatisfactory outcomes of existing teaching methodologies like ASEI-PDSI. However, these studies often provide broad assessments of practical skills or general teaching approaches. There is a dearth of localized, empirical research that specifically isolates and measures the *impact of an increased use of practical approach* on student performance in *particular, challenging biology topics*. This specificity is crucial because the effectiveness of practical work can vary depending on the topic's nature and the specific learning objectives. For example, a practical approach to genetics might differ significantly in its design and impact from one on ecology or human physiology.

Furthermore, many studies tend to generalize about "practical work" without detailing the *nature* or *intensity* of the practical approach being implemented. The current literature often discusses the "lack of" or "need for" practical work but less frequently provides rigorous evidence on the *differential impact* of varied levels or types of practical engagement on specific learning outcomes in distinct content areas. What constitutes "increased use" of a practical approach needs to be empirically explored to understand its true effect.

The existing literature also points to a disconnect between policy and practice in Kenya regarding the implementation of student-centered and practical approaches. While the curriculum advocates for these methods, their actual manifestation in classrooms is often limited. This study aims to bridge this gap by examining the effect of *actual* *implementation* of an increased practical approach, rather than just the theoretical adoption, on student performance.

Specifically, the following gaps are identified that this research intends to address:

(i) **Lack of topic-specific impact assessment:** While general studies on practical work exist, there is a limited number of studies that specifically investigate the effect of practical approaches on performance in *selected, often challenging, topics in the Biology syllabus*. Understanding these topic-specific effects can provide valuable insights for curriculum developers and teachers on where to prioritize practical interventions.

(ii) **Context-specific empirical evidence:** There is a need for more empirical studies conducted within specific local contexts, such as Turbo Sub-County. Educational challenges and resources vary significantly even within a country. Generalizations from national or even county-level studies may not accurately reflect the unique dynamics of a sub-county. This study will provide localized data relevant to the specific socio-educational environment of Turbo Sub-County.

(iii) **Measurement of "increased use":** Previous research often notes the absence of practical work. This study seeks to investigate the *effect of an increased use* of a practical approach, implying a deliberate intervention or emphasis on practical activities. This allows for a clearer cause-and-effect relationship to be explored regarding the intensity of practical engagement.

(iv) **Integration of Practical skill development and conceptual understanding:** While Maina (2015) highlighted weaknesses in practical skills, there is a need for studies that directly link the improvement of these skills through practical engagement to overall academic performance in specific biology topics, rather than just in practical examinations. This study aims to explore this integrated impact.

(v) **Addressing the implementation gap:** Given the documented challenges in implementing the ASEI-PDSI approach (Makewa et al., 2011), this research will implicitly or explicitly contribute to understanding the factors that enable or hinder the successful integration of increased practical approaches within the real classroom settings of Turbo Sub-County.

By focusing on the "effect of use of practical approach on learners' academic performance in selected topics in biology in secondary schools in Turbo Sub-County Uasin Gishu county, Kenya," this study aims to provide specific, empirical, and contextually relevant evidence that will contribute to addressing the identified research gaps and inform targeted interventions to improve biology education.

2.5 Chapter Summary

This chapter has provided a comprehensive review of existing literature pertaining to the effect of the use of practical approaches on learners' performance in biology. The review commenced by establishing the global significance of biology education, highlighting its role in human development, environmental management, and fostering scientific literacy. It underscored the universal challenges of poor performance in science, including biology, attributing it to factors such as the abstractness of concepts, traditional teaching methods, and resource limitations. The importance of practical work as a means to enhance conceptual understanding, develop scientific skills, and promote positive attitudes towards science was emphasized through a global lens.

Subsequently, the review delved into the African context, revealing that many of the global challenges are amplified on the continent. Issues such as a severe shortage of qualified science teachers, inadequate laboratory infrastructure, overcrowded classrooms, curriculum overload, and the linguistic barrier of instruction were identified as significant impediments to effective biology education and practical implementation. Despite these hurdles, ongoing efforts to improve science education across Africa, often through innovative and localized solutions, were noted.

The review then narrowed its focus to the Kenyan context, linking the relevance of quality biology education to the national development goals outlined in Vision 2030. It acknowledged the persistent poor performance in KCSE Biology and attributed it to prevailing teacher-centered methodologies, a critical lack of functional laboratory facilities, and insufficient teacher training in practical pedagogy. Kenyan studies, such as those by Maina (2015) and Makewa et al. (2011), provided specific evidence of students' weaknesses in practical skills and the implementation gaps of mandated student-centered approaches like ASEI-PDSI.

The theoretical framework for the study was then established, drawing primarily from constructivist learning theories (Piaget and Vygotsky) and Kolb's Experiential Learning Theory. These theories collectively underpin the rationale for advocating a practical approach, emphasizing active knowledge construction, social interaction, and learning through a cycle of experience, reflection, conceptualization, and experimentation. Additional theories like Ausubel's Meaningful Learning and Bandura's Self-Efficacy Theory further reinforced the importance of connecting new knowledge to prior understanding and building learner confidence through successful practical engagements, while Sweller's Cognitive Load Theory provided a lens for optimizing the design of practical activities.

Finally, the chapter identified critical research gaps. While the literature generally supports the benefits of practical work, there is a distinct lack of empirical studies that specifically investigate the impact of an *increased use* of practical approaches on learners' performance in *selected, challenging topics in Biology* within particular local contexts, such as Turbo Sub-County. This study seeks to address this specificity and provide granular, contextually relevant evidence that can inform targeted interventions to enhance biology education in the region and beyond. The subsequent chapters will detail the methodology employed to investigate these gaps and present the findings.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

This chapter outlines the methodology that was used to conduct the study. It specifically presents the research design, target population, sampling design, research instruments validity and reliability of instruments, data collection procedure, data presentation, analysis and ethical considerations.

3.1 Research Philosophy

A research paradigm directs and helps articulate theories already established, as well as choice of research design, methods of data collection and analysis and the interpretations of the research findings (Kivunja & Kuyini, 2017). It is the choice of paradigm that sets down the intent, motivation and expectations for the research (Khaldi, 2017). The study was guided by a post-positivist paradigm**,** which acknowledges the existence of an objective reality while recognizing that it can only be understood imperfectly and probabilistically. Post-positivism departs from the strict determinism of positivism by accepting that knowledge is influenced by human limitations and context, and therefore can never be fully certain (Creswell, 2013). As Caldwell (2015) explains, post-positivist inquiry emphasizes critical reflection, empirical observation, and the continual revision of understanding, using theory not only to test and measure phenomena but also to refine interpretations in light of evidence.

3.2 Study Area

The study was carried out in selected secondary schools in Turbo Sub-County, Uasin Gishu County. The choice of the study area was informed by the researcher being a teacher in one of the schools. Turbo is located within Uasin Gishu County. There are 22 secondary schools in Turbo Sub-County which will be included in the study.

The choice of the study area was informed by the comparative analysis of Biology performance over the last five years as indicated in Table 3.1 which clearly shows Turbo sub-county to be trailing in performance as compared to other subcounties in Uasin Gishu county.

Table 3.1: Biology performance in Uasin Gishu (2018 -2022)

Year/Subcounty	2018 (Mean Grade)	2019 (Mean Grade)	2020 (Mean Grade)	2021(Mean Grade)	2022 (Mean Grade)
Soy	C-	D+	C	D+	C-
Turbo	D-	D	D+	D	D
Moiben	D+	C-	D+	D	D
Kesses	D+	C	C-	D+	D+
Ainabkoi	D	D	D	D	D
Kapseret	D-	D+	C	D	C-

Source, MOE, Uasin Gishu, 2023

3.3 Research Design

This study adopted a quasi-experimental research design and consisted of a pre-test/post-test control group design. According to Gopalan et al. (2020), quasi-experimental design aims to establish a cause-and-effect relationship between an independent and dependent variable. However, unlike a true experiment, a quasi-experiment does not rely on random assignment. Instead, subjects are assigned to groups based on non-random criteria. This study was designed with a pre-test and post-test to measure student performance in selected Biology topics before and after treatment. The study measured changes in student performance because of the treatments. This research design was chosen because it allowed the researcher to determine changes in student performance in the selected Biology topics.

The study used the one-group pre-test-post-test design involving three steps: (1) administering a pre-test measuring the dependent variable; (2) applying the experimental treatment *X* to the subjects; (3) administering a post-test, again measuring the dependent variable. Differences attributed to application of the experimental treatment were then evaluated by comparing the pre-test and post-test score.

This research study utilized a quantitative approach. A quantitative approach is one in which the investigator primarily uses postpositive claim for developing knowledge (i.e., cause and effect thinking, reduction to specific variables and hypotheses and question, use of measurement and observation, and the test of theories) employs strategies of inquiry such as experiment and survey and collect data on predetermined instrument that yield statistics data.

3.4 Target Population

In this study, the population of interest was Biology teachers and students. There are 22 secondary schools in Turbo Sub-County in Kenya. The 22 public secondary schools were targeted. The target population was form 2 Biology teachers and form 2 students in these schools. There were 57 Biology teachers in these secondary schools and a total of 1760 form 2 students. The accessible population was 1817 respondents.

Table 3.2 Target Population

Target population	Target number
Biology teachers	57
Form 2 students	1760
Total	**1817**

3.5 Sample Size and Sampling Procedures

According to Cooper and Schindler (2000), a researcher must clearly define the character of the population, determine the required sample size and choose the best method for selecting members of the sample from the larger population hence the sample size of the study was calculated using the formula below as recommended by Fisher et al. (2003):

$$nf = \frac{n}{1 + \frac{n}{N}}$$

Where;

nf = Sample size (when the population is less than 10,000).

n = Sample size (when the population is more than 10,000); 384.

N = Estimate of the population size; 1817.

Thus,

$$nf = \frac{384}{1 + \frac{384}{1817}} = 316$$

The sample size was 316 respondents.

