EFFECT OF USING PHOTOMICROGRAPHS AND REAL SPECIMENS ON BIOLOGY PERFORMANCE IN SECONDARY SCHOOL IN NANDI SOUTH SUB–COUNTY, KENYA

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DECLARATION

I certify that this is my original work and has never been submitted for consideration for a certificate, degree, or publication.

CAROLINE JERONO Date

SEDU/CTE/M/007/20

Declaration by supervisors

This proposal has been submitted with our approval as University Supervisors.

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DEDICATION

This work is dedicated to my late lovely daddy may his soul continue resting in eternal peace. It is through his hard work and dedication that I was able to pursue my master’s degree.

ABSTRACT

The study focused on examining the effect of teaching secondary school biology using photomicrographs and real specimens on Biology performance in secondary schools in Kenya. Constructivism Learning Theory and Cognitive Discovery Theory were the two theories that the study used. This was predicated on the assumption that students actively create meaning from experience, which enabled them to find new concepts to supplement prior knowledge The statement of the problem is that Biology one of the three sciences being taught in secondary schools in Kenya, has been performing poorly as shown by the Kenya National Examination Council KNEC, (2022) report. Despite a lot of interventions by the Ministry of Education to improve on Biology academic performance, the objective has never been achieved. The objectives of the study were as follows; to examine the effect of teaching Biology using photomicrographs and real specimen on students' academic performance. Secondly was to evaluate the influence of students' attitude towards the use of photomicrographs and real specimens on their Biology academic performance, and finally to evaluate how the use of science process skills of the experiment during handling of real specimens and photomicrographs affects Biology academic performance. The Quasi –experimental design was used in the study where a pre-test Standardized Biology evaluation test (SBET) was administered to all the study participants. Then a treatment offered and later a post-test Standardized Biology evaluation test (SBET) to both photomicrograph and real specimens groups corresponding to treatment given. The target population was 2980, where 298 form one Biology student and 18 teachers were used as the respondents. The population of interest were identified using stratified sampling and simple random sampling techniques. Standardized Biology Evaluation Test SBET, a questionnaire for teachers TQ and for students SQ and checklist instruments were used as data collection instruments to generate data. The researchers' supervisors validated the instruments during piloting. The reliability coefficient of r=0.83 was obtained. The internal consistency of instruments was estimated by use of test-retest technique. For establishment of consistency of the questionnaire, Cronbach's Alpha coefficient that estimates the reliability of the instrument was used which gave Cronbach's coefficient alpha of 0.89 for students and 0.84 for teachers. The researcher then carried out the data analysis from the collected data using descriptive statistics that is use of frequencies mean standard deviation and percentages. Also, inferential statistics (t-test) were used being guided by SPSS and excel. The study found out that the students in the experimental group performed better than those in the control group, the students' attitude were positive on the use of real specimen teaching approach and that also the students had minimal mastery of the science process skills. The study recommended that the Teachers Service Commission (TSC) provide the use of real specimens teaching approach in secondary schools in order to improve performance in KCSE Biology Examinations, the Ministry of education (MOE) to provide guidelines on teacher training institutions on provision of adequate training to aid science teachers have transferable science process skills in teaching and learning and finally the Kenya Institute of curriculum Development (KICD) to take corrective measures in provision of adequate resources to meet the demands required for the education of teachers. This would in turn enable the teachers to use their skills in teaching and evaluating learners leading to improved performance in Biology in secondary schools in Kenya.

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LIST OF ABBREVIATIONS AND ACRONYMS

S.B.E.T	Standardized Biology Evaluation Test
K.C.S.E	Kenya Certificate of Secondary Education
K.I.C.D	Kenya Institute of Curriculum Development
M. O. E	Ministry of Education
N.G.S.S	Next Generation Science Standards
R.SP	Real Specimens
S.P.S.	Science process skills
S.P.S.S	Statistical Package for the Social Science
S.Q	Students' Questionnaire
T.Q-	Teachers' Questionnaire
U.R.S	use of Real Specimens Model
W.A.E.C	West African Examination Council

CHAPTER ONE

INTRODUCTION OF THE STUDY

1.1 Introduction to chapter

This chapter gives insight on the background of the study, statement of the problem, purpose of study, objectives of the study, hypothesis, justification of the study, significance of the study assumptions of the study, scope of the study, limitations of study theoretical frame work and conceptual frame work.

1.2 Background of study

Biology is a branch of science that aims at equipping learners with fundamental science skills and a deep understanding of the biological principles governing life in the world. The learners get to obtain the skills needed to be independent, life-long learners, including the ability to evaluate scientific issues that affect daily life and society. As well, biology is a pre-requisite subject for many fields of learning contributing immensely to the understanding of oneself, nature and contribution to the technological growth of the nation for instance in medicines, forestry, agriculture and biotechnology. In any Curriculum science, education is acknowledged as means of providing knowledge for developing technological skills. The process for effective learning in Biology is generally the case in other sciences which require a practical input. But the use of Practical approach to teaching and learning in schools is on the decline in the belief that it is time consuming as teachers rush to complete the syllabus (Kiprono, et al., 2018).

As educators implement new science standards in teaching of Biology, one of the most important decisions they face is selecting the best instructional approach that support learning, promote scientific skills gapping the poor academic performance of biology (NGSS Lead States, 2013). The teachers, states and leaders in Biology education research, have to develop a suitable teaching approach to support educators in effort which include teaching and evaluation using real specimens rather than photomicrographs on the parts applicable in Biology practical and where it is not available the artificial specimens should be improvised as recommended by (KNEC, 2022) report. Practical carries weight in grading of the total mark in Biology academic performance as it is marked out of 40 implying a grade (C) out of the total 100 marks. For one to score well in biology he or she should look for 30 marks then only 6 marks from the rest 0 marks from the theory part. (Owino et al., 2015). According to Sumrall & Sumrall, (2021), teachers have to use appropriate teaching approaches so as to get the most effort from their students to learn Biology and model what scientists do.

In USA, the use of Real Specimen has strategies that equip students with scientific skills necessary in the 21st century for development of socio-economic, industrial and technological activities (Williams & Gray, 2021). Biology instruction approach remains a backbone of academic performance and scientific skills development as the scientific and technological divide widens and when learners are not in access of the rigorous activities involving real specimens, then the Biology academic performance has been and will continue being poor and as well as poor scientific skill development among the learners.

In Africa, there have been a lot of discussions about 21st century skills and how important they are to equip students and this can be done by exposing the learners to resources that enables them to embrace their learning environment as a living world according to Hunter-Thomson, (2019). The use of real specimens enhances the curiosity and a lasting passion for learning and development of scientific skills, thus raising students' academic performance and therefore teachers should use the approach to help improve their learners' scientific skills and academic performance of Biology in schools (Olatoye, 2017).

The role of Education in Kenya is to promote economic, technological and industrial development for the goodness of the nation (Gacheri, 2014). For this to be attained, the youth has to be having scientific skills as per 21st century where almost all tasks have to be done technologically (Cherono, 2021). Since Kenya as a nation depends on skills, knowledge and expertise in science to meet vision 2030, the appropriate teaching approach method should be used by the teachers to administer the content of Biology to the students. Biology therefore should receive much emphasis on practical hands-on activities to enable the students acquire skills that are significant and relevant to life and society (Mwangu & Sibanda 2017).

(Cherono,2021), teaching methods or strategies currently recommended appropriate experimental approach of teaching to help the students learn science process skills to meet the vision 2030, a number of initiatives has to be enhanced in practical teaching in schools as pedagogy. This includes equipping school laboratories through government funding.

This study sought to fill the gap through investigating the effect of teaching using real specimens and photomicrographs in students' performance. Practical valuation assessment mostly deals with acquisition of practical skills (Gok , 2014). In this work, an opportunity is provided for testing application of scientific procedures, Manipulative abilities as well as scientific skills.

1.3 Statement of the problem

Biology, one of the three sciences being taught in secondary schools in Kenya, has been performing poorly as shown by the Kenya National Examination Council KNEC, (2022) report. The report showed there was a decline in performance of Biology paper three. Biology paper three tests a candidate's manipulative, observation and interpretation skills. Most students interacted with Specimens for the first time when they did their Biology paper three exams. Despite a lot of interventions by the Ministry of Education to improve on Biology academic performance, the objective has never been achieved. No empirical study has been conducted in Nandi County to investigate the instructional approach on photomicrographs and real specimens offered by the teacher to students and its effects on student's performance in Biology examinations.

1.4 Purpose of study

The purpose of the study was to investigate the effects of using photomicrographs and real specimen for instructional purposes of topics in secondary school biology to enhance academic performance in Kenya

1.5 Objectives of the study

1.5.1 Main Objectives

To investigate the effect of using photomicrographs and real specimens on biology performance in secondary schools in Nandi South sub-county.

1.5.2 Specific Objectives

i. To investigate the use of photomicrographs and real specimens in the teaching Biology in Secondary schools and its effects on students' performance.
ii. To evaluate the influence of students' attitude towards the use of photomicrographs and real specimens on their biology academic performance.
iii. To examine the effects of using Science process skill on students biology academic performance during handling of real specimens and photomicrographs.

1.6 Research Questions

i. What is the effect of teaching using photomicrographs and real specimens on students' Biology academic performance?
ii. What is the influence of students' attitude on the use of photomicrographs and real specimens in their Biology academic performance?
iii. Are the six science process skills of the experiment used during handling of real specimens and photomicrographs and how does its effect Biology academic performance?

1.7 Hypothesis

Ho1: There is no significant difference in Biology academic performance students taught using Real Specimens and those taught using Photomicrographs.

1.8 Justification of the study.

Biology assists in the development of a set of transferable skills including handling data, practical problem-solving, and applying the scientific method in dealing with daily life activities. By learning it the right way, the learners develop relevant attitudes, such as concern for accuracy and precision, objectivity, integrity, inquiry, initiative and inventiveness. Thus leads to acquisition of the essential scientific skills required in 21st century for progression towards the achievement of Kenya's vision 2030.

1.9 Significance of the study.

The teachers service commission (TSC) whose mandate is to ensure effective service for quality teaching standards, will find this study useful as it will serve as a source of information from schools about the teaching approach in learning in secondary schools and how this affects the performance in KCSE biology Examinations and also generate a way of improving Biology academic performance.

The findings of the study will enable the Ministry of education make the right decision on calling for in service courses to induct teachers have skills in teaching and learning process.

The finding of study will also help the Kenya Institute of curriculum Development (KICD) to take corrective measures in provision of adequate resources to meet the demands required for the education of teachers. This would in turn enable the teachers to use their skills in teaching and evaluating learners leading to improved performance in Biology in secondary schools in Kenya.

1.10 Assumptions of the study

The study made the following assumptions:

- That, study participants provided honest answers to the questions.
- That, there was not numerous differences between the methods of teaching adopted by teachers to the learners in the sampled schools.
- That the respondents cooperated during the study

1. 11 Scope of the study

The study focused on investigation of teaching approach on students’ Biology academic performance in secondary schools in Nandi South Sub-county Kenya. This is due to poor performance as per the KCSE results (2020) report and also this research has never been conducted there. Form one students of the selected secondary schools were used. This is due to the fact that the topic on cell is offered at this level. The researcher used the topic because it is one of the recommendations by KNEC (2018) that it should be tested comprehensively as this involves the skills critical for the current world.

1.12 Limitation of the study

Different schools had different calendar of activities and this made it difficult for the researcher to efficiently carry out their research. The study was limited to form one students in Nandi South Sub-county; hence the findings of this study is not to be generalized to other counties. The study was also affected by the attitude of the respondents.

1.13 Theoretical framework

Constructivism Learning Theory and Cognitive Discovery Theory were the two theories that the study used. This is predicated on the assumption that students actively create meaning from experience, which enables them to find new concepts to supplement prior knowledge (Taber, 2019). Students should be able to engage with genuine specimens while making observations that lead to the learning of scientific skills in order for them to actively create knowledge (NGSS, 2021). Understanding is created through invention, according to Piaget's individual cognitive discovery theory and Vygotsky's social constructivism hypothesis. Moreover, output and creativity are lost in the absence of comprehension. According to Hunter-Thompson (2019), discovery learning is the use of instructional tactics and methodologies that emphasize students' active handling of genuine specimens as learning opportunity. Piaget outlined three primary characteristics of discovery learning: problem-solving and exploration to produce and generate knowledge..

Engaging in student-driven activities inspires students to produce new knowledge. The first and most crucial aspect of discovery learning is that, rather than passively taking in information through lectures or drills, students actively create and generalize knowledge through problem-solving and exploration (Bicknell-Holmes & Hoffmans, 2000). This allows for broader applications of skills to be tested. Vygotsky's primary area of study was development psychology, and he put forth a theory on how children's higher cognitive skills develop and that reasoning emerges from practical action in a social setting.

In the beginning of his professional life, he maintained that universal cognitive processes and cultural practices, as well as signs and symbols, mediated the development of reasoning. According to his idea, learning occurs when a student-centered strategy is used to enhance the teaching and learning process.

Additionally, Vygotsky proposed the idea of the zone of proximal growth, which is commonly believed to describe how prior knowledge and the availability of teaching are prerequisites for learning new information.

The constructivist theory of Bruner (1966), which holds that learning is an active process in which the learner builds meaning from various experiences, served as the foundation for this investigation. Students build new concepts based on what they already know and what they have learned in the past as claimed by (Burner,1996). Without allowing students to engage with the real specimens, a teacher cannot "pour" material into their brains and expect them to comprehend and apply it correctly afterward. This was highlighted by (Brooks & Brooks, 1993). While allowing pupils to experiment, ask questions, or engage in activities that call for their full engagement, the instructor facilitates, modifies, and makes suggestions.

The study looked into instructional strategies for both teaching and learning. According to (Dewey, 1997), children have an innate desire to learn actively. Rather than viewing children as passive recipients of knowledge, he thought of them as active participants in it. It is the responsibility of educators to provide students with resources and opportunities to learn new things. Process skills including applying, interpreting, classifying, observing, exploring, experimenting, drawing, hypothesizing, and gaining practical experimentation skill are the main focus of science. Form One Cell topic includes areas to test the various cell aspects that enable fundamental practical skills like drawing, observing, and measuring with the help of apparatus manipulation, data recording, and being able to observe specimens and make analyses and drawings of them. This study looked at developing science process abilities while learning via exploration.

1.14 Conceptual Framework

The study was conceptualized with teaching using real specimens and photomicrographs, students' attitude towards use of RSP and photomicrographs and the six components of experiment during handling of RSP and photomicrographs during experiment as the independent variables while the teachers experience were the intervening variable and Biology students' academic performance as the dependent variable.

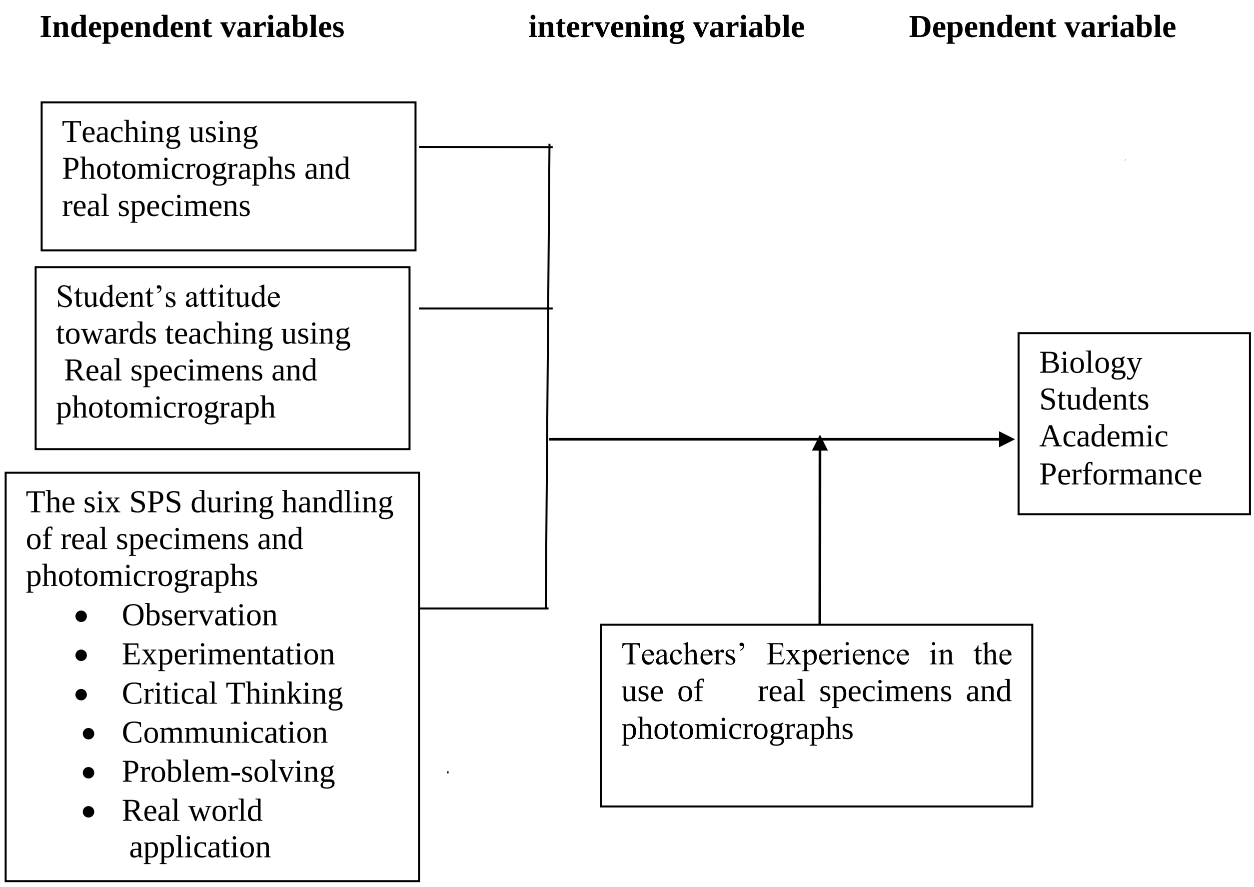


Figure 1. 1: Conceptual Framework of the study

(Source: Author, 2024)

1.15 Operational definition of terms

Attitude- This is a mental position with regard to a fact or state (Muyassaroh, et al., 2020). Altitude can be positive or negative. For this study, learners and teachers attitude on the two instructional approaches of learning were assessed.

Biology academic performance- It is the measurement of student achievement in Biology subject (Grunspan, et al., 2016). This is normally graded from the lowest score to the highest score. For the purpose of the study, these were achieved by use of Standardized Biology Evaluation Test on learners where good Biology academic performance is the grade that cans allow a learner to join a prospected medical field.

Photomicrographs – This is a photograph of a microscopic object, taken with the aid of a microscope (Miller, et al., 2017). For the purpose of this study, a photograph of a cell were used to teach learners and compared with the use of a real specimen. These were done to assess which of the two illustration methods led to better performance in Biology test.

Real Specimens –This is a real body or plant tissue that is taken for a Biology test without using a photograph or a photomicrograph (Toninato & Santovito, 2015).

Teaching approach- It is a collection of fundamental concepts, convictions, or notions about the character of learning that are applied in the classroom (Nordin, 2017). An approach is a perspective on instructing and learning. Any approach to teaching a language must start with a theoretical understanding of what language is and how it can be learned.

1.16 Summary of the chapter

The chapter has dealt with introduction of study, the essence to use the proper instructional method in the background of the study, the statement of the problems which clearly indicates that there is poor performance in Biology, the research objectives that will guide the study, the research questions that the research ought to answer, hypothesis that will show whether there is significant difference on students taught using photomicrographs and those taught using real specimens ,justification of the study also have been dealt with ,assumptions of the study, scope of study, limitations have been stated , theoretical framework also have been elaborated, conception frame work have also been dealt with which clearly shows the independent and dependent variables and finally operation definition of terms have been elaborated.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction of the chapter

This chapter dealt with literature review which contains sections on theories behind the research that is; constructivism theory, constructivist instructional method and conventional instructional method. It also address the literature that compare students' performance on teaching using real specimens and those taught using photomicrographs, literature on students' attitude towards teaching using real specimen and photomicrograph, literature on the six science process skills during handling of real specimen and photomicrographs and finally the elaborate details on summary of the literature review.

2.2 Theories behind the research

2.2.1 Constructivism theory

According to the 21st century, instructional theories dictate that a learner should be active during the knowledge construction because the process of learning science is complex and requires active learners during the learning process. Therefore, application of appropriate instructional theory and methods help a learner to be active (Wodaj, 2020). Learning in a constructivism perspective is viewed as a dynamic process that permits learners to construct knowledge in a social setting, from their experiences and prior understanding (Driver, et al., 1994). Constructivist theory originated from two theorists in the early 19th century: Piaget (1976) and Vygotsky (1986). Piaget's theory explains how a learner actively constructs knowledge while Vygotsky's deals with theory of cognitive development as being brought about by social and cultural interactions of the learner.

2.2.2 Cognitive constructivism

According to cognitive constructivism, a learner actively constructs knowledge based on mental schema as opposed to being passive absorber of knowledge (Piaget, 1970). Piaget argued that a child undergoes cognitive development in four stages. Sensorimotor stage (0-2 years), is the first phase where a child acquires language, thereby increasing social and mental development. It is a stage of object permanence (Lazarus, 2010). The second stage, pre-operational (2-7 years), a child is able to work with images and symbols enhancing their imagination, language and problem-solving capabilities (Lazarus, 2010).At the third stage, concrete operational (7-11 years)based on concrete evidence, a child can be able to develop logical reasoning. The fourth stage, formal operational (11-and above), a child is able to develop logical thinking and abstract reasoning. Social context is paramount at this stage (Lefa, 2014). The child's mental structures involve conceptual reasoning and therefore are able to perform activities involving tests of hypotheses therefore enhancing problem solving skills (Lazarus, 2010).Piaget (1953), asserts that an individual actively constructs knowledge as they pass through the stages of development through assimilation and accommodation. When an individual encounters a new knowledge, incorporated into his or her existing schema, assimilation occurs. He further claims that when new knowledge cannot fit into existing schema, the schema has to be altered so that new learning can take place.

Therefore, it is important that teachers create an environment that prompts student's cognitive development through challenging activities that promotes assimilation and accommodation. Implications to Piaget's theory is that learners should be made active by use of instructional approach method that challenges their ideas (Beard, 2013). One such instructional method is teaching using real specimens rather than photomicrographs where a student's prior knowledge is prompted through actively participating on hands on activities constructing new knowledge into their mental structures of assimilation and if not so, the mental structures have to be altered so that the new knowledge can fit in the accommodation, hence better concept acquisition takes place.

2.2.3 Social constructivism

Social constructivism views cognitive development as being brought about by social and cultural interactions of the learner. Vygotsky came up with a principle that cognitive development in a learner can be accessed through interactions with the environment. The learner is an active participant in their environment by assuming an active role in learning while the teacher is seen as a facilitator. When a learner encounters new ideas by interacting with RSP, new ideas are constructed (Vygotsky, 1980). Vygotsky (1962) argued that culture, social interactions, language and zone of proximal development (ZPD) contribute to cognitive development of an individual. One of his major theories was ZPD where learning occurs when an individual is assisted in the learning process. According to Vygotsky(1980), individuals learn when they actively interact with their peers. Cooperative learning is vital in creating a profound conceptual understanding; hence, teachers should embrace individual difference by ensuring that students interact socially (Wodaj,2020).Therefore, students should be grouped according to different cognitive abilities so that high achieving students can help their peers who are low achievers work within their zone of ZPD. Teaching using real specimen is an instructional approach in which students are engaged in development of new knowledge and socially benefits through group settings. The teacher guides the students during the learning process and ensures that the groups formed are of different learning abilities. Students with lower cognitive ability can be able to carry out tasks successfully with the help of their peers who have a higher cognitive ability.

2.2.4 Constructivist Instructional

Constructivist instructional methods are basically student-centered and thus allow students to actively construct knowledge which requires a high degree of self-driven learning (Amineh & Asl, 2015). At the beginning instructional processing is a constructivist classroom; students' prior knowledge is considered and students participate actively during the learning process, leading to meaningful conceptual understanding. Learners' misconceptions are corrected by asking prompting questions (Meyer & Land, 2013). Evaluation of learning in a constructivist classroom takes place during teaching. Learners' work and all other activities are assessed (Savery, 2015). Among the constructivist instructional methods are cooperative learning, discovery method, inquiry-based learning.

The constructivist approach to learning highlighted in the provided text emphasizes the importance of learners actively constructing their understanding based on prior knowledge. While this approach is praised for fostering critical thinking skills and real-life application, it is essential to critically examine its implications.