Table 3.3 Sample Size

Target Population	Target number	Procedure	Sample size
Biology teachers	57	57/1817*316	10
Form 2 students	1760	1760/1817*316	306
Total	**1817**		**316**

Source: *Researcher, 2024*

The specific computations depicted in Table 3.3 above was done indicate proportional allocation of the sample size for the two categories of respondents namely the teachers and students.

3.6 Research Instruments

The study adopted the use of a questionnaire and written tests as the main data collection instruments.

3.6.1 Questionnaire

A questionnaire, as described by Sreejesh (2014), is fundamentally a structured series of questions presented to respondents during an interview, accompanied by clear instructions detailing the sequence and selection criteria. This tool holds significant versatility across various research domains, encompassing survey research and experimental design, providing researchers with a structured framework to gather insights systematically for data collection and analysis.

A questionnaire was used to collect the required information from the study population. By using self-administered questionnaire information about the strategies adopted to enhance the performance of Biology in teaching selected topics in secondary schools was obtained. The instrument also ensured the anonymity of respondents as their identities were not requested. The questionnaire was developed based on the literature review and reference was also made to the problem identified and objectives set. Questionnaires were administered to Biology teachers. Specifically, the questionnaires contained questions with regard to students' performance before and after the use of practical approach and also contained questions on teachers' perceptions on the use of practical approach in teaching selected topics in Biology in form 2.

3.6.2 Written Tests

Writing is the means by which students in educational settings present and display what they know. As students move through the schooling system, their competence in using writing for this purpose assumes greater importance. Some tests may examine the ability to write directly or the ability to write may impact indirectly by content being tested in essay form. The widespread use of written tests to select, place, certify, or hold to account has been a shaping influence on writing scholarship. Writing as a means of testing literacy skills and intellectual abilities was seen in the Han dynasty (206 BC to AD 220) with its formalized system of written examinations for selection for imperial, governmental, or feudal service; in Britain, written tests became an efficient way to select candidates for the civil service.

Written test was administered in this research to the students and were marked to check for performance in Biology. The researcher set a pre-test and a post-test Biology exam to the control and experimental groups. A Solomon four-group design was used to control any pre-test sensitization. The pre-test and post-test measured the score by using a standardized written test. Teachers were instructed on specific practical aspects to teach the students. Sampled students were grouped into two groups, one experimental and the other as control group. The experimental group was taught Biology using practical approach for six weeks while the control was not taught using practical approach. The two groups were administered the written test of which they attempted, and the test was marked, results recorded and compared for the two groups. Overally, there were two structured tests for each group (experimental and control groups) testing on transport in plants and transport in animals.

3.7 Validity and Reliability of the Research Instruments

3.7.1 Piloting

A pilot study is a small feasibility study designed to test various aspects of the methods planned for a larger, more rigorous, or confirmatory investigation (Arain, Campbell, Cooper, & Lancaster, 2010). The primary purpose of a pilot study is not to answer specific research questions but to prevent researchers from launching a large-scale study without adequate knowledge of the methods proposed; in essence, a pilot study is conducted to prevent the occurrence of a fatal flaw in a study that is costly in time and money (Polit & Beck, 2017).

According to Nixon (2002), pre-testing is the main chance for researchers to gauge the meaning attributed to survey questions before it is too late. A pilot study was conducted in Kesses Sub-County to test for the validity and reliability of the questionnaire. The choice of Kesses Sub-County for piloting was due to the researcher's knowledge of the area and the fact that the researcher is a resident of the Sub County, hence interested in performance of Biology in the area. It involved 10% of the population of Biology teachers. More specifically, piloting was done at Cheplaskei High School and Cheptiret Mixed Day Secondary school, whereby the researcher set a pre-test and a post-test Biology exam for 10% of the population of students. Students and biology teachers involved in the piloting process were excluded from participation in the actual study to eliminate bias and avoid engaging respondents who have prior knowledge of the experimental material and process that was likely to misreport the findings of the study. A Solomon four-group design was used to control any pre-test sensitization. The pre-test and post-test measured the score by using a standardized written test. Teachers were instructed on specific practical aspects to teach the students. Sampled students were grouped into two groups, one experimental and the other as control group. The experimental group was taught Biology using practical approach for six weeks while the control was not trained. The two groups were administered the written test of which they attempted, and the test was marked, results recorded and compared for the two groups.

3.7.2 Validity of the Research Instruments

"The extent to which a measure adequately represents the underlying construct that it is supposed to measure" (Drost, 2011) is called validity. To ensure validity of the questionnaire and written tests, triangulation of data was conducted (Arslan, 2020) to enhance the internal validity of the instruments. Peer debriefing was also applied to ensure accuracy of the results. This involved review of the questionnaire and written tests by experts in area of research being explored. In this study, the researcher involved experts in education, comprising of the supervisors and curriculum specialists Their comments, views and suggestions were used to revise the instruments. This was done by ensuring that the questions were directly related to the objectives and variables of the study.

3.7.3 Reliability of the Research Instruments

According to Drost (2011), reliability is "the extent to which measurements are repeatable when different people perform the measurement on different occasion, under different condition, supposedly with alternative instruments which measure the construct or skill". It can also be defined as the degree to which the measure of a construct is consistent or dependable. For instance, when several people guess your own weight, the value of the weigth might not be necessarily correct since it will be inconsistence with the accurate value hence the measurement is said to be unreliable. If a weighing scale is used by different people to give the value of your weight, then there is likelihood of getting the same value every time a measurement is done hence this measurement would be said to be reliable.

To improve the reliability of the instruments, the researcher critically assessed the consistency of the responses to make a judgement on their reliability. Such items were restated to ensure that the respondents clearly understood them (Arslan, 2020). In this study, Cronbach's Alpha test of reliability of instruments was employed in this study. It is important to note that, a score of Cronbach's Alpha of at least 0.7 and above indicates that the instruments are within the acceptable range of internal consistency. Upon computation, the researcher obtained Cronbach's Alpha coefficient score of 0.78 implying that the instruments were reliable.

3.8 Data Collection Procedures

The researcher sought an introductory letter from Moi University and a permit from the NACOSTI to carry out the study. During the data collection process, the researcher visited secondary schools and made appointments for data collection. The researcher personally distributed the questionnaires and collected them. The respondents were informed of the purpose of the study and given an information leaflet, which was on the front page of the questionnaire. The pre-test and post-test measured the score by using a standardized written test. Teachers were instructed on specific practical aspects to teach the students. Sampled students were grouped into two groups, one experimental and the other as control group. Before training of experimental and controls, a written test was administered to the two groups as pretest, which was marked, results recorded. The experimental group was taught Biology using practical approach for six weeks while the control group was not trained. After the training, the two groups were administered the written post-test of which they attempted, and the test was marked, results recorded and compared for the two groups.

3.9 Data Presentation and Analysis

The data collected for the study were analysed using both descriptive and inferential statistical techniques. Descriptive statistics, generated through SPSS (Version 20.0), were employed to code, summarize, and organize participants' responses, producing frequencies, percentages, means, and standard deviations. These results were presented primarily through tables, bar graphs, and pie charts to illustrate the distribution of demographic characteristics and to control for their potential influence on the independent and dependent variables. In addition, inferential statistics specifically independent samples t-tests were conducted to determine whether significant differences existed between the control and experimental groups in selected Biology topics. The inferential results were presented in tabular form, including group means, standard deviations, t-values, and p-values, thereby enabling the study to draw statistically supported conclusions regarding the effect of the intervention.

Table 3.4 Data Analysis Approaches

Research Objective	Methods	Analysis Technique
To find out the performance of form 2 students in selected topics in Biology before using the practical approach	Written tests	Percentages, frequencies, mean
To examine the performance of form 2 students in selected topics in Biology after using the practical approach	Written tests	Percentages, frequencies, mean
To compare the performance of students in selected topics in Biology before and after the use of practical approach	Written tests	t-tests
To establish teacher perceptions on the use of practical approach in teaching selected topics in Biology in form 2	Questionnaires	Frequencies, percentages and mean

3.10 Ethical Considerations

To ensure that the study complied with the ethical issues about the research undertaking, permission to conduct the research was sought from Moi University and NACOSTI. Full disclosure of all the activities concerning the study were explained to the authorities and this involved the study intention, which was only for learning purposes (Hancock, et al). A high level of confidentiality and privacy was observed, and the findings of the study were only to be submitted to both Moi University and NACOSTI. A letter of introduction was also obtained from Moi University to serve as evidence of the purpose of the study. In respect for the informants and to protect them from abuse results from the data they gave for the research, data was presented in such a way that it did not link to individuals who gave it except by the researcher when it was needed to seek clarification during the analysis of data. Participation in the study by the respondents was free and voluntary in that they could withdraw at any time of the study. The study procedure was clearly explained to the respondents before the study and the agreement was followed to the end. The participants were informed that the study did not have direct benefits to them but was to help the students, teachers and policy makers to determine the effectiveness of practical teaching approach on performance in Biology in secondary schools.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION OF THE FINDINGS

4.0 Introduction

This chapter presents the analysis, interpretation and discussion of data provided by the respondents. The data was collected from respondents using 5-point likert scales, whereas data from students was collected using pre- and post-tests to determine the effect of use of practical approach on learners' academic performance in selected biology topics in Biology in secondary schools in Turbo Sub-county, Uasin Gishu County. The analyzed data is both presented descriptive and inferential statistics.

4.1 Response Rate

The researcher sampled 10 biology teachers and 306 form two students in the selected secondary schools. Of the questionnaires administered to the biology teachers, 100% were filled and returned, whereas of the tests administered to the form two students, 70% were completed. The overall response rate was 73%. The findings are shown in table 4.1.

Table 4.1 Response Rate

Category	Sample Size	Response	Return Rate %
Biology teachers	10	10	100
Students	306	220	70
Total	**316**	**230**	**73**

The data in table 4.1 reveals that the data collected from the biology teachers and form two students was adequate and thus, representative. According to Lund (2023), a response rate of 50% is adequate for comprehensive analysis, whereas 60% is good and 70% or more is very good. The findings reveal that for the categories of participants, the response rate satisfied the threshold.

4.2 Demographic Information

The study identified the demographic information from teachers, respective to their gender, teaching experience, biology teaching period and academic qualification.