The assertion that teachers in a realism classroom are merely facilitators guiding learners towards making their conclusions aligns with the constructivist philosophy. However, the effectiveness of this approach heavily relies on the quality of students' prior knowledge and their ability to construct accurate understandings. The text acknowledges the importance of prompting students' previous knowledge to correct misconceptions, a crucial step in constructivist learning (Driver et al., 1994).

The cited studies provide valuable insights into the comparative effectiveness of constructivist and conventional learning environments. For instance, Marfilinda & Apfani (2020) found improvements in critical thinking skills and conceptual understanding with realism. Similarly, Chopra and Gupta (2011) demonstrated that learners exposed to hands-on activities in a realism environment outperformed those taught through theoretical concepts.

However, the study by Weltman and Whiteside (2010) challenges the notion that active learning, synonymous with the constructivist approach, is always effective. They suggest that a student's high-grade point average may be a more significant factor in understanding than the level of active participation. This raises questions about the universality of the constructivist approach, indicating that its effectiveness might vary based on individual student characteristics.

Furthermore, the text suggests that students' interest and enthusiasm are stimulated in a realism environment, leading to increased eagerness to learn. While this aligns with the principles of constructivism, it is crucial to acknowledge that student engagement is a complex and multifaceted construct influenced by various factors, including teaching methods, student motivation, and the learning environment (Fredricks et al., 2004).

The assertion that attitude significantly influences an individual's actions is well-supported by psychological theories (Ajzen, 1993). The text rightly emphasizes the role of attitude in the learning process, highlighting its manifestation through observable behaviors such as preferences, acceptance, and values (Welch, 2010).

The connection between attitude and the learning environment is a crucial aspect. According to Han and Carpenter (2014), the learning environment plays a pivotal role in shaping students' attitudes and, consequently, their academic performance. This aligns with the idea that a positive learning environment can enhance students' engagement and receptiveness to instructional approaches (Slavin, 2009).

The example from Loveland's study in Utah (2014) adds practical insight into how students' attitudes can be influenced by the instructional approach. The preference for hands-on activities over photomicrographs suggests that active, learner-centered approaches contribute to a positive attitude. Furthermore, Loveland's study highlights the connection between students' enjoyment of classes and the instructional approach, indicating a potential correlation between positive attitudes and academic achievement.

Hus, et al.,(2014) provides additional support for the argument that students' attitudes towards instructional methods can influence academic performance. The mention of the main principle of constructivism - student’s actively constructing knowledge on their own - reinforces the idea that a positive attitude towards learning leads to better academic outcomes.

The study conducted in Kenya by (Ongowo, et al., 2015) adds a valuable perspective on the perception of student-centered learning environments. The variation in perception between high- and low-achieving schools highlights potential disparities in attitudes based on the learning context. However, the text doesn't delve into the reasons behind the differing perceptions, which could have provided a deeper understanding of the dynamics at play.

2.3 Students’ academic performance on teaching using real specimen and photomicrographs instructional Method

In a constructivist environment, learners are able to build their own understanding by use of their previous knowledge to create new ideas. A teacher in a realism classroom is just but a facilitator who guides the active learners towards making their own conclusion. Students’ previous knowledge is prompted to ascertain what they know before a concept is taught. This will enable the teacher to correct any misconception that would arise and therefore concepts will be built on factual knowledge leading to learning of new concepts. In addition, transfer of new knowledge to new contexts and real-life situations occurs, which are a vital component in science education. Several studies done that compares learners’ academic performance between constructivist and conventional learning environments have shown better results in favor of constructivist learning environment (Adak, 2017; Chopra and Gupta, 2011; Marfilinda & Apfani 2020; Naade, Alamina & Okwelle, 2018; Oludipe & Oludipe, 2010; Shaheen & Kayani,2015; Sharma, 2018; Weltman & Whiteside, 2010). Marfilinda & Apfani,(2020) in their study found that critical thinking skills of students were improved when realism was employed. The study further found that students' conceptual understanding of scientific concepts was improved. Chopra and Gupta, (2011) conducted a study to investigate the impact of hands-on activities on performance amongst students on the 9th standard. Achievement tests were given to control and experimental groups. The Instrumental method for the experimental group was real specimen and the other group was theoretical questions. The study showed that learners instructed using realism performed better than those taught using theoretical concepts on photomicrograph. A similar study conducted by Oludipe and Oludipe, (2010) showed that students who were taught using realism performed significantly higher on pre-test and delayed post-test than those taught using theory methods. Consequently, the group on realism showed a higher mean score than the control group on their post-test as compared to their pre-test scores. Students in the realism group were able to retain 80% of the taught concepts while the control group had 10% retention of concepts. Consequently, students' master content at higher cognition level was achieved based on their study, (Naade, et al.,2018). Students' interest and enthusiasm are stimulated in the realism environment as opposed to those using photomicrographs. This leads to students developing eagerness and interest to learn. On the contrary, Weltman and Whiteside (2010) study showed that active learning is not always effective but rather the students having a high-grade point average attained a greater degree of understanding when a student actively participated in taking a central role in during instruction. It is the researcher's view that studies that involve learners are bound to result in improved learning. This is because participation of learners gives the teacher an opportunity to see where learning is hindered for whatever reason and step in to assist the learners resulting in better understanding of the material being learnt. However, because of studies that seem to suggest that even instructional methods with passive involvement of the learners can also result in improved performance, this study therefore sought to establish the effect of teaching using photomicrographs and real specimens on students' academic performance in Biology among secondary schools in Kenya.

2.4 Students' Attitude towards teaching using real specimens and photomicrographs

Attitude is a main contributing factor to an individual's action. How one thinks or feels either positively or negatively towards a particular environment is determined by the individual's attitude. Attitude can be unobservable and can only be comprehended in the form of manifested behavior. Attitude encompasses a span of emotional behaviors for instance, prefer, accept and value (Welch, 2010). Attitudes expressed in the form of understanding and behavior comes out due to learning environments. When planning lessons, the learning environment should be given utmost consideration as it determines the efficacy of an instruction (Han & Carpenter, 2014).

Students' attitude, emotion or view on a teacher, instructional approach or area has a great impact on a learning process. Students achieve higher scores academically when they have a positive attitude towards an instructional approach than those with a negative attitude (Slavin, 2009).A study conducted in Utah by Loveland (2014) showed that students enjoyed hands-on activities rather than photomicrographs . Students enjoyed classes when the approach involved; learner centered activities, and tasks that involved students constructing their own knowledge. The study also sought to find out that during hands-on activities, students acquire scientific skills that are crucial for the achievement of Kenya vision 2030. As the students construct ideas, they will find an opportunity to further understand the concept. This will eventually lead to an increase in class performance. (Hus, et al.,2014) in their study proved that students' attitude towards instructional methods influenced their academic performance in science and when the students are exposed to experimental activities and research work hence, they are able to actively construct knowledge on their own which is the main principle of constructivism.

Studies carried out in Kenya by (Ongowo, et al., 2015) showed that students generally had high perception for a student centered learning environment. However, the perception of low achieving schools towards student centered learning environments was higher than those of high achieving schools. Researchers attributed this difference to the fact that students in low achieving schools have views on what to expect in a constructivist learning environment. The findings of the study proved that the students preferred more on teaching using realism than teaching using photomicrographs.

2.5 The six science process skills of the experiment used during handling of real specimens and photomicrographs

2.5.1 Observation Skills

Observation is a fundamental science process skill. Engaging students in careful observation of natural phenomena enhances their understanding of scientific concepts. According to the American Association for the Advancement of Science (AAAS), developing observation skills is crucial for scientific inquiry (AAAS, 2009).

2.5.2 Experimentation and Inquiry-Based Learning

Hands-on experiments and inquiry-based learning promote the development of science process skills. Engaging students in designing and conducting experiments helps them apply critical thinking and problem-solving skills. This is supported by the Next Generation Science Standards (NGSS), emphasizing the importance of inquiry-based practices (NGSS Lead States, 2013).

2.5.3 Critical Thinking and Analysis

Critical thinking is a key aspect of science process skills. Analyzing data, evaluating evidence, and drawing conclusions contribute to a deeper understanding of scientific concepts. The National Science Teachers Association (NSTA) highlights the importance of critical thinking in science education (NSTA, 2016).

2.5.4 Communication Skills

Effectively communicating scientific ideas is integral to the scientific process. Presenting findings, writing reports, and engaging in scientific discourse contribute to academic success. Communication skills are emphasized in various science education frameworks, including NGSS and AAAS (AAAS, 2009; NGSS Lead States, 2013).

2.5.5 Problem-Solving Abilities

Science process skills, such as hypothesis formulation and testing, support students in developing problem-solving abilities. The ability to propose solutions, test hypotheses, and troubleshoot enhances academic performance across various subjects (NSTA, 2016).

2.5.6 Real-World Application

Science process skills encourage students to apply scientific concepts to real-world situations. This practical application enhances academic performance by connecting theoretical knowledge with real-life scenarios (NSTA, 2016).

2.6 Critique of the literature

2.6.1 Students' academic performance on teaching using real specimen and photomicrographs instructional Method

The provided passage discusses the benefits of a constructivist approach over a conventional one in the context of science education, particularly in the teaching of Biology in secondary school. The passage asserts that in a constructivist environment, learners can build their understanding by using previous knowledge to generate new ideas. The teacher is depicted as a facilitator guiding active learners towards forming their own conclusions. This aligns with the principles of constructivism, emphasizing student engagement and the importance of prior knowledge in the learning process. However, the passage could benefit from a clearer definition of constructivism and how it differs from other educational paradigms. A concise theoretical framework could enhance the readers' understanding of the underlying principles.

Studies by Adak (2017), Chopra and Gupta (2011), Marfilinda & Apfani (2020), Naade, Alamina & Okwelle (2018), Oludipe & Oludipe (2010), Shaheen & Kayani (2015), Sharma (2018), and Weltman & Whiteside (2010), provide a diverse range of perspectives and supporting evidence. However, it would be beneficial to include specific details about the methodologies employed in these studies to assess their rigor and applicability to the current argument.

The passage highlights the positive impact of realism on critical thinking skills and conceptual understanding, citing Marfilinda & Apfani (2020) and Chopra and Gupta (2011). These studies suggest that hands-on activities and the use of real specimens contribute to better academic performance. While these findings are compelling, it is important to consider potential limitations and external factors that may have influenced the outcomes. For instance, variations in teaching styles, student demographics, or cultural contexts could impact the generalizability of these findings.

The passage also touches on students' interest and enthusiasm being stimulated in a realism environment, contrasting it with the study by Weltman and Whiteside (2010) that questions the effectiveness of active learning. This presents an interesting perspective but could benefit from a deeper exploration of factors influencing student engagement. It would be valuable to investigate how different instructional methods contribute to sustained interest and motivation over time.

2.6.2 Students' Attitude towards teaching using real specimens and photomicrographs

The literature discusses the significance of attitude in the learning process, emphasizing its impact on students' academic performance. The central claim is that a positive attitude towards instructional approaches and learning environments contributes to better learning outcomes. While the passage introduces relevant studies and provides insights into the relationship between attitude and academic performance, there are areas that could benefit from further elaboration and clarification. The mention of emotional behaviors like preference, acceptance, and value, as components of attitude, is a valuable addition. However, it would be beneficial to cite specific sources or studies supporting these assertions, adding credibility to the conceptualization of attitude (Welch, 2010).

The connection between attitude and the learning environment is highlighted, with an emphasis on the importance of considering the learning environment when planning lessons. Citing Han and Carpenter (2014) supports this assertion but lacks a more detailed explanation of how specific aspects of the learning environment impact attitude and subsequent behavior.

The literature introduces the idea that students' attitudes towards teachers, instructional approaches, or subject areas influence the learning process. The claim that students achieve higher scores when they have a positive attitude is supported by Slavin (2009). However, it would strengthen the argument to provide specific examples or mechanisms through which attitude translates into academic success. Additionally, acknowledging potential counterarguments or limitations to this claim would add depth to the discussion.

The passage refers to Loveland's (2014) study in Utah, indicating that students preferred hands-on activities over photomicrographs. While this study supports the importance of instructional approach in shaping attitudes, it would be valuable to delve deeper into the reasons behind students' preferences. Additionally, considering the geographical and cultural context of Utah may provide insights into the generalizability of the findings.

The mention of (Hus, et al., 2014) study linking students' attitudes to instructional methods and academic performance aligns with the constructivist approach. However, the passage could benefit from a brief explanation of the main principles of constructivism and how they relate to the study's findings.