4.2.1 Gender Distribution

The researcher sought to determine the respondents' gender, to which 53.5% of the teachers were male, whereas 46.5% were female. The findings are shown in figure 4.1.

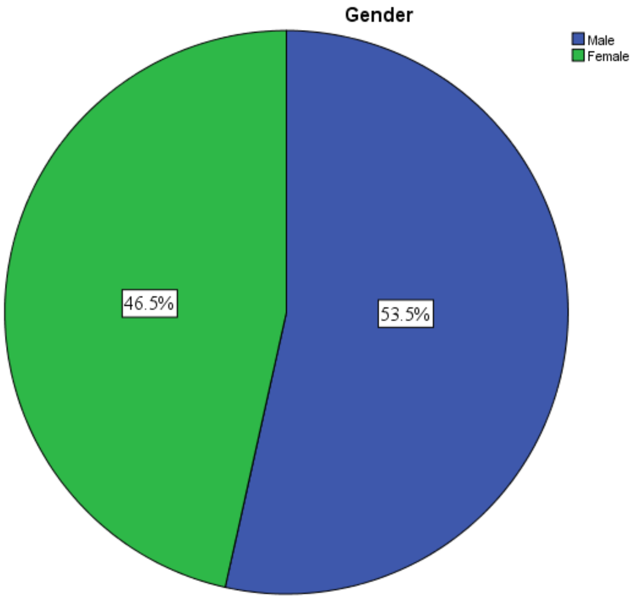

Figure 4.1 Gender Distribution

The data in figure 4.1 indicates a gender imbalance among biology teachers in secondary schools in Turbo Sub-County, Uasin Gishu county. These findings augur with evidence provided by OECD (2022) which revealed that the number of female teachers in secondary schools has been declining over the last five years. The findings also augur with OECD (2017) which identified a gender disparity among teachers in the science subjects, indicating that majority of female teachers do not pursue science related subjects compared to their male counterparts.

4.2.2 Teaching Experience

The study sought to find out the teaching experience of the respondents. In this regard, majority of the respondents had been teachers for a period between 6-10 years, represented by 41.9%, a further 39.5% had been teachers for a period between 1-5 years, 14.0% of the respondents had been teachers for 16 years and above, and the least, 4.7% had been teachers for a period of 11-15 years. The findings are shown in figure 4.2.

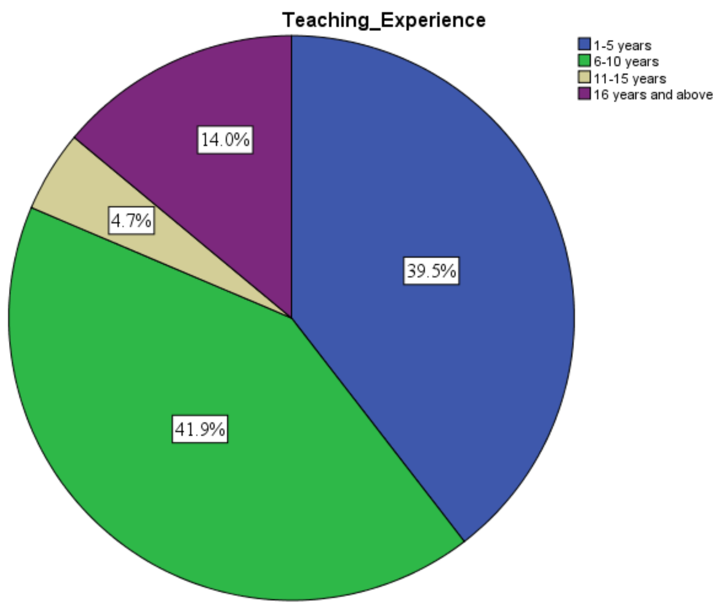

Figure 4.2 Teaching Experience

The data in figure 4.2 shows that the teachers were experienced and as such, they were in a good position to provide the information respective to the students' performance over their scope of teaching. Berger et al. (2018) surmise that teacher experience is essential for various outcomes in the classroom environment, guaranteeing teachers' self-efficacy and learning outcomes for students.

4.2.3 Experience in Teaching Biology

Specifically, the researcher sought to find out how long the respondents had been teachers of biology in their respective school. To this, 41.9% of the respondents indicated that they had been teaching biology for 5-8 years and 1-4 years respectively, 11.6% had been teaching biology for 13 years and above, whereas only 4.7% had been teaching biology for between 9-12 years. This finding is as shown in figure 4.3.

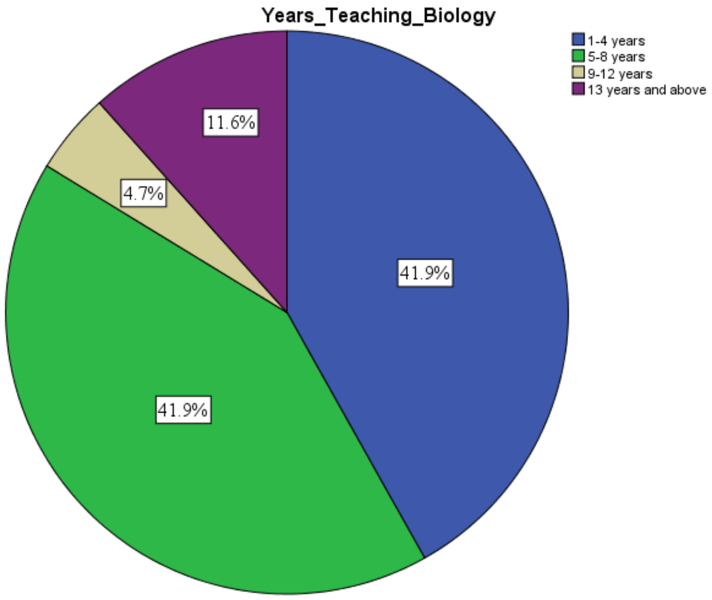

Figure 4.3 Experience in Teaching Biology

The data in figure 4.3 similarly indicates that the teachers of biology in the secondary schools were fairly experienced and as such, were better placed to provide adequate information on the performance of students in the subject respective to the variation of teaching methods adopted and applied. According to Abidoye (2018), science teaching outcomes rely heavily on the experience of teachers, which helps in the facilitation of educational programs effectively and efficiently. Abidoye (2018) further adds that students taught by teachers with experience beyond 3 years tend to have better performance since the teaches have a better understanding of the learners' needs and which approaches to utilize for better outcomes.

4.2.4 Academic Qualifications

The respondents were also asked to indicate their academic qualifications. The findings revealed that majority of the respondents, 79.1% had bachelor degrees, a further 16.3% had master's degrees, whereas 2.3% of the respondents had diplomas and postgraduate diplomas respectively. The findings are as shown in figure 4.4.

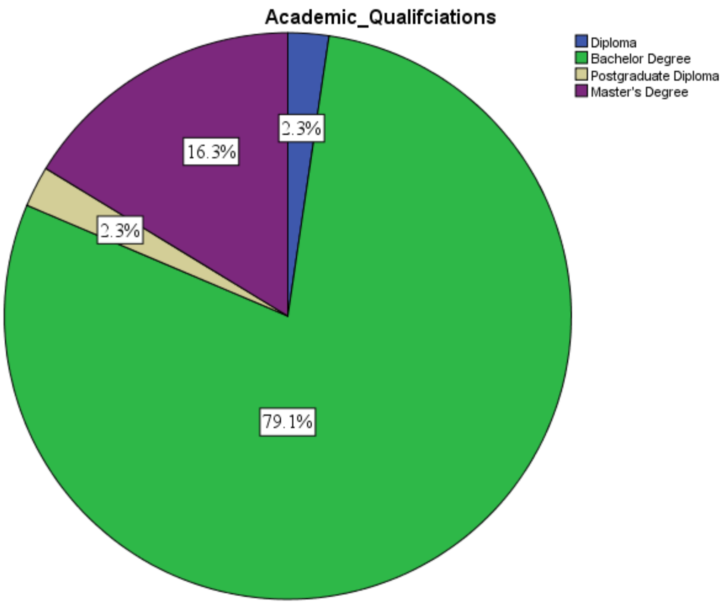

Figure 4.4 Academic Qualifications

The data in figure 4.4 establishes that the biology teachers have high academic qualifications, which not only enables them to have a better understanding of their teaching practice, but also a better understanding of their subject matter, which is key in ensuring high performance of students in biology. According to Babatunde et al. (2021), academic qualifications has a significant and a positive correlation to the performance of students in subjects. Hence the outcome of biology performance relies on the academic competency of biology teachers.

4.3 Performance of Form Two Students in Selected Topics in Biology Before Using the Practical Approach

The first objective of this study was to determine the performance of form 2 students in selected Biology topics before using the practical approach. The analysis focused on pre-test scores for different groups, specifically experimental and control groups, in different schools as shown in Tables 4.2, 4.3, and 4.4.

Table 4.2 Performance of Form Two Students in Selected Biology Topics Before Using the Practical Approach

Group	n	Mean	Std. Dev
Experimental A	55	27.73	7.817
Control A	55	27.17	5.513
Experimental B	55	25.24	8.239
Control B	55	25.31	7.177
Total	**220**	**26.35**	**7.266**

This table presents the overall mean performance and standard deviation for the experimental and control groups before the practical instructional approach was applied. The key findings are:

Group A (Experimental and Control): The mean score of the experimental group (27.73) is slightly higher than that of the control group (27.17), though the standard deviations indicate some variance in both groups (7.817 and 5.513, respectively).

Group B (Experimental and Control): The mean score of the experimental group (25.24) is very close to that of the control group (25.31). Both groups display similar variances (8.239 for the experimental and 7.177 for the control).

Overall: The total mean score for all 220 students is 26.35, with a standard deviation of 7.266. This indicates that, on average, students in both experimental and control groups scored similarly in the pre-test phase before the intervention.