The reference to studies conducted in Kenya by (Ongowo, et al.,2015) introduces the context-specific aspect of attitudes towards student-centered learning environments. The literature suggests that the perception of low-achieving schools differs from that of high-achieving schools. Providing more details on the methodologies and specific findings of these studies would enhance the credibility of the claims and help readers understand the nuances of the Kenyan context.

2.7 Summary of the Chapter

The chapter outlines the key areas covered in the literature review, including constructivism theory, instructional methods, a comparison of teaching with real specimens and photomicrographs, students' attitudes, and the summary of the literature review. The focus is on exploring the impact of these factors on students' academic performance.

The section on theories behind the research delves into constructivism, with subsections on cognitive constructivism and social constructivism. It emphasizes the active role of learners in knowledge construction, drawing from the theories of Piaget and Vygotsky. The passage suggests that constructivist instructional methods, such as teaching with real specimens, align with these theories and facilitate better concept acquisition.

The literature on students' academic performance highlights studies favoring constructivist approaches. Hands-on activities with real specimens are shown to improve critical thinking skills and conceptual understanding. The critique acknowledges the effectiveness of active learning but introduces Weltman and Whiteside's study, suggesting that high-grade point averages might play a significant role. The passage invites a more nuanced exploration of the universality of the constructivist approach.

The section on students' attitudes towards instructional methods emphasizes the importance of attitude in the learning process. Studies suggest that positive attitudes lead to higher academic performance. Loveland's study in Utah provides practical insights into student preferences for hands-on activities. However, the passage could further explore the reasons behind these preferences and consider the cultural and geographical context.

The discussion on science process skills outlines various skills such as observation, experimentation, critical thinking, communication, problem-solving, interdisciplinary connections, and real-world application. These skills are essential for scientific inquiry and contribute to academic success.

The critique provides constructive feedback on the need for a clearer definition of constructivism, more details on study methodologies, and a deeper exploration of factors influencing student engagement. It suggests considering potential limitations and external factors in the studies presented.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The chapter dealt with the research design, area of the study, target population, sampling procedure, sample size, research study variables, instrument of the proposed study, validity and reliability research instruments, administration of the research instruments, data collection procedures, data analysis and ethical consideration.

3.2 Research design

Research study was conducted by the use of quasi –experimental design. This was undertaken on Form one students where the topic on cell Biology is covered. The design was adopted because the form one students were in intact classrooms and the researcher was not able to control the treatment based on real specimen and photomicrographs independently. This therefore allowed non-random assignment of treatment to both groups. There were two groups that were formed; the control and the experimental groups. Both groups were given a pretest (SBET) exam prior to the deployment of any teaching techniques. For treatment, the experimental groups were divided into two groups where one group was instructed using photomicrographs while the second instructed using real specimen. After a period of two week, posttest (SBET) was administered to both groups. The data obtained from both groups were analyzed descriptively: percentages, means and standard deviations. The data was presented in form tables, graphs and charts.

Table 3. 1: Illustration of the research design

Stages	RSP Group	photomicrograph Group
Pre-test	Measure of Biology academic performance before intervention on real specimen	Measure of Biology academic performance before intervention on photomicrographs
Intervention	Teaching Biology using real specimens	Teaching of Biology using photomicrographs
Post-test	Analysis of performance on real specimens after intervention	Analysis of performance on photomicrographs after intervention

3.3 Area of the study

The study was carried out in Nandi South Sub-County. Nandi South sub-county is one of the six sub-Counties in Nandi County that is located in the Northern Rift Kenya. Nandi County is about 2884.8 square kilometers. Nandi South Sub-county occupies about 369.77 square kilometers (appendix VIII). It borders Tinderet sub-County to the South and Mosop Sub-County to the North.

3.4 Target population

Target population was the form one Biology learners in the three selected categories secondary schools with each category having two schools one for the photomicrograph and another for the real specimen. There were approximately 2980 form one learners in Nandi South distributed in 42 secondary schools with approximate 70 learners per school. The researcher used the form one class because of the topic ‘the cell’ that is offered at this level and requires elaborated teaching approach to meet the target of grasping the content.

3.5 Sample size

The total sample size amounted 298 respondents which equates to 20% of the total population. According to Taherdoost (2016), a good sample size should range from 60 to 300 respondents with most averaging about 200. This is also dictated by the nature study therefore, the sample size was calcul;ated as;

$$n = 1490 * \frac{20}{100} = 298 \text{ respondents}$$

The respondents were divided among the three categories of school as 100 for Extra County, 98 respondents for County and 100 for Sub County schools as illustrated in table 3.2.

Table 3. 2: Sample size determination

School category	Total	Sample size (n)
Extra county(2)	500	100
County(2)	490	98
Sub county(2)	500	100
Total (N)	1490	298

(Source: Author, 2024)

3.6 Sampling procedures of the respondents

Both simple and stratified random sampling was used to select a sample list of the chosen secondary schools in Nandi South sub-county Kenya. The sub county was divided into respective wards. Secondary school in the same category was pooled together and number of learners in form one noted. The researcher wrote the strata and the name of the school on a small piece of paper and select them using simple random sampling. Simple random sampling technique was used to select the six schools from each category. Simple random sampling was used to choose three school for control and the other three for experimental. That gave a total 298 learners. Eventually, 149 students were assigned to the experimental group and 149 students were assigned to the control group. The teachers who participated in the study was selected by use of purposive sampling that gave a total of 18 teachers from a total of 63 teachers who taught form one biology.

Table 3. 3: Sampling frame

Group	School category	Total	Sample size (n)
Control	Extra county	250	50
	County	245	49
	Sub county	250	50
	Total	745	149
Experimental	Extra county	250	50
	County	245	49
	Sub county	250	50
	Total	745	149

Source: Author (2024)

3.7 Research variables

The research study variables were: the independent, intervening and dependent variables.

The independent variable was the variable that the researcher manipulated so as to establish its effects on the dependent variable. For that case the independent variable of the study were the real specimen and photomicrographs, the attitude of the students towards the use of real specimens and photomicrographs and the six components of the experiment which reflected the students Biology academic performance.

This variable was caused by the independent variable and determines the dependent variable. Normally, it supports the independent variable or fails to support the independent .The intervening variable of the study were that teachers' experience on using the real specimens and photomicrographs. This were aided by teachers' induction such that it could not manipulate the outcome of the study.

This variable showed the effect of the independent variable. The dependent variable for the study was Biology students' academic performance.

3.8 Research Instruments

The study used Biology Evaluation Test (BET), Students' Questionnaire (SQ), teachers' Questionnaire (TQ) and observation checklist as the research instruments.

3.8.1 Biology Evaluation Test (BET)

The researcher administered a Biology Evaluation Test to the control and experimental group to evaluate their academic performance on Biology Evaluation Test (BET). The test had two sections, identification of parts of the cell and the second section on functionality of different parts.

3.8.2 Students' and teachers' Questionnaire (SQ)

The researcher administered the (SQ) after the (BET) as in the appendix. Both teachers and learners were also issued with questionnaires to test their attitude on the two instructional methods (Appendix VI & VII). Questionnaires had three sections. The first section was on demographic characteristic, second section on academic performance and the third on attitude toward the instructional methods employed while teaching the topic on cell.

3.8.3 Observation check list

Observation check list were used to assess the application of 6 components of experiment by teachers (Appendix X).

3.9 Piloting

Piloting of the instruments was done using form one students in the neighboring sub county (Tinderet Sub County). The topic on cell were used for control and experimental groups followed by Biology academic performance using BET. This allowed the calibration of the research instruments prior to use in the main field.

3.10 Validity and Reliability of Research Instruments

3.10.1 Validity of the Research Instrument

Validity refers to the degree to which evidence and theory support the interpretation of test scores entailed by the use of tests. According to Mugenda (2008) Validity is the accuracy and meaningfulness of inferences which are based on the research obtained from the analysis of the data that actually represents the variables of the study. The research instrument was validated by university supervisors at University of Eldoret School of education. The research instruments were validated in terms of content and face validity. The content related technique measured the degree to which the question items reflected the specific areas that were covered.

3.10.2 Reliability of the Research Instrument

Reliability is the ability of a research instrument to consistently measure characteristics of interest over time. Cronbach's Alpha coefficient which estimates the reliability of the instrument were used. The use of Cronbach's Alpha coefficient of more than 0.8 were appropriate since the items used would not score open-ended questions and scores would take a range of values. The reliability coefficient of 0.85 is acceptable to a researcher as suggested by Mugenda and Mugenda (2023).

3.11 Data collection Procedures

The researcher sought an introduction letter from the University of Eldoret and research permit from the National commission of science, Technology and innovation (NACOSTI) of the Ministry of Education science and Technology through the Board of Postgraduate studies University of Eldoret to collect the data. Thereafter, distributed the letters requesting for authorization to carry out research from each of the target sample secondary schools selected. The researcher administered the questionnaires to the identified personnel which then filled then retrieved upon completion.

3.12 Method of Data Analysis

Qualitative and quantitative analysis of data were done with the aid of Statistical Package for Social Sciences (SPSS version 21). Differences for mean scores for learners instructed using photomicrographs and real specimens on students' Biology were assessed using student t- test at 95% confidence. To test for differences in mean score for learners in different categories of school, one way analysis of variance (t-test) were used. Significant differences in means were separated using Fisher Least significant difference test (LSD).

To determine the influence of students' attitude towards the use of photomicrographs and real specimens on their Biology academic performance, the differences in percentage frequencies tested using chi square contingency test. Correlation test were also performed to assess whether the responses are the same for teachers and learners.

To investigate whether the six components of the experiment are used during handling of real specimens and photomicrographs and how it affects Biology academic performance the mean scores in the frequencies between the two instruction methods were ascertained using student t-test. Correlation test was also performed to assess whether the responses correlate between the two instruction methods.

3.13 Ethical Considerations

Research in education is governed by various ethics. According to APA (2010), the legal due process has to be followed especially where the respondents involve human beings as this may affect them negatively especially if the area presented needs rigorous work like the practical. To deal with this problem, the researcher presented a formal request to all schools undertaking the task. The researcher also obtained National Commission for

Science, Technology and Innovation (NACOSTI). Furthermore, the researcher explained to the respondents about the research and the purpose of the research that it is for academic purpose only and not to harm them in anyway whatsoever and also that they were to participate voluntarily without indicating their names on the scripts.

3.13.1 Informed consent

The researcher made sure that the respondents had consent to make the choice to participate in the study or not. Each respondent had the right to decline if not willing to participate and this gave the participant confidence to take part in the study.

3.13.2 Confidentiality

The researcher guaranteed the participants that the information given and data collected will be protected and treated with total confidentiality. To ensure this, the researcher did not include the questionnaire with the names but rather use the number codes and thereafter, destroyed the used questionnaires as soon as the study was collected.

3.13.3 Dressing Code

The researcher also made sure that she was dressed appropriately while conducting her research because this would offer the respondents confidence that whatever the researcher was doing then it was valid and allowed them to cooperate.

3.13.4 Beneficent

The researcher made sure that the study was of benefit to the respondents as they were to get added knowledge and not harm them.

3.14 Summary of the chapter

The chapter has dealt with all the components entailed in chapter three in a proposed study and has given the expectations of each and every component. Among the areas captured is the research design which proposes the quasi-experiment design, target population, study area, variables.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION OF THE RESULTS

4.1 Introduction of the Chapter

The chapter has dispensed the data collected, the analysis, interpretation and the findings based on objectives of the study. The data obtained were presented in tables and graphs. The data collected was analyzed descriptively as well as inferentially: independent sample t-test to test the hypothesis at $p>0.05$ significance level. Lastly the findings were interpreted and discussed.