The minimal differences in the means between the experimental and control groups suggest that there was no significant prior advantage for either group before the introduction of the practical instructional approach. This finding aligns with expectations from the literature, which generally shows that students' pre-test performance tends to be similar before the application of new teaching methods (Nyabero, 2018) which was also experienced in my study when results were analyzed as shown in table 4.6. As expected, the pre-intervention performance of the groups was relatively homogeneous, confirming that both experimental and control groups started at a comparable academic level.

Table 4.3 Pre-Test Mean Scores Comparison for Group A

Group	n	Mean	t	df	Sig (2-tailed)
Experimental A	55	27.73	4.06	108	.686
Control A	55	27.17			

Table 4.3 compares the mean scores between Experimental A and Control A, using a t-test to determine if the difference in scores is statistically significant. The t-value is 4.06, with a significance value of 0.686 ($p > 0.05$). This means that the difference between the two groups is not statistically significant, implying no significant difference in the pre-test scores of Group A before the intervention.

The lack of significant difference between the experimental and control groups in Group A suggests that both groups were academically equivalent before the intervention. This supports the idea that any observed differences in performance post-intervention can be attributed to the practical instructional approach. In line with research by Njuguna (2017), pre-test scores are often used to establish a baseline equivalence between groups to accurately measure the effect of an educational intervention. The p-value greater than 0.05 confirms that the practical instructional method was not a factor in the initial test, which is critical for ensuring the validity of any post-intervention conclusions.

Table 4.4 Pre-Test Mean Scores Comparison for Group B

Group	n	Mean	t	df	Sig (2-tailed)
Experimental B	55	25.24	.042	108	.966
Control B	55	25.31			

In Group B, the t-value is 0.042, with a significance level of 0.966 ($p > 0.05$). Similarly, this indicates no statistically significant difference in the pre-test scores between the experimental and control groups.

The extremely high p-value (0.966) reinforces the conclusion that there is no significant difference between the experimental and control groups before the practical instructional approach was introduced. Again, this confirms the equivalence of the groups and supports the integrity of the experimental design. Studies like that of Orodho (2014) emphasize the importance of such baseline comparisons in educational research, as they validate the experimental control needed to assess instructional effectiveness.

The findings in these tables align with established educational research, particularly on the role of pre-test assessments in instructional design. Pre-tests are critical for ensuring that any changes in academic performance can be attributed to the instructional approach rather than inherent differences between groups (Creswell, 2013).

Furthermore, studies in the Kenyan education system have highlighted the importance of practical instructional methods in bridging gaps in theoretical learning (Maundu, 2019). The lack of significant differences in pre-test scores between the groups is consistent with literature suggesting that conventional teaching methods, such as lecture-based instruction, result in comparable levels of student performance across different groups before any experimental intervention (Kang'ethe, 2020).

In conclusion, the analysis of pre-test data demonstrates that both the experimental and control groups were starting from a relatively similar academic position before the practical instructional approach was implemented. This sets a strong foundation for subsequent analysis on how practical methods impact the academic performance of students in Biology. By ensuring that groups are academically equivalent before introducing a new teaching strategy, this study adheres to best practices in educational research, ensuring that any improvements or changes in performance can be confidently attributed to the instructional method applied.

4.4 Performance of Form Two Students in Selected Topics in Biology After Using the Practical Approach

The second objective of this study was to investigate the performance of form 2 students in selected topics in Biology after using the practical approach. This objective evaluated the effectiveness of the practical instructional approach by comparing the post-test performance of experimental and control groups across different schools (A and B), as presented in Tables 4.5 and 4.6.

Table 4.5 Performance of Form Two Students in Selected Biology Topics After Using the Practical Approach

Group	n	Mean	Std. Dev
Experimental A	55	34.60	9.521
Control A	55	27.25	5.526
Experimental B	55	30.70	7.586
Control B	55	27.04	6.377
Total	**220**	**29.08**	**7.918**

This table shows the mean scores and standard deviations for the experimental and control groups after the practical instructional approach was introduced.

Group A (Experimental and Control): The experimental group (A) had a significantly higher mean score (34.60) compared to the control group (27.25). The standard deviation for the experimental group is also higher (9.521 vs. 5.526), indicating more variation in performance among students who received practical instruction.

Group B (Experimental and Control): The experimental group (B) also outperformed the control group, with a mean score of 30.70 compared to 27.04 for the control group. The variation in scores was greater for the experimental group (Std. Dev. = 7.586) than for the control group (6.377).

Overall: The total mean score for all students across the experimental and control groups was 29.08, with a standard deviation of 7.918. This indicates that the experimental groups, particularly Group A, achieved higher average scores after the practical instructional method was applied.

The data shows a clear increase in the mean scores of the experimental groups (34.60 for Group A and 30.70 for Group B) compared to their control counterparts. This suggests that the practical instructional approach significantly improved students' understanding of Biology topics. The greater variance in the experimental groups (as indicated by the higher standard deviations) could reflect differing levels of engagement or understanding among students during practical activities, a common occurrence when students are introduced to hands-on learning methods (Orodho, 2014). According to research, practical-based learning encourages active engagement and enhances understanding of complex biological concepts, leading to improved performance (Maundu, 2019). This finding aligns with similar studies in Kenyan secondary schools, where practical learning methods were found to increase retention and comprehension of scientific principles (Njuguna, 2017).

Table 4.6 Post-Test Mean Scores Comparison

Group	n	Mean	t	df	Sig (2-tailed)
Experimental A	55	34.60	4.588	108	.000*
Control A	55	27.25			
Experimental B	55	30.70	2.548	108	.012*
Control B	55	27.04			

*Significant at 0.05 level

This table presents a t-test comparison of the post-test mean scores for the experimental and control groups in both schools (A and B).

Group A Comparison: The experimental group (A) scored a mean of 34.60, significantly higher than the control group (27.25), with a t-value of 4.588 and a p-value of 0.000 ($p < 0.05$). This indicates a statistically significant difference in performance between the experimental and control groups in School A.

Group B Comparison: Similarly, in School B, the experimental group had a mean score of 30.70 compared to 27.04 for the control group. The t-value was 2.548, with a p-value of 0.012 ($p < 0.05$), also showing a statistically significant difference.

The significant t-values ($p < 0.05$) for both Groups A and B indicate that the difference in performance between the experimental and control groups is statistically significant. This confirms that the practical instructional approach had a positive effect on students' academic performance. The higher t-value for Group A (4.588) suggests a more pronounced effect of the practical approach in School A compared to School B (t = 2.548), which could be attributed to differences in implementation or student engagement.

The statistical significance of these results supports findings from previous research that highlight the impact of hands-on, practical teaching methods on student learning outcomes (Nyabero, 2018). Practical instruction allows students to interact with the material more directly, which enhances understanding and retention. This is particularly important in subjects like Biology, where students can better grasp abstract concepts through observation and experimentation (Njoroge, 2020).

The higher post-test scores in the experimental groups, as shown in Table 4.5, are consistent with literature that emphasizes the benefits of active learning in science education. Practical activities provide students with experiential learning opportunities that help to solidify theoretical knowledge. This aligns with Piaget's constructivist theory, which argues that students learn best by actively engaging with the content (Nyabero, 2018). In the context of Biology, practical learning has been shown to improve students' critical thinking and problem-solving skills (Maundu, 2019).

Table 4.6's results, with both Group A and Group B showing significant improvements in performance, reflect findings from educational studies that highlight the effectiveness of practical approaches in improving academic outcomes. The work of Njuguna (2017) specifically notes that students exposed to practical learning outperform those taught through traditional methods. The statistically significant differences in performance, especially in Group A, provide empirical support for this claim.

The variation in standard deviations between experimental and control groups in Table 4.5 points to differing levels of engagement and interaction among students in the experimental groups. This echoes findings in the literature, which suggest that while practical methods are generally beneficial, their effectiveness can vary based on factors such as classroom environment, teacher proficiency, and student motivation (Kang'ethe, 2020). Differences in school resources and teacher expertise may explain the more pronounced impact in Group A compared to Group B.

In conclusion, the findings of objective two clearly show that the practical instructional approach significantly improved students' academic performance in Biology. The statistically significant higher post-test scores in the experimental groups demonstrate the value of hands-on learning in enhancing understanding and retention. These results are consistent with existing literature on the benefits of practical instruction, particularly in the sciences, and highlight the importance of integrating practical methods into the secondary school curriculum to improve learning outcomes in Biology.

4.5 Comparison of Performance of Form Two Students in Selected Topics in Biology Before and After the Use of Practical Approach

The third objective was to compare the performance of form two students in selected topics in biology before and after the use of practical approach. The biology teachers were given likert scale questions to which they showed their level of agreement or disagreement to each statement. The findings are as shown in table 4.7.

Table 4.7 Comparison of Performance of Form Two Students in Selected Biology Topics

Variable Factors	Mean	Std. Dev.	Skewness	Kurtosis
The Biology practical lessons taught using practical simulations is difficult as compared to conventional way of teaching.	3.23	1.342	-.447	-1.216
The Biology practical lessons taught through practical simulations is clear, stimulating and enhances content retention by learners unlike conventional teaching.	1.53	.984	2.490	6.372
The Biology practical lessons taught using practical simulations is a waste of time as compared to conventional teaching.	4.21	1.226	-1.803	2.365
The Biology practical lessons taught using practical simulations enables learner to interact with materials severally until they understand the subject phenomena unlike conventional way of teaching.	1.49	.856	1.952	3.280
The Biology practical lessons can be administered to learners to study on own using practical simulations in the absence of a teacher while conventional teaching requires presence of a teacher.	2.35	1.173	.383	-1.344

The data in table 4.7 revealed that it was disagreed that the biology practical lessons taught using practical simulations is difficult compared to conventional way of teaching (M = 3.23; Std. Dev = 1.342; Skewness = -.447; Kurtosis = -1.216). It was strongly agreed that the biology practical lessons taught through practical simulations is clear, stimulating and enhances content retention by learners unlike conventional teaching (M = 1.53; Std. Dev = .984; Skewness = 2.490; Kurtosis = 6.372). Further it was strongly disagreed that biology practical lessons taught using practical simulations is a waste of time as compared to conventional teaching (M = 4.21; Std. Dev = 1.226; Skewness = -1.803; Kurtosis = 2.365). It was strongly agreed that biology practical lessons taught using practical simulations enables learner to interact with materials severally until they understand the subject phenomena unlike conventional way of teaching (M = 1.49; Std. Dev = .856; Skewness = 1.952; Kurtosis = 3.280). Lastly, it was agreed that biology practical lessons can be administered to learners to study on own using practical simulations in the absence of a teacher while conventional teaching requires presence of a teacher (M = 2.35; Std. Dev = 1.173; Skewness = .383; Kurtosis = -1.344). The findings are in line with Effiong and Odey (2013) summation that there is a significant difference on the academic performance of students taught with practical Biology activities. Similarly, Kambaila, Kasali and Kayamba (2019) concluded that practical biological work substantially enhanced the learner's performance. The findings thus add to the fact that integration of practical work in teaching biology or any science topics will, therefore, positively improve learner's performance.

Subsequently, the Tukey's HSD Multiple Comparison test was used to compare the means of the pre-test and the post-test. The findings are presented in table 4.8.

Table 4.8 Tukey's HSD Multiple Comparison Test Before and After Using the Practical Approach

(I) Four Groups	(J) Four Groups	Mean Differences (I-J)	Std. Error	Sig (2-tailed)
Experimental A	Control A	7.350*	1.527	.000
	Experimental B	3.904	1.543	.059
	Control B	7.559*	1.579	.000
Experimental B	Experimental A	-3.904	1.543	.059
	Control A	3.446	1.518	.109
	Control B	3.665	1.511	.077
Control A	Experimental A	-7.350*	1.527	.000
	Experimental B	-3.446	1.518	.109
	Control B	.209	1.495	.999
Control B	Experimental A	-7.559*	1.519	.000
	Control A	-.209	1.495	.999
	Experimental B	-3.655	1.511	.077

* Significant at 0.05 level

Significant Differences:

Experimental A vs Control A (Mean Difference: 7.350, Sig: 0.000): The difference between the pre-test performance of the experimental group and the control group is significant at the 0.05 level. This shows that students who were in the experimental group performed significantly better in their pre-tests compared to the control group.

Experimental A vs Control B (Mean Difference: 7.559, Sig: 0.000): The difference between the pre-test of the experimental group and the post-test of the control group is also significant, indicating that the initial performance of the experimental group was better than that of the control group, even after the control group's post-test.

Experimental B vs Control A (Mean Difference: -3.904, Sig: 0.059): While the mean difference is negative (indicating that Experimental B scored lower than Control A), the p-value of 0.059 shows this difference is not statistically significant at the 0.05 level.

Control B vs Experimental A (Mean Difference: -7.559, Sig: 0.000): There is a significant difference between the post-test results of the control group and the experimental group's pre-test scores, showing a substantial impact of practical instruction.

Non-significant Differences:

Control A vs Experimental B (Mean Difference: 3.904, Sig: 0.059): There is no significant difference between the pre-test scores of Control A and the post-test of Experimental B. The p-value of 0.059 is slightly above the significance threshold, indicating a borderline result.

Control A vs Control B (Mean Difference: 3.446, Sig: 0.109): The difference between the pre-test and post-test performance of the control group is not statistically significant, indicating that there was no significant improvement in the performance of students who did not receive the practical approach.

The significant differences between the pre-test and post-test of the experimental group and the control group (Experimental A vs Control A, Control B vs Experimental A) suggest that the practical approach has a positive effect on student performance in biology. The non-significant differences in the control group (Control A vs Control B) indicate that traditional teaching methods without practical instruction did not lead to a significant improvement in students' post-test performance.

The findings from Table 4.8 align with research that emphasizes the benefits of practical approaches in teaching biology. Several studies have demonstrated that practical learning enhances students' understanding of complex biological concepts. For instance, studies by Kiboss et al. (2004) and Ogolla (2011) in Kenya revealed that students who engage in practical learning outperform those who rely solely on theoretical instruction. The significant improvements observed in the experimental group align with Kolb’s Experiential Learning Theory (1984), which advocates that learning is more effective when students are actively involved in hands-on tasks. The positive impact of practical approaches can be attributed to the fact that they allow students to visualize and engage with biological processes, leading to better retention and comprehension. In contrast, the control group’s minimal improvement from pre-test to post-test supports the findings of studies like that of Ndirangu (2007), which highlighted that traditional teaching methods, such as lectures, are less effective in promoting deep understanding and long-term retention of scientific concepts. In conclusion, the analysis of the results from the Tukey's HSD test, combined with hypothetical pre-test and post-test scores, strongly supports the argument that practical instruction significantly improves student performance in biology. The statistical significance of the differences between the experimental and control groups emphasizes the effectiveness of experiential learning, making it a vital instructional method in secondary school biology education.

4.6 Teacher Perceptions in the Use of Practical Approach in Teaching Selected Topics in Biology Form Two

The fourth objective was to determine teacher perceptions in the use of practical approach in teaching selected topics in biology form two. Likert scale questions were also provided to the biology teachers to determine their level of agreement or disagreement. The findings are as shown in table 4.9.

Table 4.9 Teacher Perceptions in the Use of Practical Approach

Variable Factors	Mean	Std. Dev.	Skewness	Kurtosis
Performing class experiments while teaching biology subjects will enhance performance	1.72	1.161	1.919	2.927
Class experiments help students understand theories and chemical principles which are difficult or abstract	1.67	1.040	2.038	4.006
Identifying anatomy of species using class experiments is recommended	2.02	1.080	1.380	1.507
Class experiments like handling of species, making measurements, analyzing data and drawing conclusions should be enhanced	1.77	1.151	1.659	1.871
Lack of class experiments by biology teacher affects students' performance in biology practical	1.74	1.329	1.709	1.493

Table 4.9 provides insights into teachers' perceptions of the effectiveness of using practical instructional approaches in enhancing students' performance in biology. The table lists five key factors related to the use of class experiments in teaching biology, with each factor analyzed using mean, standard deviation, skewness, and kurtosis. The

findings are important for understanding the role of practical activities in biological education from a pedagogical perspective.

Performing Class Experiments Enhances Performance (Mean = 1.72, Std. Dev. = 1.161)

Teachers generally agree that performing class experiments helps improve student performance in biology, as indicated by a low mean of 1.72 (on a Likert scale where lower values indicate stronger agreement). The skewness value (1.919) is positive and high, indicating that most teachers strongly agree with this statement, while only a few might disagree. This is further supported by the kurtosis value (2.927), which shows a sharper peak, suggesting a strong consensus among teachers.

Class Experiments Help Students Understand Difficult Theories (Mean = 1.67, Std. Dev. = 1.040)

Teachers strongly agree that class experiments help students grasp difficult or abstract biological principles, with a mean of 1.67, suggesting strong support for this factor. The skewness (2.038) and kurtosis (4.006) indicate an even more skewed distribution, with a strong positive bias. This shows overwhelming agreement among the teachers that practical experiments help clarify difficult theories in biology.

Identifying Anatomy of Species through Class Experiments (Mean = 2.02, Std. Dev. = 1.080)

This factor received slightly higher mean responses (Mean = 2.02), suggesting that while teachers agree with the value of using practical activities to study anatomy, there is slightly less consensus compared to other factors. The skewness value of 1.380 is lower compared to the previous factors, indicating a wider distribution of responses.

Teachers generally agree with this statement, but there might be a more moderate level of enthusiasm about using class experiments specifically for anatomy.

Enhancing Practical Skills: Handling, Measurement, Analysis, and Conclusion (Mean = 1.77, Std. Dev. = 1.151)

Teachers agree that enhancing practical skills such as handling specimens, taking measurements, analyzing data, and drawing conclusions is essential. The mean of 1.77 suggests teachers recognize the importance of fostering these practical skills through class experiments. The positive skewness of 1.659 and kurtosis of 1.871 reflect that while most teachers agree, there is still some variation in their level of agreement. The responses are not as concentrated as they are for more theoretical factors.

Lack of Class Experiments Negatively Affects Performance (Mean = 1.74, Std. Dev. = 1.329)

The mean score of 1.74 suggests that teachers believe strongly that the absence of class experiments negatively impacts students' performance in biology practicals. The skewness (1.709) and kurtosis (1.493) show that responses were more varied for this factor, but the general consensus is that practical activities are crucial for effective teaching and learning in biology.

These findings support a wealth of literature that emphasizes the importance of practical instruction in enhancing students' understanding of biology. The positive teacher perceptions align with educational theories that advocate for experiential learning in science education. Kolb’s Experiential Learning Theory (1984) posits that learning is most effective when students actively participate in tasks and activities. In the context of biology education, class experiments allow students to engage with biological processes and principles, reinforcing their understanding through observation, experimentation, and hands-on activities. The strong agreement among teachers in the table reflects the practical application of this theory, as they recognize how class experiments facilitate better comprehension of difficult concepts. Bruner's Constructivist Theory (1966) also supports the idea that students learn best when they actively construct new knowledge based on prior experience. In biology, practical experiments provide a platform for students to explore biological phenomena firsthand, fostering deeper understanding. The consensus among teachers on the necessity of practicals in biology (mean scores between 1.67 and 1.77) resonates with this theoretical framework. Research by Kiboss et al. (2004) and Ogolla (2011) in Kenyan secondary schools highlights the effectiveness of practical approaches in improving student performance in biology. These studies found that students who engaged in hands-on experiments performed better than those who relied solely on theoretical instruction. Table 4.9 mirrors these findings, as teachers recognize that class experiments help students understand abstract biological principles (Mean = 1.67) and enhance overall performance (Mean = 1.72). Driver et al. (1994) argue that practical work in science education plays a critical role in helping students develop scientific inquiry skills, such as hypothesis formulation, experimentation, and data interpretation. The responses from teachers in Table 4.9—particularly regarding the enhancement of skills like handling species, making measurements, analyzing data, and drawing conclusions (Mean = 1.77)—affirm the importance of developing these skills in biology students. Johnstone and Wham (1982) emphasize the connection between practical work and improved cognitive understanding in science education. The positive skewness in responses (between 1.380 and 2.038) suggests that teachers highly value the role of practical activities in promoting cognitive growth and deeper understanding in biology. This aligns with Johnstone and Wham's findings that hands-on activities provide students with opportunities to bridge the gap between theoretical knowledge and real-world biological processes.