4.2 Demographic characteristics of the respondents

Two hundred and ninety eight learners (298) learners were involved in this research from three categories of schools. These categories were Extra County, County and Sub County. The proportion of learners from each category of school was the same. In terms of gender, female learners were the majority 158(53.02%) while male learners represented 140(46.98%). When learners were asked if they used photomicrographs and real specimens in biology practical lesson, majority indicated they used Photomicrographs 202(67.79%) followed by those who indicated the used both Photomicrographs and Real specimens 76(25.50%) while the rest specified to use Real specimens. In terms of how often learners used photomicrographs per week, majority indicated once per week 262(87.92%) while those who used real specimens indicated they did so rarely 218(73.15%) as illustrated in Table 4.1

Table 4. 1: Demographic characteristics of the learners

Demographic characteristics	Attribute	Frequency (n)	Percentage (%)
Gender	Male	140	46.98
	Female	158	53.02
	Total	298	100.00
Do you use photomicrographs and real specimens	Photomicrographs	202	67.79
	Real specimens	20	6.71
	Both	76	25.50
	Total	298	100.00
How often do you use photomicrographs per week	Once per week	262	87.92
	Twice per week	36	12.08
	Total	298	100.00
How often do you use real specimens per week	Once per week	78	26.17
	Twice per week	2	0.67
	Rarely	218	73.15
	Total	298	100.00

(Source: Author, 2024)

Table 4. 2: Demographic characteristics of the teachers

For the Biology teachers, female teachers represented the majority in the study participants 11(61.11%). Those with undergraduate degree 16(88.89%) represented majority of the teachers while those with diploma and master's degree represented the lowest proportion of 1(5.56%). A large fraction of teachers had between 6 to 11 years of experience 10(55.56%) while few had above 17 years 1(5.56%). A large proportion of teachers confirmed that they offered at least one practical lesson in Biology per week 16(88.89%) as illustrated in Table 4.2.

Demographic characteristics	Attribute	Frequency (n)	Percentage (%)
Gender	Male	7	38.89
	Female	11	61.11
	Total	18	100.00
Highest academic qualification	Diploma	1	5.56
	Undergraduate degree	16	88.89
	Master's degree	1	5.56
	Total	18	100.00
Years of experience in teaching biology	0-5 years	5	27.78
	6-11 years	10	55.56
	12-17 years	2	11.11
	Above 17 years	1	5.56
	Total	18	100.00
Number of practical lessons offered per week	1 lesson per week	16	88.89
	2 lesson per week	1	5.56
	Above 2 lesson per week	1	5.56
	Total	18	100.00

(Source: Author, 2024)

4.3 The use of photomicrographs and real specimens in teaching Biology in secondary schools and its effects on students' performance.

4.3.1 Standardized Biology evaluation test (SBET) pre- test

Pre-test was carried out to test whether the experimental group differed significantly with control group in mean scores in Standardized Biology Evaluation test (SBET). The results of pre-test was as shown in Table 4.3

Table 4. 3: The pre-test results on the Standardized Biology Evaluation test (SBET) pre- test

School category	Pre-test test	Count	Mean±sd	t- test	p- value
Extra county	Control	50	22.27±1.74	-0.2580	0.7972
	Experimental	50	23.20±1.32		
County	Control	49	13.60±1.88	-0.1681	0.8670
	Experimental	49	14.17±1.42		
Sub county	Control	50	11.07±1.83	-0.1274	0.8990
	Experimental	50	11.53±1.41		
All schools combined	Control	149	15.86±1.82	-0.4580	0.7920
	Experimental	149	16.30±1.38		

(Source: Author, 2024)

From Table 4.3 the mean score and the standard deviation for the control group was 15.86±1.82 (Mean±sd) while that of experimental group was 16.30±1.38 (Mean±sd). From this results it can be seen that there was no significant difference between the two groups ($t=-0.4580$, $df= 297$, $p=0.7920$).

For the school categories extra county ($t=-0.2580$, $df= 49$, $p=0.7972$), county ($t=-0.1681$, $df=48$, $p=0.8670$) and sub county ($t=-0.1274$, $df=49$, $p=0.8990$) did not differ significantly between experimental and control group performance in Standardized Biology Evaluation Test (SBET) pre- test inferring that students in both control and experimental groups had similar ability but differed with category of school as illustrated in Table 4.2. There was no significant difference between performance in school categories ($p>0.05$).

4.3.2 Standardized Biology Evaluation test (SBET) post- test

After the pre-test, the control groups were practically taught through use of photomicrographs while the experimental group on the other hand was instructed through experimental method where the teacher used real specimens as they do experiments in Biology practical. During the practical lesson, the groups lasted for 80 minutes. At the end of the instruction period of two weeks, the two groups were subjected to a Standardized post-test (SBET). The results of post-test is shown in the table 4.4.

From the table 4.4 the mean score and standard deviation for the control group was 32.98±4.82 (Mean±sd) while that of experimental group was 39.23±4.38 (Mean±sd) with a significant difference between the two groups ($t=-0.0180$, $df= 297$, $p=0.0277$).

For the school categories, the extra county ($t=-8.8063$, $df= 49$, $p=0.0171$), county ($t=-6.8185$, $df=48$, $p=0.0212$) and sub county ($t=-8.1424$, $df=49$, $p=0.8990$) differ significantly between experimental and control group performance in Standardized Biology Evaluation test (SBET) post-test inferring that students in control and experimental groups did not have similar ability as illustrated in Table 4.3.

The null hypothesis was postulated as: There is no significant difference in Biology academic performance between the students taught using Real Specimens and those taught using Photomicrographs. The null hypothesis (Ho) was tested using Biology evaluation scores in a t- test as shown in the table 4.4 and it was rejected since experimental group statistically and significantly ($p<0.05$) performed better that the control group in the post test scores whether in school categories, or all schools combined as illustrated in Table 4.4 in schools.

Table 4. 4: Standardized Biology Evaluation (SBET) post- test

School category	Test	Count	Mean±sd	T-test	P-value	Null hypothesis (Ho)
Extra county	Control	50	41.27±4.74	-8. 8063	0.0171	Rejected
	Experimental	50	49.00±4.32			
County	Control	49	33.60±4.88	-6.8185	0.0212	Rejected
	Experimental	49	36.17±4.42			
Sub county	Control	50	24.07±4.83	-8.1424	0.0145	Rejected
	Experimental	50	32.53±4.41			
All schools combined	Control	149	32.98±4.82	-0.0180	0.0277	Rejected
	Experimental	149	39.23±4.38			

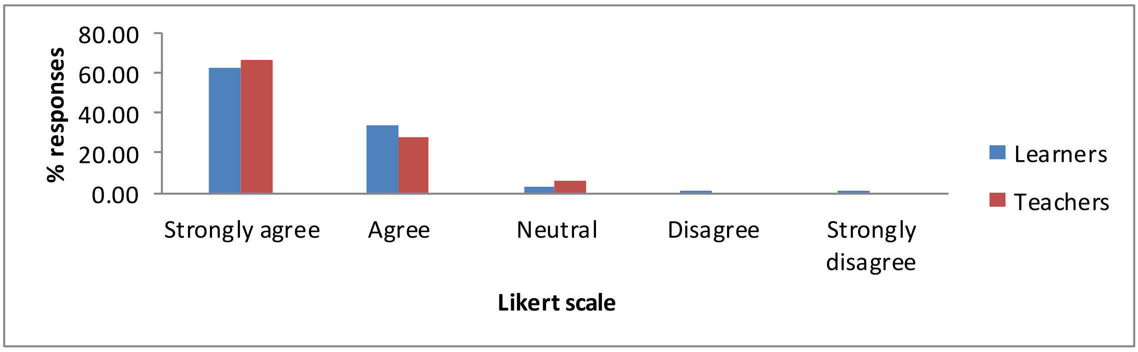
(Source: Author, 2024)

4.4.1 Learners and teachers attitude towards the use of photomicrographs and real specimens on their Biology academic performance

To assess the influence of students' attitude towards the use of photomicrographs and real specimens on their Biology academic performance, both learners and teachers were provided with statements to rate them. The first statement stated that teaching using real specimens is better than using photomicrographs where the majority of learners 93(62.41%) strongly agreed with the statement followed by those who agreed 51(34.23%)

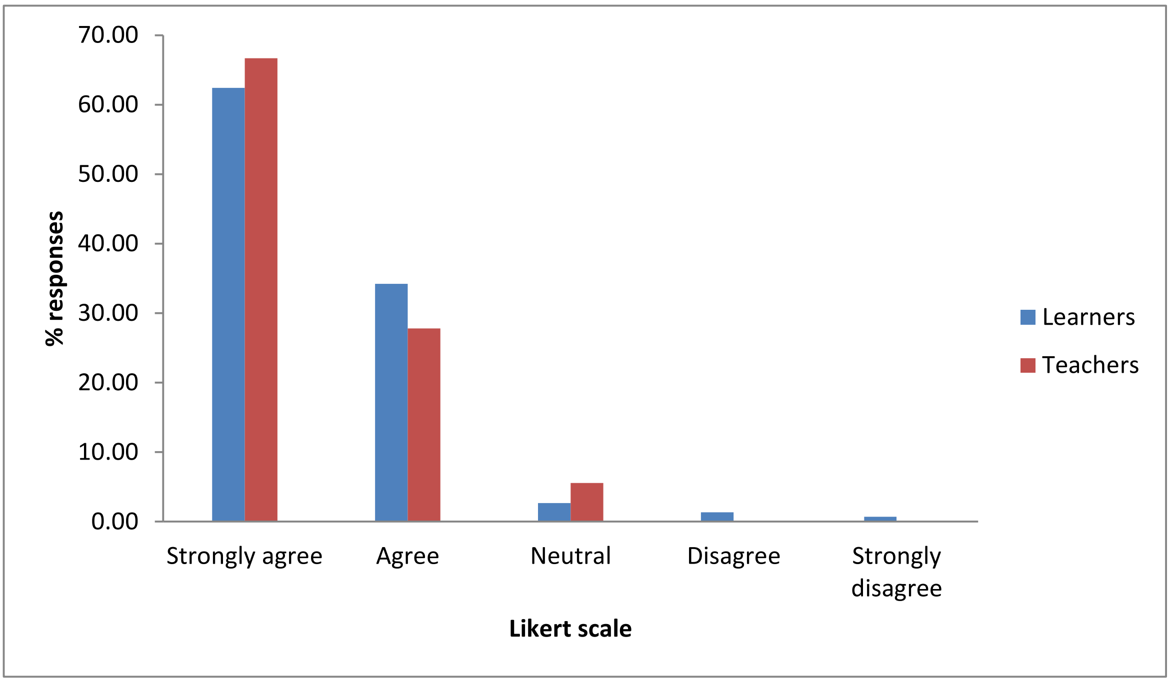
with a significant difference (χ^2= 146.57, d.f.=4, p<0.0001) from those who were neutral, disagreed and strongly disagreed. Similar observation was recorded in teachers where majority strongly agreed 12(66.67%) with the statement while a low proportion of them were neutral 1(5.56%) with a significant difference (χ^2= 57.27, d.f.=2, p<0.0001) as portrayed in Figure 4.1. There was a positive correlation between earners and teachers responses pertaining the statement (r=0.9823, p=0.0201). As show in the Figure 4.1

Figure 4. 1: Responses on statement that teaching using real specimens is better than using photomicrographs



On the second statement that the evaluation using the real specimens is a satisfying approach, the majority of learners 104(69.80%) (χ^2= 174.709, d.f.=4, p<0.0001) as well as teachers 13(72.22%) (χ^2= 71.12, d.f.= 2, p<0.0001)agreed with the statement that evaluation using real specimens is a satisfying approach. There was appositive correlation between the responses obtained from learners and those obtained from teachers (r=1, p<0.0001) as illustrated in Figure 4.2.

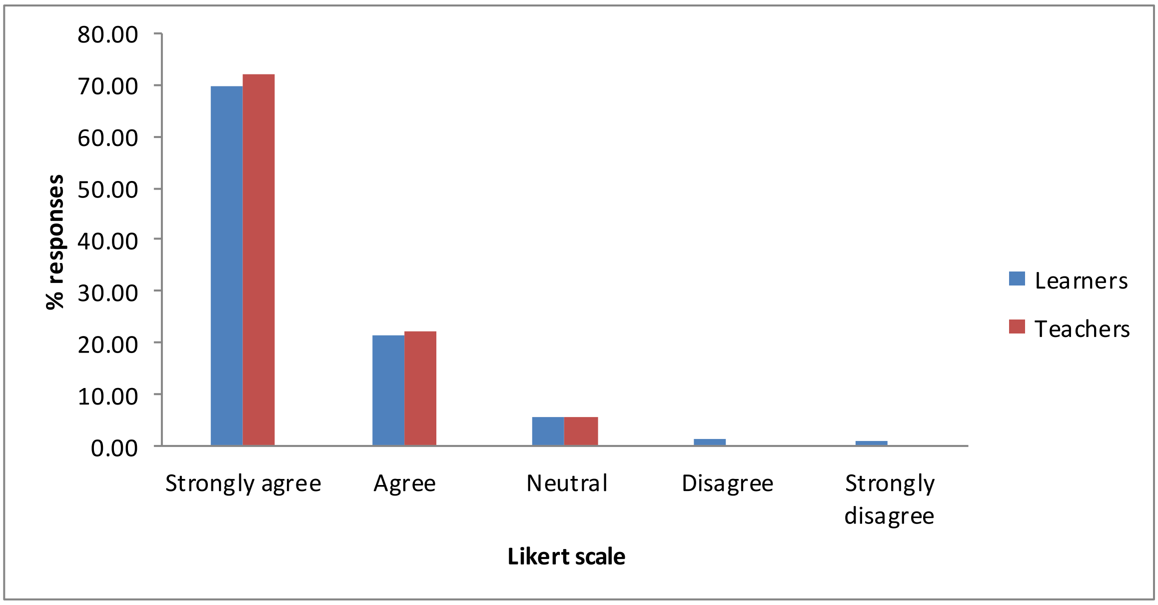
Figure 4. 2: Responses on statement that the evaluation using the real specimens is a satisfying approach



The findings imply that both students and teachers have a consistent and aligned preference for instruction with genuine specimens. It is likely that pupils' later academic performance will be impacted by this common positive attitude toward experiential learning. Academic performance can be positively impacted by having a favorable attitude toward educational approaches, according to the literature (Slavin, 2009). Real specimens are more likely to elicit greater student involvement, deeper knowledge, and ultimately better academic results in the setting of biology teaching (Bybee et al., 2006; Lawson, 2002).

The third statement stated that using real specimens in Biology practical lesson is enjoyable than when using photomicrographs, the on the learners responses, majority of them strongly agreed with the statement 130(87.25%) followed by those who agreed 16(10.74%) agreed while the rest were neutral with a significant difference (χ^2= 130.82, d.f=1, p<0.0001). Similar observations were made on responses from teachers where majority strongly agreed 16 (88.89%) while the rest were neutral with a significant difference (χ^2= 60.84, d.f.=1, p<0.0001). There was appositive correlation between the responses obtained from learners and those obtained from teachers (r=1, p<0.0001) as in Figure 4.3:

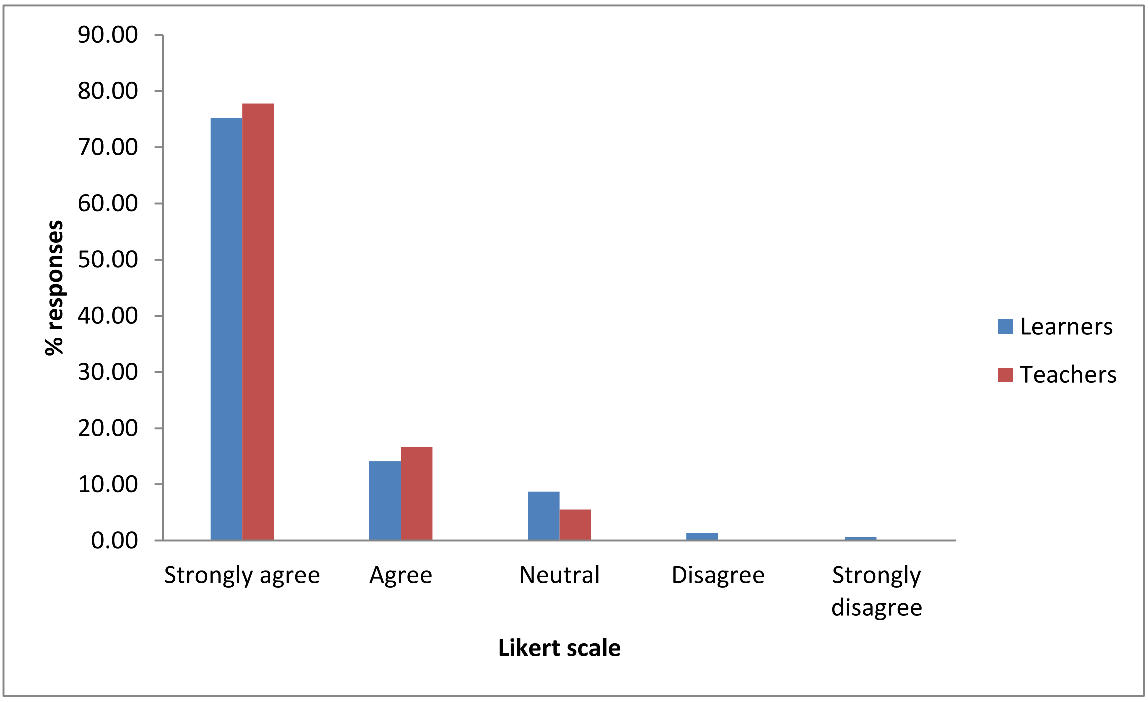
Figure 4. 3: Responses on statement that using real specimens in Biology practical lesson is enjoyable than when using photomicrographs



On the fourth statement that instructional method used when using real specimens in Biology practical lessons is better than that used when using photomicrographs the results was, that the majority of the respondents indicating that they strongly agreed that real specimens in Biology practical lessons is better than the use of the photomicrographs. The results showed that in the learners category, those who strongly agreed 112(75.17%), agreed 21(14.09%), neutral 13(8.72%), disagreed 2(1.34%) and strongly disagreed 1(0.67%) differed significantly (χ^2= 195.2, d.f.=4, p< 0.0001). on the same note, Similar observation were made on teachers with majority of them strongly agreed with the statement 11(61.11%) while the rest pointed out that they agreed 6(33.33%) and others were neutral on the response to the statement with a significant difference (χ^2= 45.38,d.f.=2, p<0.0001) as portrayed in Figure 4.4. There was appositive correlation between the responses obtained from learners and those obtained from teachers (r=1, p=0.0449).

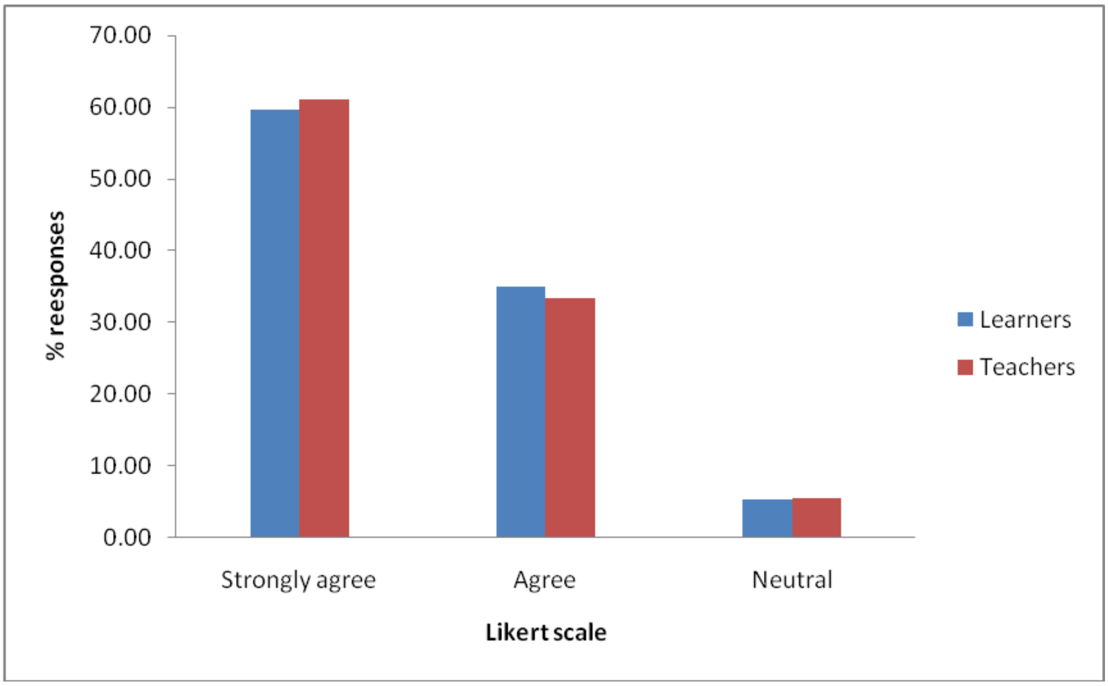
s shown in the Figure 4.4

Figure 4. 4: Responses on statement that the use of real specimens in Biology practical lessons is better than the use of photomicrographs.



The last statement to assess the influence of students' attitude towards the use of photomicrographs and real specimens on their Biology academic performance stated that the instructional method used in real specimens in Biology lessons makes learners understand the concepts better than the use of photomicrographs. Majority of learners strongly agreed 59.732(61.11%) with the statement followed by those who agreed 34.89(33.33) while the rest were neutral 5.36(5.56) with a significant difference (χ^2= 45.5,d.f.=2, p<0.0001). Similar observation was made on the teachers' responses (χ^2= 45.38, d.f.=2, p<0.0001). There was appositive correlation between the responses obtained from learners and those obtained from teachers (r=1, p=0.0449). As illustrated in the Figure 4.5:

Figure 4. 5: Responses on statement that the instructional method used in real specimens in biology lessons makes learners understand the concepts better than the use of photomicrographs



4.4.2 Extent of real specimen utilization

Both learners and teachers were asked if there were preserved specimens used for teaching Biology practical lessons. For learners, majority indicated no 89(59.73%) while majority of teachers indicated yes 14(77.78%). This resulted to negative correlation in the responses as illustrated in Table 4.2.

Table 4. 5: Extent of real specimen utilization

Question	Category	Yes	No	r	p value
Do you have preserved specimens used for teaching biology practical lessons?	Learners	40.27	59.73	1	<0.0001
	Teachers	77.78	22.22		
Do you think the provision of real specimens will improve performance of students in biology in KCSE	Learners	89.20	10.80	1	<0.0001
	Teachers	100.00	0.00		

Source: Author (2024)

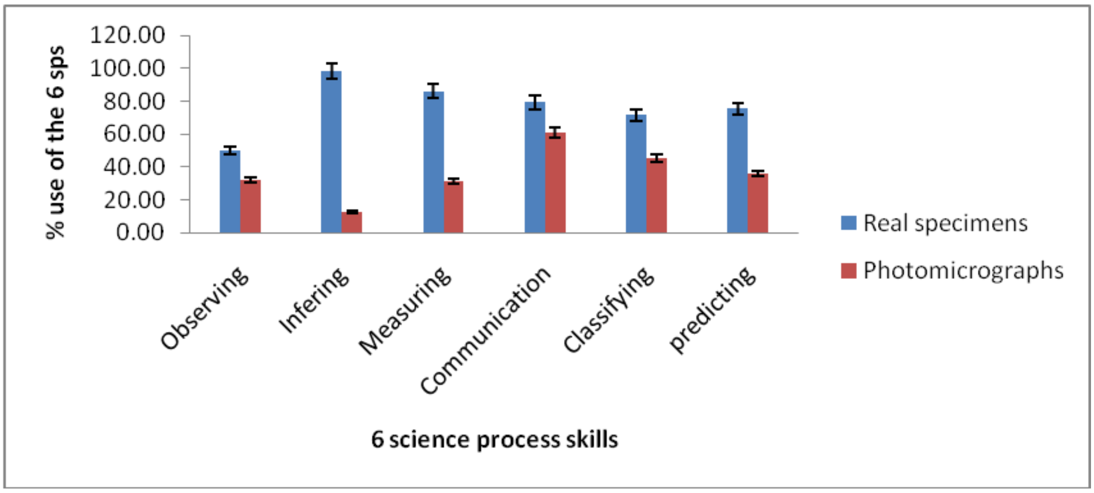
Teacher also added that the use of real specimens led improved performance in biology and suggested that the school buy the specimen to enhance academic performance of the learners.

4.5 The effects of using Science process skill on students Biology academic performance during handling of real specimens and photomicrographs

There were six Science process skill (Observation Skills, Experimentation and Inquiry-Based Learning, Critical Thinking and Analysis, Communication Skills, Problem-Solving Abilities, Interdisciplinary Connections and Real-World Application) that were assessed on students Biology academic performance during handling of real specimens and photomicrographs. Teachers were asked if they thought that the Science process skill influenced Biology academic. All teachers indicated yes 18(100.00%) and added that the skills allowed them in observation, Experimentation and Inquiry-Based Learning, ensured Critical Thinking and Analysis, facilitated Communication Skills, allowed Problem-Solving Abilities, enhanced Interdisciplinary Connections and as well as initiated Real-World Application. The observational checklist showed that majority of teachers effectively used the Science process skill on students Biology academic performance during handling of real specimens as compared with use of photomicrographs.