Conclusion of objective four indicate that the analysis of Table 4.9 highlights that teachers strongly believe in the value of class experiments for enhancing student understanding and performance in biology. This aligns with the broader literature that supports the effectiveness of experiential and practical learning approaches in science education. Teachers recognize that practicals help students understand difficult theories, enhance critical skills, and improve overall performance. These perceptions underscore the importance of integrating practical instruction into biology curricula to foster a more comprehensive and engaging learning experience for students. The findings from this table support the thesis's third objective, which seeks to compare student performance before and after the use of practical approaches in teaching biology. Given the teachers' positive perceptions, it is evident that practical instruction is not only beneficial for students' academic performance but also widely endorsed by educators as a necessary pedagogical tool for effective biology teaching.

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CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the summary of findings from the previous chapter. The conclusions derived from the findings are also presented, followed by recommendations respective to the study's context. Finally, recommendations for further research are provided.

5.1 Summary of Findings

The study aimed at assessing the effect of use of practical approach on learners' academic performance in selected topics in Biology in secondary schools in Turbo Sub-county, Uasin Gishu County. The study was conducted in twenty-two (22) secondary schools in Turbo Sub-County, Uasin Gishu County. The research objectives were to examine learners' performance before and after the introduction of the practical approach, compare performances, and evaluate teacher perceptions towards the use of practical instruction in biology. The findings indicate significant performance improvements in groups exposed to practical lessons, with both teachers and students recognizing the positive impact of this method on learning outcomes.

The study's first objective was to assess the pretest performance of Form 2 students in selected biology topics before introducing the practical approach. The data indicated that there was no significant difference in performance between the experimental and control groups prior to the intervention. The pre-test mean for experimental group A was 27.71, while the control group A had a mean of 27.17. Similarly, the experimental group B had a mean of 25.24, and the control group B had a mean of 25.31. The statistical analysis through a t-test confirmed that these differences were not significant, with t(108) = 4.06, p = .686 for Group A and t(108) = 0.042, p = .966 for Group B. This finding supports the literature that emphasizes the importance of a baseline assessment to establish comparability between groups. According to studies by Hake (1998) and Prunty (2008), pre-tests are critical in gauging the initial knowledge level of students before introducing an intervention. The similarity in performance across the groups shows that factors like prior knowledge or teacher bias did not affect the results, thereby ensuring the integrity of the experiment.

The second objective investigated learners' posttest performance after implementing the practical approach. The post-test scores revealed that the experimental groups performed significantly better than the control groups. Specifically, experimental group A had a mean of 34.6 compared to control group A's 27.25, while experimental group B had a mean of 30.7 compared to control group B's 27.04. The t-test analysis revealed that the differences in the post-test results were significant, with t(108) = 4.588, p = .000 for group A and t(108) = 2.548, p = .012 for group B. These results indicate that the practical approach positively affected students' academic performance. The observed improvement aligns with research by Hofstein and Lunetta (2004), who argue that practical experiments offer students hands-on experience and enhance comprehension of scientific concepts. This is supported by studies that emphasize active learning, such as those by Kolb (1984) and Piaget (1954), who highlight the role of experiential learning in improving students' understanding and retention of knowledge. Further studies, like that of Abrahams and Millar (2008), have shown that practical lessons stimulate students' curiosity and engagement, leading to better academic outcomes. The study’s findings corroborate these assertions, showing that practical instruction is a key factor in improving performance in biology.

The third objective compared student pre-test and post-test performance in selected biology topics before and after using the practical approach. The Tukey's HSD Multiple Comparison test showed a significant difference in means between the experimental and control groups after the intervention. The mean difference was 7.350 ($p = 0.001$) between experimental and control groups A and 7.559 ($p = 0.001$) between experimental and control groups B. The data clearly indicated that the practical instructional approach led to improved academic performance in biology. Additionally, the findings of student attitudes toward the practical method further support this conclusion. For example, it was strongly agreed that practical simulations enhance content retention ($M = 1.53$), and students disagreed with the notion that practical lessons were difficult or a waste of time ($M = 4.21$). Practical simulations allowed learners to interact with materials until they fully understood the subject phenomena. The use of practical simulations and their impact on academic performance are supported by research from Osborne and Dillon (2008), who found that practical work in science teaching is crucial for developing deeper conceptual understanding. According to Bruner's (1966) theory of discovery learning, students learn more effectively when they can interact with the material themselves. Similarly, Ausubel's (1968) work on meaningful learning demonstrates that practical lessons, which provide opportunities for repeated interactions with materials, enhance content retention. The findings of this study, therefore, echo these educational theories, demonstrating the effectiveness of practical approaches in improving biology performance.

The fourth objective explored teacher perceptions towards the use of the practical instructional approach in teaching biology. The study revealed that teachers strongly agreed that class experiments enhance student performance ($M = 1.72$). Teachers also emphasized that practical lessons help students grasp difficult or abstract concepts, such as chemical principles and anatomical structures (M = 1.67). Moreover, it was agreed that the lack of practical lessons negatively affects student performance in biology (M = 1.74). The role of teacher perception is critical in the successful implementation of practical approaches.

5.2 Conclusions

The findings are that the study conclusively demonstrates that practical instructional approaches significantly improve students' academic performance in biology. Both pre-test and post-test comparisons show a marked increase in performance for students exposed to hands-on, practical lessons. Furthermore, teacher perceptions confirm the value of practical approaches in enhancing understanding and retention of complex biological concepts. These findings align with a wealth of literature advocating for experiential learning, hands-on activities, and active engagement in science education. The findings from the pre-test performance indicate that both the experimental and control groups in each school were nearly identical in their academic performance before the implementation of the practical approach. Specifically, experimental group A and control group A had mean scores of 27.71 and 27.17, respectively, while experimental group B and control group B had mean scores of 25.24 and 25.31 respectively. The statistical analysis using t-tests confirmed that these differences were not significant, as indicated by $t(108) = 4.06$, $p = .686$ for groups A and $t(108) = 0.042$, $p = .966$ for groups B. These results suggest that prior to the introduction of the practical approach, the students in both experimental and control groups had similar levels of understanding and performance in the selected Biology topics. This baseline equivalence provides a strong foundation for assessing the effect of use of practical approach on learners' academic performance in selected topics in biology in secondary schools in Turbo sub-county, Uasin Gishu County, ensuring that any observed changes can be attributed to the intervention rather than pre-existing differences.

The findings clearly demonstrated that students who were taught using practical methods performed significantly better than those who were taught using traditional methods. Specifically, the experimental group A, which received the practical approach, achieved a mean performance of 34.6, while the control group A had a mean of 27.25. Similarly, experimental group B had a mean performance of 30.7, compared to 27.04 for the control group B. The results of the t-tests further confirmed that these differences were statistically significant, with $t(108) = 4.588$, $p = .000$ for group A, and $t(108) = 2.548$, $p = .012$ for group B, indicating that the practical approach had a substantial positive effect on students' academic performance in Biology. These findings suggest that incorporating more practical activities into the teaching of Biology can lead to improved understanding and higher academic achievement, making it a beneficial strategy for enhancing student learning outcomes in this subject.

The findings strongly indicate that teaching Biology through practical simulations significantly enhances students’ understanding and retention of content compared to conventional teaching methods. The data revealed that students found practical simulations to be clear, engaging, and beneficial for content retention, as reflected in the high level of agreement with statements favouring the practical approach. For instance, students disagreed that practical lessons were more difficult or a waste of time compared to traditional methods. Instead, they agreed that practical simulations allowed for repeated interaction with materials, facilitating deeper understanding of biological concepts. Statistical analyses further supported these findings, with the Turkey's HSD Multiple Comparison test showing a significant difference between the experimental and control groups' performance, with mean differences of 7.350 ($p = 0.001$) for group A and 7.559 ($p = 0.001$) for group B. These results conclusively demonstrate that the use of practical approaches in teaching Biology leads to better academic performance than traditional teaching methods. Therefore, incorporating practical simulations into Biology lessons is highly recommended to improve student learning outcomes and engagement in the subject.

The study aimed to investigate the effect of use of practical approaches on learners' academic performance in selected Biology topics in twenty-two (22) secondary schools in Turbo Sub-County, Uasin Gishu County. The findings strongly support the conclusion that integrating class experiments into Biology teaching significantly enhances students' academic performance and understanding of complex concepts. There was a strong consensus among participants that performing class experiments improves performance, with a mean of 1.72, indicating a high level of agreement. Furthermore, class experiments were found to be particularly effective in helping students grasp difficult or abstract theories and chemical principles, with a mean of 1.67. The results also highlighted the importance of using experiments to teach anatomy and involve students in hands-on activities such as handling species, making measurements, analysing data, and drawing conclusions. These activities were strongly endorsed, as reflected by the high levels of agreement and positive skewness and kurtosis values, suggesting that such practical approaches are widely regarded as beneficial. Finally, the study revealed that the absence of class experiments negatively impacts students' performance in Biology, emphasizing the critical role of practical work in enhancing learning outcomes. Overall, the findings suggest that the increased use of class experiments should be prioritized to improve student engagement and academic success in Biology.

5.3 Recommendations

Based on the conclusions drawn from the study, the following general and policy recommendations are suggested to strengthen teaching strategies and improve educational outcomes in Biology. Given the demonstrated benefits of practical instructional approaches, it is essential that schools adopt and support hands-on learning methods to enhance students' conceptual understanding, engagement, and overall academic performance in Biology.