Comparison between the two categories of biology practical lesson administration indicated that the real specimen method allowed the teacher to observe (50.01%), Experiment (98.40%), Critically think and analyze (86.00%), facilitation of Communication Skills (79.20%), allowed Problem-Solving Abilities (71.40%), enhanced Interdisciplinary Connections (75.30%) as well as ensured Real-World Application (98.20%) with a mean of 79.78±16.84. For the use of photomicrographs, teachers were able to observe 32.1%, Experiment 12.40%, Critically think and analyze 31.00%, facilitation of Communication Skills 61.00%, allowed Problem-Solving Abilities 45.01%, enhanced Interdisciplinary Connections 35.91% and ensured Real-World Application 10.30% with a mean of 32.52±17.69 with a significant different between the two methods ($t = 5.1173$, $p = 0.0003$) as portrayed in Figure 4.6. This meant that the null hypothesis was rejected at $\alpha = 0.05$.All students interviewed indicated that they were not aware of the 6sps and its applicability in experiments

Figure 4. 6: The effects of using 6 science process skills on students Biology academic performance during handling of real specimens and photomicrographs



From assessment of the teacher application of the Science process skill, the use of real experiment helped the learners more than use photomicrographs thus real specimens leading to positive effects on students' academic achievement. This is brought in by vital components such as elicit and extend. These two are unique to this model. This research also found out that engage as one of the Science process skill played a role in boosting academic achievement in Biology. This helps to assess and corrects any misconceptions that the learners may develop which the teacher did not intend as learners construct knowledge based on prior understanding and experiences. The findings are in line with those of Adesoji & Idika, 2015; Cherono, Dinah & Kabesa (2021) who attributed students' academic achievement in biology from Science process skill.

The extend phase was rated high. This is good as it helps the learners to apply gained concept to new concepts in life. This helps to build learners with dependent minds in future.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction to the chapter

The chapter has dealt with the summary of the findings according to the results obtained, the conclusion and the recommendations.

5.2 Summary of the findings

5.2.1 The use of photomicrographs and real specimens in teaching Biology in secondary schools and its effects on students' performance.

As per the results of the study, the findings clearly affirms that there is significant main effect of treatments on student evaluation in Biology academic performance when there is use of real specimen in practical lesson as compared to the use of photomicrographs. The reason for high performance is the applicability of mental schema developed during hands-on activities to answering an evaluation test. This result is consistent with research by Bili, Resnyansky, Ahin, and Billinghurst (2020), who discovered a substantial relationship between the treatment (instructional materials) and students' science evaluation. This viewpoint was corroborated by Onyinyechi (2020), who also found that using genuine specimens as teaching aids had a statistically significant impact on students' academic performance compared to not using them. This finding was also supported by Olatoye (2017), who found that each instructional material offers more learning opportunities and that different instructional materials may offer different learning opportunities. For instance, real objects offer more learning opportunities than photomicrographs, charts and even the videos do.

5.2.2 Learners and teachers attitude towards the use of photomicrographs and real specimens on their Biology academic performance

To assess the influence of students' attitude towards the use of photomicrographs and real specimens on their Biology academic performance, both learners and teachers were provided with statements to rate them**.**

5.2.2.1 Statement that teaching using real specimens is better than using photomicrographs

The findings established that teaching using real specimens is better than using photomicrographs. This is due to the fact that real specimens make the classroom more interesting and enjoyable due to hands-on practical. In addition, real specimen enables learners to be more creative and active in classroom as there is limited boredom. This is due to the fact that real specimens make classroom more interesting. The findings are in line with those of Olatoye, (2017) who asserted that using real specimens enhanced better performance than when using photomicrographs in teaching. This is attributed to making the classroom more interesting and enjoyable.

5.2.2.2 Responses on statement that the evaluation using the real specimens is a satisfying approach

The findings proved that evaluation using the real specimens is a satisfying approach. This is due to the fact that the real specimen provides a hand on experience which makes learners to be more satisfied with knowledge they get as far as Biology subject is concerned. The findings are in line with those of McMenamin, Hussey, Chin, D., Alam, Quayle, Coupland, & Adams (2021) who noted that use of real specimen results in increased focus being placed on the ability of students to describe the gross anatomical pathology of specimens thus increase satisfaction level of students to post-mortem based teaching in medical training programs.

5.2.2.3 Statement that the evaluation using the real specimens is a satisfying approach

The findings established that using real specimens in Biology practical lesson is enjoyable than when using photomicrographs. Real specimens provide students with the opportunity to observe the characteristics of living organisms' first-hand, which can be more engaging and memorable than looking at a photograph. Real specimens can also be used to demonstrate how living organisms move, react to stimuli, and interact with their environment. In addition, using real specimens can help students develop their fine motor skills, such as manipulating a dissection tool or handling a live specimen. His makes the practical lesson enjoyable. This is in line with the findings of Olatoye (2017); Onyinyechi(2020); Adam, Lameed & Ayodele (2022) that real specimen are the way to go to enhance understanding of the lesson as the learners have hand of practical experience which is enjoyable.

5.2.2.4 The use of real specimens in Biology practical lessons is better than the use of photomicrographs

The findings established that that real specimen in Biology practical lessons is better than using photomicrographs. This results from the fact that real specimen leads to authentic learning which makes the subject course concepts relevant to learners so that they can retain the information at hand and pivot the knowledge to real-world situations which is a dream for every teacher or educator. The findings are in line with those of Bishara (2021), fostering self-directed learners with a long-term, deep understanding of concepts is a key goal for educators. The same was echoed by Hasnine, Ogata, Akçapınar, Mouri, & Uosaki

(2019), that authentic learning (or active learning that can result from use of real specimen) is, “real life learning encourages students to create a tangible, useful, quality product/outcome to be shared with their world.

5.2.2.5 The instructional method used in real specimens in biology lessons makes learners understand the concepts better than the use of photomicrographs

The last statement to assess the influence of students’ attitude towards the use of photomicrographs and real specimens on their Biology academic performance stated that the instructional method used in real specimens in Biology lessons makes learners understand the concepts better than the use of photomicrographs

5.2.3The effects of using Science process skill on students Biology academic performance during handling of real specimens and photomicrographs

The findings are in line with those of Balta & Sarac (2016); Cherono, Dinah & Kabesa (2021) who attributed the importance of Science process skill in enhancing curiosity in students as well as eagerness to lean leading to efficient acquisition of knowledge and skills. This was also affirmed by Adam, Lameed & Ayodele (2022) who asserted that students instructed using Science process skill perform better than students instructed through conventional methods. In line Gyampon, Aido, Nyagbblosmase, Kofi & Amoako (2020), students in the experimental group taught using Science process skill always tend to have higher performance than those in the control group.

5.3 Conclusion

The study involved a relatively balanced gender distribution, with a slight majority of female learners. Learners from various school categories participated, reflecting diverse educational contexts. The predominant use of photomicrographs indicated a reliance on visual aids, while others employed a combination of photomicrographs and real specimens showcasing a balanced instructional approach. Analysis of usage frequency revealed that most used photomicrographs weekly, contrasting with rarely employing real specimens. This suggests a prevalent preference for photomicrographs in Biology practical, emphasizing the need for strategic resource allocation.

The instructional intervention, comparing photomicrographs to real specimens, resulted in the experimental group on the use of real specimens outperformed the other experimental group on the use of photomicrographs in the post-test. This significant difference in scores underscores the positive impact of real specimens on Biology academic performance. The consistency of this superiority across school categories implies a universal benefit, irrespective of school type. While the study highlights the inclination towards visual aids, educators and policymakers should consider the advantages of incorporating real specimens for a more profound understanding of biological concepts. The findings underscore the importance of balancing instructional methods to optimize student engagement and academic performance in Biology.

The results demonstrated a significant difference in mean scores between the two groups, favoring the experimental group taught with real specimens. The performance gap suggests that the use of real specimens in practical lessons had a positive impact on students' academic performance compared to the use of photomicrographs.

The study reveals a significant positive correlation between students' and teachers' attitudes towards the use of real specimens compared to photomicrographs in Biology practical lessons. A majority of learners strongly agreed that teaching with real specimens is superior, with similar sentiments echoed by teachers. This alignment in perspectives underscores a shared preference for hands-on learning experiences, emphasizing the potential impact on academic performance.

Students and teachers expressed satisfaction with the evaluation approach using real specimens. The positive correlation between their responses reinforces the notion that the use of real specimens contributes to a more satisfying educational experience. Additionally, both learners and teachers strongly agreed that using real specimens in Biology practical lessons is more enjoyable than using photomicrographs. This preference is attributed to the engaging nature of hands-on experiences, allowing students to observe living organisms directly and develop fine motor skills, enhancing the overall enjoyment of the practical lessons. Furthermore, a substantial majority of respondents, strongly agreed that the instructional method employed when using real specimens is better than that used with photomicrographs. This preference is associated with the authenticity of learning facilitated by real specimens, making subject concepts relevant and aiding retention for real-world application. The overall findings highlight a consistent inclination towards the positive impact of real specimens on students' understanding and academic performance in Biology.

The study explored the impact of Science process skills on students' Biology academic performance, comparing the handling of real specimens and photomicrographs. Teachers unanimously affirmed the influence of these skills, encompassing Observation, Experimentation, Critical Thinking, Communication, Problem-Solving, Interdisciplinary Connections, and Real-World Application. The observational checklist revealed that teachers effectively utilized these skills more with real specimens than with photomicrographs.

Teachers employing Science process skills, particularly through the use of real specimens, positively impacted students' academic performance. The unique components of the use of real specimen instructional approach played a crucial role in enhancing learning outcomes. This addressed misconceptions, fostering a deeper understanding of Biology. The high performance rate indicated that students exposed to Science process skills were better equipped to apply acquired concepts in various life contexts, nurturing independent and curious minds.

5.4 Recommendations

1. The teachers service commission (TSC) whose mandate is to ensure effective service for quality teaching standards, will find this study useful as it will serve as a source of information from schools about the teaching approach in learning in secondary schools and how this affect the performance in KCSE biology Examinations and also generate a way of improving Biology academic performance.

2. The Ministry of education (MOE) to take the right decision on the provision of guidelines to teacher training intuitions to provide adequate training to aid science teachers have transferable science process skills in teaching and learning process.

3. The finding of study will help the Government education policy makers to take corrective measures in provision of adequate resources to meet the demands on the education of teachers and students for successful teaching and learning skills in teaching and evaluating in the secondary schools in Kenya.

4. The findings underscore the importance of balancing instructional methods to optimize student engagement and academic performance in Biology by the teachers.

5.5 Suggestions for further studies

1. The research to be conducted in other science subject to check on frequency of the effectiveness of the use of realism in the teaching approach to enhance students' academic performance

2. The same study to be further conducted in other sub-counties to confirm consistency of the results

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APPENDICES

Appendix I: Research Permit From University Of Eldoret

University of Eldoret
flame of knowledge and innovation

P.O. Box 1125-30100, ELDORET, Kenya
Tel: 053-2063111/8 Ext.2032
Fax No. 20-2141257
Email: soe@uoeld.co.ke
www.uoeld.ac.ke

UNIVERSITY OF ELDORET

SCHOOL OF EDUCATION
CENTRE FOR TEACHER EDUCATION

Ref: UOE/B/CTE/REF/040 **Date:** 29TH APRIL,2021

The Executive Secretary,
National Council for Science and Technology,
P.O. Box 30623-00100,
NAIROBI.

Dear Sir/Madam,

SUBJECT: RESEARCH PERMIT FOR: CAROLINE JERONO
REG. NO.: SEDU/CTE/M/007/20

This is to confirm that the above-named Post Graduate Student has completed Course Work and has successfully defended her thesis proposal.

She is currently preparing for a Field Research Work on her thesis entitled: *"EFFECT OF USING PHOTOMICROGRAPHS AND REAL SPECIMEN ON SECONDARY SCHOOL STUDENTS' PERFORMANCE IN BIOLOGY IN NANDI SOUTH SUB-COUNTY, KENYA".*

Any assistance accorded to her to facilitate successful conduct of the research will be highly appreciated.

Yours Faithfully,

DR. AMING'A ROBERT
HEAD, CENTRE FOR TEACHER EDUCATION

University of Eldoret is ISO 9 001:2015 Certified

Appendix II: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **788968**

Date of Issue: **26/May/2021**

RESEARCH LICENSE

This is to Certify that Ms.. CAROLINE JERONO of University of Eldoret, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nandi on the topic: EFFECTS OF USING PHOTOMICROGRAPHS AND REAL SPECIMEN FOR INSTRUCTIONAL PURPOSES OF SELECTED TOPICS IN SECONDARY SCHOOL BIOLOGY TO ENHANCE ACADEMIC PERFORMANCE IN NANDI SOUTH for the period ending : 25/August/2024.