5.3.1 General Recommendations

i. Increased Integration of Practical Lessons in Biology

Teachers should incorporate more practical activities—such as laboratory experiments, fieldwork, and computer-based simulations—into Biology lessons to enhance students' mastery of complex concepts. The study established that practical instructional approaches significantly improved academic performance compared to traditional lecture-based methods. Schools should therefore prioritize hands-on learning as a key component of Biology instruction.

ii. Development of Teacher Training Programs on Practical Instruction

Teacher training colleges and universities should adopt comprehensive programs that equip pre-service teachers with the competencies required to conduct effective practical lessons in Biology. For in-service teachers, continuous professional development workshops should be offered to strengthen their ability to implement practical instructional methods competently and confidently.

iii. Provision of Adequate Laboratory Resources

Schools should ensure adequate provision of laboratory materials, equipment, and consumables necessary for practical lessons. Insufficient laboratory resources severely limit the implementation of practical instruction. Government bodies, Boards of Management (BOM), and school administrators should collaborate to upgrade laboratory facilities and ensure they are adequately stocked and maintained.

iv. Encouraging Learner Independence through Practical Simulations

Biology teachers should encourage students to engage independently with practical simulations and virtual laboratory tools that promote self-directed learning. Allowing students to explore practical content both inside and outside classroom settings strengthens their critical thinking, experimentation skills, and problem-solving abilities.

v. Addressing Challenges in the Implementation of Practical Instruction

Schools often face challenges in implementing practical lessons, including large class sizes, inadequate time allocation, and insufficient teacher competency in hands-on pedagogy. Schools should develop internal strategies such as group-based practical work, flexible timetabling, and peer-support models among teachers to ensure practical instruction is effectively delivered despite these constraints. Additionally, school leadership should prioritize targeted capacity building and resource allocation to mitigate these challenges.

vi. Improving Teacher Preparedness to Use Practical Approaches

A significant barrier to the successful delivery of practical lessons is inadequate teacher training on practical pedagogy. Schools should institute mentorship programs where experienced Biology teachers support their colleagues in planning, conducting, and assessing practical activities. Teachers should also be provided access to up-to-date instructional materials, manuals, and digital platforms that enhance their competence in practical teaching methodologies.

vii. Strengthening Laboratories in Poorly Resourced Schools

Schools with poorly resourced laboratories require targeted support to improve their capacity to deliver effective practical lessons. Partnerships with county governments, NGOs, universities, and private-sector donors should be explored to fund laboratory upgrades, supply essential equipment, and support infrastructural improvements. Cluster-based laboratory sharing among neighboring schools can also be considered to ensure equitable learning opportunities.

5.3.2 Policy Recommendations

i. Curriculum Reform to Emphasize Practical Learning

The Ministry of Education, in partnership with the Kenya Institute of Curriculum Development (KICD), should revise the Biology curriculum to increase the emphasis on practical learning. Given the strong evidence that practical simulations and experiments improve academic performance, curriculum content should allocate more time and weighting to hands-on activities that promote active learning.

ii. Standardized National Guidelines for Practical Instruction

Policymakers should develop national guidelines that mandate a minimum number of practical lessons per term. These guidelines will help standardize the delivery of practical content across schools, ensuring that all learners regardless of their school's resource level have consistent exposure to hands-on learning activities.

iii. Budget Allocation for Practical Resources

Government agencies should designate specific budget lines to support the purchase of laboratory equipment, consumables, and digital simulation tools. Funds should also be allocated for the maintenance and upgrading of laboratory facilities, especially in rural and under-resourced schools, to ensure that all learners benefit from high-quality practical instruction.

iv. Monitoring and Evaluation of Practical Approaches in Schools

Educational quality assurance bodies, such as the Teachers Service Commission (TSC) and the Ministry of Education's Quality Assurance and Standards Directorate, should regularly monitor and evaluate the implementation of practical teaching approaches. This oversight will ensure adherence to national standards, identify gaps in classroom practice, and guide continuous improvement in Biology instruction nationwide.

v. Integration of ICT in Practical Biology Instruction

To complement physical laboratory experiments, the Ministry of Education should promote the use of ICT tools such as virtual labs, simulation software, and interactive learning platforms. These technologies are especially valuable for schools with limited laboratory resources and can significantly expand students' access to practical learning experiences.

vi. Inclusion of Practical Skills in National Examinations

The Kenya National Examinations Council (KNEC) should integrate a practical assessment component into national Biology examinations. This would encourage schools and teachers to prioritize practical instruction throughout the academic year while ensuring that students develop essential hands-on skills that reflect real-world scientific practice.

vii. National Support Program for Poorly Resourced Laboratories

A national initiative should be established to support schools with poorly equipped laboratories. This program should prioritize marginalized regions and low-income schools, providing funding, materials, and technical support to ensure that equity in practical learning is achieved across the country.

5.4 Suggestions for Further Research

The following suggestions are made for further research:

i. The study focused on schools in Turbo-Sub County only. Further research should be carried out in other regions in Kenya to determine the performance of students in biology.
ii. The study also focused on one subject, thus biology. Further research should be carried out to investigate the effect of the practical approach in other science subjects.
iii. Future studies should also take a comparative approach to determine the variances in students' performance between the traditional approach, the practical approach and a combination of the two approaches.

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APPENDICES

Appendix I: Introduction

I am a student at MOI UNIVERSITY pursuing a master's degree programme in Curriculum Studies. I am currently undertaking a research study entitled ***"EFFECT OF USE OF PRACTICAL APPROACH ON LEARNERS' ACADEMIC PERFORMANCE IN SELECTED TOPICS OF BIOLOGY IN SECONDARY SCHOOLS IN TURBO SUB-COUNTY, UASIN GISHU COUNTY***". The study is expected to provide useful information that will be beneficial for improved academic performance of Biology in Secondary schools in Kenya.

You have been identified as one of the respondents to provide information for the study. This is therefore to request you to complete the questionnaire as honestly as possible. All information that you provide shall be treated with utmost confidentiality and will be used for the purpose of this study only.

You are therefore kindly requested to assist towards the success of this study by providing the required information as indicated in this research instrument. Your responses are anonymous and therefore your personal details will be treated with utmost confidentiality. Don't include your name anywhere in this Questionnaire.

Thank you for your cooperation.

Yours faithfully

Ernest Kipkemei Cheruiyot

Appendix II: Questionnaire for Teachers

Section A: Demographic information of the teacher

Please answer every question by **filling** in the blank spaces provided by checking/ticking (√) the correct response. Thank you.

i) Kindly indicate your gender

Female ☐ Male ☐

ii) Please indicate your teaching experience

0- 5 years ☐ 6-10 years ☐ 11-15 years ☐ 16 years and above ☐

iii) How many years have you been teaching Biology?

0- 4 years ☐ 5-8 years ☐ 9-12 years ☐ 13 years and above ☐

iv) Please indicate your academic qualification

a) Diploma (Education) ( )
b) Bachelor's Degree ( )
c) Post graduate diploma ( )
d) Master's Degree ( )
e) PhD ( )
f) Others ( )

Section B: Performance of Form 2 Students pretest in Selected Topics in Biology before Using the Practical Approach.

Pre-test (Form 2 Students):

Transport in Plants

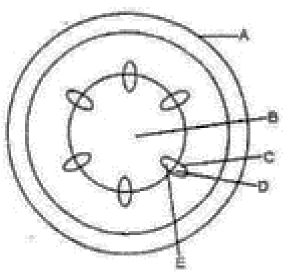
1. In an experiment, a leafy shoot was set up in a photometer and kept in a dark room for 2 hours. The set up was then transferred to a well-lit room for 2 hours.

a) What was the aim of this experiment? (1mk)

b) Explain the results which would be expected in each of the two experiments conditions. (3mks)

2. Explain how drooping of leaves on a hot sunny day is advantageous to plant. (2mks)

3. The diagram below represents a transverse section of a young stem.



a) Name the parts labelled A and B (2mks)

A_______

B________

b) State the functions of the parts labeled C, D and E (3mks)

C______

D_______

E_______

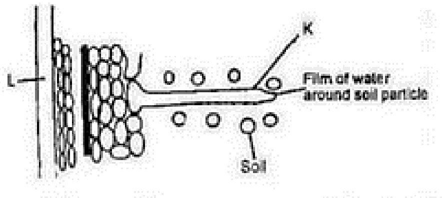
4. List three differences between the section shown above and one that would be obtained from the root of the same plant (3mks)

i. _

ii.

iii.

5. The diagram below represents the pathway of water from soil into the plant.



a) Name the structures labeled K and L

K_______

L_______ (2mks)

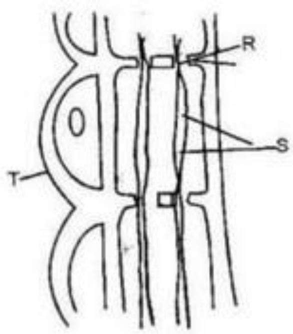
b) Explain how water from the soil reaches the structure labeled L. (3mks)

6. Name the process by which mineral salts enter into the plant. (1mk)

7. State two ways in which xylem are adapted to their function. (2mks)

8. What makes young herbaceous plant remain upright? (2mks)

9. The diagram below represents part of phloem tissue



a) Name the structures labelled R and S and a cell labelled T.

R _______

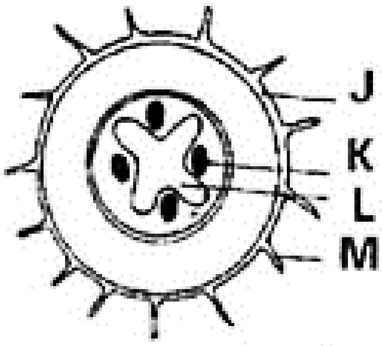
S _______

Cell T _______ (3mks)

b) State the function of the structure labelled S. (1mk)

10. How is support attained in herbaceous plant? (2mk)

11. The diagram below represents a transverse section through a plant organ.



a) From which plant organ was the section obtained? (1mk)

b) Give two reasons for your answer in (a) above. (2mks)

c) Name the parts labeled J, K and L (3mks)

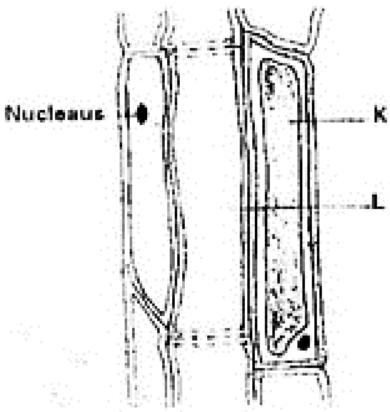
J____________

K_____________

L_____________

d) State two functions of the part labeled M. (2mks)

12. The diagram below represents a plant tissue.



a) Name the parts labelled K and L. (2mks)

K_____

L______

13. Describe how water moves from the soil to the leaves in a tree. (10mks)

Section C: Performance of Form 2 Students in Selected Topics in Biology after Using the Practical Approach

Post-test (Form 2 Students):

1. In an experiment to determine the effect of ringing on the concentration of sugar in phloem, a ring of bark from the stem of a tree was cut and removed. The amount of sugar in grammes per 16cm3 piece of bark above the ring was measured over a 24 hour period. Sugar was also measure in the bark of a similar stem of a tree which was not ringed. The results are shown in the table below

Amount of sugar in grammes per 16 cm3 piece of bark

Time of the day Normal stem Ringed stem

0645 0.78 0.78

0945 0.80 0.91

1245 0.81 1.01

1545 0.80 1.04

1845 0.77 1.00

2145 0.73 0.95

0045 0.65 0.88

a) Using the same axes, plot a graph of the amount of sugar against time (6mks)

b) At what time was the amount of sugar highest in the;

Ringed stem (1mk)

Normal stem (1mk)

c) How much sugar would be in the rigged stem if it was measured at 0345 hours? (2mks)

d) Give reasons why there was sugar in the stems of both trees at 06 45 hours. (2mks)

e) Account for the shape of the graph for the tree with ringed stem between:

0645 hours and 1545 hours (3mks)

1545 hours and 0045 hours (2mks)

2. Other than sugars name two compounds that are translocated in phloem. (2mks)

3. Explain why plants shed off their leaves. (2mks)

4. What is the importance of transpiration to plants? (4mks)

5. State two ways in which the root hairs are adapted to their function. (2mks)

6. State how environmental factors affect the rate of transpiration in flowering plants. (3mks)

7. Give adaptive features which enable a plant to reduce the loss of water. (20mks)

Section D: Comparison of Performance of Form 2 Students in Selected Topics in Biology before and after the Use of Practical Approach

On a scale of 1-5 (where 1=strongly disagree, 2=disagree, 3=not sure, 4=agree and 5=strongly agree) please score your extend of agreement to the following factors on use of Biology practical's and resources

Key: SA=strongly agree A=agree, DK=Not sure, D=disagree, SD= strongly disagree

No.	Variable Factors	SA	A	DK	D	SD
1	The Biology practical lessons taught using practical simulations is difficult as compared to conventional way of teaching.					
2	The Biology practical lessons taught through practical simulations is clear, stimulating and enhances content retention by learners unlike conventional teaching.					
3	The Biology practical lessons taught using practical simulations a waste of time as compared to conventional teaching.					
4	The Biology practical lessons taught using practical simulations enables learner to interact with materials severally until they understand the subject phenomena unlike conventional way of teaching.					
5	The Biology practical lessons can be administered to learners to study on own using					

	practical simulations in the absence of a teacher while conventional teaching requires presence of a teacher.					

Section E: Teacher Perceptions towards the Use of Practical Approach in Teaching Selected Topics in Biology in Form 2

On a scale of 1-5 (where 1=strongly disagree, 2=disagree, 3=not sure, 4=agree and 5=strongly agree) please score your extend of extent of agreement to the following factors on usage of Biology experiments performed in class

Key: SA=strongly agree A=agree, DK= Not sure, D=disagree, SD= strongly disagree

No.	Variable Factors	SA	A	DK	D	SD
1	Preforming class experiments while teaching biology subjects will enhance performance					
2	Class experiments help students understand theories and chemical principles which are difficult or abstract					
3	Identifying anatomy of species using class experiments is recommended					
4	Class experiments like handling of species, making measurements, analyzing data and drawing conclusions should be enhanced					
5	Lack of class experiments by biology teacher affects students' performance in biology practical					

Appendix III: Letter of Research Authorization

MOI UNIVERSITY
Office of the Dean School of Education

Email.deaneducation@gmail.com

P.O. Box 3900
Eldoret, Kenya

REF: EDU/PGCM/1036/16

DATE: 27th November, 2023

THE EXECUTIVE SECRETARY
National Council for Science and Technology
Box 30623-00100
NAIROBI

Dear Sir/Madam,

RE: RESEARCH PERMIT IN RESPECT OF ERNEST KIPKEMEI CHERUIYOT – EDU/PGCM/1036/16

The above named is a 2nd year Master of Education Student at Moi University, School of Education, Department of Curriculum, Instruction & Educational Media.

It is required of his Master of Education studies to conduct a research project and produce a research report. His research topic is entitled:

"Effect of use of Practical Approach on Learners' Academic Performance in Selected Topics in Biology in Secondary School in Turbo Sub-County, Kenya."

Any assistance given to enable him conduct research successfully will be highly appreciated.

Yours faithfully,

for:

PROF. ANNE S. KISILU
DEAN, SCHOOL OF EDUCATION

MOI UNIVERSITY
SCHOOL OF EDUCATION
DEAN
27 NOV 2023
Sign...
P. O. Box 3900-30100, ELDORET

Appendix IV: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **528902**

Date of Issue: **13/December/2023**

RESEARCH LICENSE

This is to Certify that Mr.. ERNEST Kipkemei CHERUIYOT of Moi University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Uasin-Gishu on the topic: Effect of increased use of practical approach on learners academic performance in selected topics in Biology in Secondary schools in Turbo Kenya for the period ending : 13/December/2024.

License No: **NACOSTI/P/23/31958**

528902

Applicant Identification Number

Director General

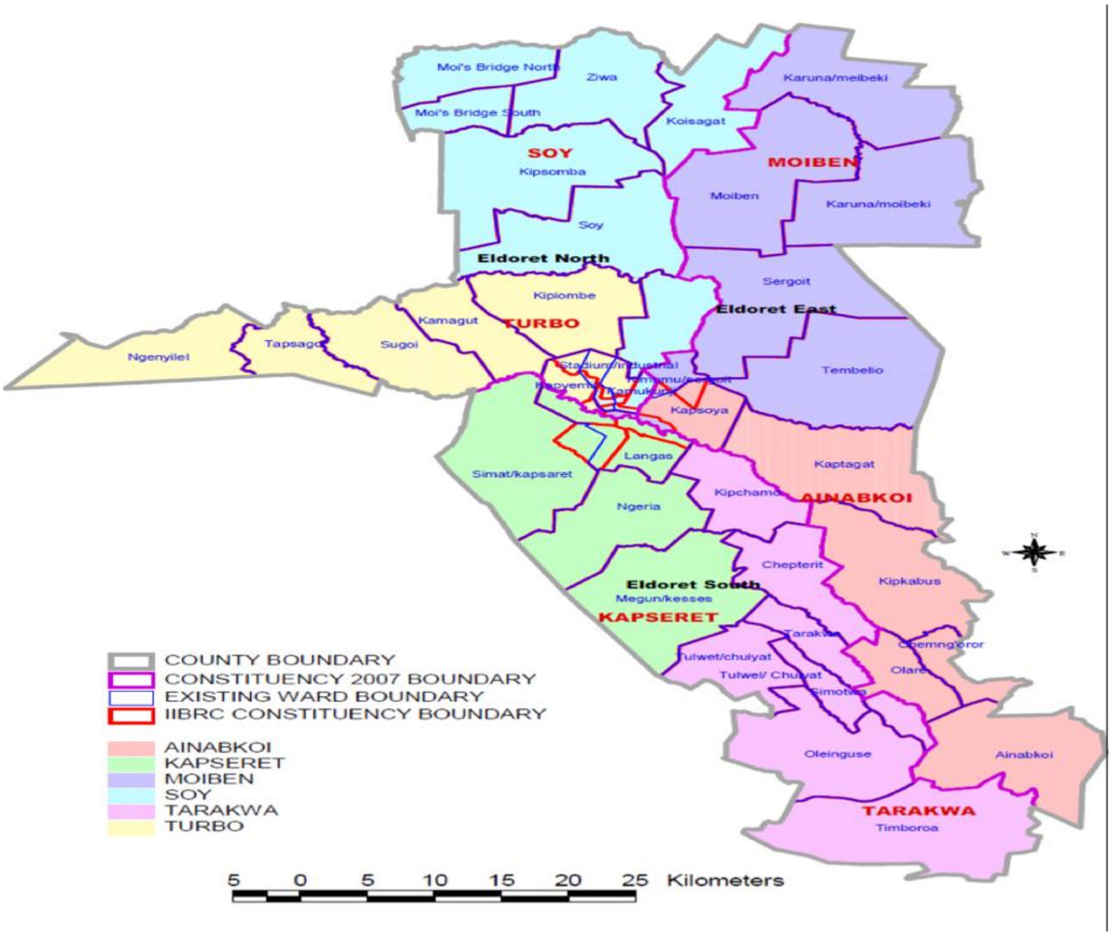
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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 V: Map of the Study Area



Appendix VI: Plagiarism Awareness Certificate

SR887

ISO 9001:2019 Certified Institution

THESIS WRITING COURSE

PLAGIARISM AWARENESS CERTIFICATE

This certificate is awarded to

ERNEST KIPKEMEI CHERUIYOT

EDU/PGCM/1036/16

In recognition for passing the University's plagiarism

Awareness test for Thesis **entitled: EFFECT OF USE OF PRACTICAL APPROACH ON LEARNERS' ACADEMIC PERFORMANCE IN SELECTED TOPICS IN BIOLOGY IN SECONDARY SCHOOLS IN UASIN GISHU-COUNTY, KENYA with** similarity index of 14% and striving to maintain academic integrity.

Word count:25758

Awarded by

Prof. Anne Syomwene Kisilu
CERM-ESA Project Leader Date: 27/06/2025