License No: **NACOSTI/P/21/29021**

788968

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 III: Research Authorization from the Sub-County Director of Education

MINISTRY OF EDUCATION

Telegrams "**EDUCATION**",
Telephone: 0208011883
Fax: 053-643340
E-mail: nandisouth@gmail.com
Ref: NSD/

Sub County Education Office
Nandi South
P.O Box 43,
Kobujoi-30305
28.05.2021

STATE DEPARTMENT OF EARLY LEARNING & BASIC EDUCATION

TO WHOM IT MAY CONCERN

RE: AUTHORITY TO CARRY OUT RESEARCH IN NANDI SOUTH- CAROLINE JERONO.

The above mentioned, a student of University of Eldoret, is hereby authorized to carry out research in Nandi South as per the provisions of Science, Technology and Innovation Act,2013.

Any assistance accorded her will be appreciated.

SUB-COUNTY DIRECTOR OF EDUCATION
NANDI SOUTH
28.05.21
P.O. Box 43 - 30305 KOBUJOI

SAMUEL CHEMWOLO
SUB COUNTY DIRECTOR OF EDUCATION.
NANDI SOUTH

Appendix IV: Letter of Information to the Principal

University of Eldoret
flame of knowledge and innovation

P.O. Box 1125-30100, ELDORET, Kenya
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www.uoeld.ac.ke

UNIVERSITY OF ELDORET

2nd June,2021

TO,

THE PRINCIPLAL,

Dear Sir/Madam

RE: DATA COLLECTION

I am a post graduate student in the department of center for teacher education, university of Eldoret. Am doing a research study entitle : E**ffect of using Photomicrographs and Real Specimens on secondary school students performance in biology in Nandi South sub–County, Kenya.**

The research am carrying out is purely for academic purposes and any information provided shall be treated with confidentiality. I am kindly requesting for your grant permission to collect data in your school. When I will be collecting the data I will administer a questionnaire to Biology teachers and form one Biology students and also a test. The outcomes of study will be used to enhance Biology academic performance in Kenya secondary schools.

Yours faithfully

CAROLINE JERONO SEDU/CTE/M/007/20.

Appendix V: Consent Letter to the Participant

University of Eldoret
flame of knowledge and innovation

P.O. Box 1125-30100, ELDORET, Kenya
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UNIVERSITY OF ELDORET

2nd June,2021

Dear participant,

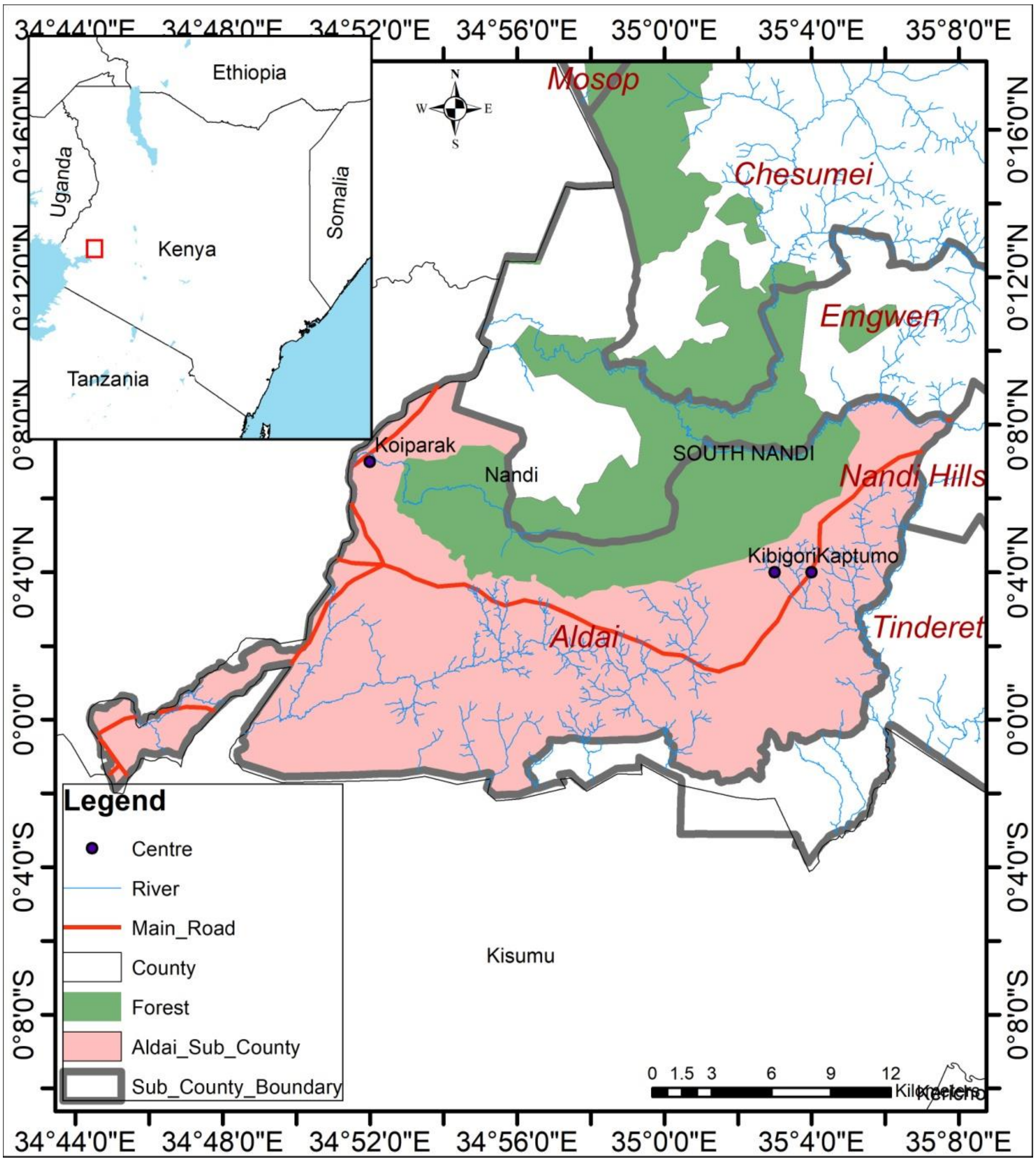
I am a postgraduate student in the school of education, University of Eldoret. I am pursuing a Master's degree in Education science. Would like to kindly appreciate if you spare a few minutes to fill the questionnaire provided. The main objective of this study is to Examine the *Effect of using photomicrographs and real specimen on Secondary Schools Students performance in Biology in Nandi South Sub-County, Kenya.*

You are hereby requested to provide sincere and accurate responses to all the items in each research questionnaire to the best of your knowledge. The information you will give will be kept confidential and will only be used for academic purpose. Please do not write your name. You may contact the researcher for the information about the study and to communicate the findings of the study.

Yours Faithfully,

Caroline Jerono
SEDU/CTE/M/007/20

Appendix VI: Map of Aldai Sub County in Kenya



Appendix VII: Sample Lesson Plans

WEEK 1

LESSON PLAN 1 & 2

TOPIC: The Cell

Sub-topic: Introduction to light microscope

OBJECTIVES: By the end of the lesson the learner should be able to;

-Define the cell

- Draw and label the light microscope

LESSON PRESENTATION

TIME	CONTENT	LEARNING ACTIVITIES	RESOURCES	REFERENCE
10 MINUTES	**INTRODUCTION** Teacher review the previous lesson through the question and answers method and presents the objectives of the current lesson	-Listening on the review -answering the asked questions and noting down the objectives of the lesson	-white board and white board marker -lesson notes	KLB secondary Biology Book 1 Golden tips Biology
60 MINUTES	**LESSON DEVELOPMENT** -Give the learners a proper definition of the cell. -Drawing and labeling the light microscope - presenting the chart on the parts of the light microscope and discussing it	-writing down the notes on cell definition -Drawing and labeling parts of light microscope -Observing the chart and discussion -Asking questions	-light microscope - Chart on the parts of light microscope	-KLB secondary Biology Students book 1 -KLB teachers book 1 -Principles of biology vol.1&2 Golden tips biology

10 MINUTES	**CONCLUSION** -Summarizing the lesson through question and answer method - Oral evaluation on the sub-topic's objectives.	-Answering the questions asked. Note taking down the evaluation on sub-topic's objectives	-white board marker -Learners exercise books	- Lesson notes -KLB students book 1

SELF –Evaluation: Questions asked were well responded to hence objectives made

WEEK 1

LESSON 3 & 4

TOPIC: THE CELL

Sub-topic: Parts of the light microscope and functions

Calculation of magnification using light microscope

OBJECTIVES: By the end of the lesson the learner should be able to;

- Identify parts of the light microscope and state their functions
- Describe how to care for a light microscope
- Describe how a microscope is used

LESSON PRESENTATION

TIME	CONTENT	LEARNING ACTIVITIES	RESOURCES	REFERENCE
10 MINUTES	**INTRODUCTION** Teacher review the previous lesson by asking the learners to state the purpose of light microscope	-answering questions asked by the teacher.	-white board and white board marker -lesson notes	KLB secondary Biology Book 1 Golden tips Biology
60 MINUTES	**LESSON DEVELOPMENT** -presenting the notes on the parts of light microscope and stating their functions and demonstrating chart. -Presenting chart on light microscope. - Describing the use and care of light microscope and how	-Group discussion -Taking down the notes on parts and functions of light microscope. -Observing the demonstration and asking	- Chart on the parts of light microscope and their functions. KLB BK 1	-KLB secondary Biology Students book 1 -KLB teachers book 1 -Principles of biology vol.1&2 Golden tips biology

	to calculate magnification.	quizzes.		
10 MINUTES	**CONCLUSION** -Summarizing the lesson by asking question on the covered content.	-Answering the questions asked. -Writing down the questions given	-Made familiar Biology book.	- Lesson notes -KLB students book 1

SELF- Evaluation: Questions asked were well responded to hence objectives made

WEEK 2

LESSON 1 & 2

TOPIC: The Cell

Sub-topic: Plant cell structures as seen in light.

OBJECTIVES: By the end of the lesson the learner should be able to;

- Identify the components of plant cell as seen under the light microscope and relate to their functions.

LESSON PRESENTATION

TIME	CONTENT	LEARNING ACTIVITIES	RESOURCES	REFERENCE
10 MINUTES	**INTRODUCTION** Teacher review the previous lesson by asking questions on parts and functions of a light microscope.	- Answering questions.	-Lesson notes revision questions.	Lesson notes -KLB students book 1
60 MINUTES	**BODY DEVELOPMENT** - Dividing the class into groups of eight students providing a microscope per group and providing an onion epidermal cells to each group. - Administer the requirements and procedure as per the practical manual book. Ask students to observe the parts of the plant cell as seen under a light microscope. Ask each group to present their	-Take down the procedure as administered by the teacher -Performing an experiment of the parts of cell as seen under the light microscope. - present their observations.	-onion epidermal cell -light microscope - scalpel -Iodine	-KLB secondary Biology Students book 3 Page 1-3 -KLB teachers book 3 pages 1-3 -Principles of biology vol. 2 pages 1-4

	observations. Harmonize each group’s findings.			
10 MINUTES	**CONCLUSION** Summarizing the lesson by giving out the assignment of the parts of the cell as seen under the light microscope.	Taking down the given assignment.	-Get it right biology revision book.	-Apple deklerk biology textbook

SELF- Evaluation: the learners were able to identify the parts of the cell as seen under the light microscope correctly hence the objective of the lesson were achieved

LESSON 3-4

TOPIC: THE CELL

Sub-topic: Animal cell structures as seen in light.

OBJECTIVES:

- Identify the components of animal cell as seen under the light microscope and relate to their functions.

LESSON PRESENTATION

TIME	CONTENT	LEARNING ACTIVITIES	RESOURCES	REFERENCE
10 MINUTES	**INTRODUCTION** Teacher review the previous lesson by asking the learners on parts of animal cell as seen under a light microscope.	- Answering the asked questions.	-Lesson notes KLB BK 1.	Lesson notes -KLB students book 1
60 MINUTES	**BODY DEVELOPMENT** - Dividing the class into groups of eight students providing a light microscope per each group. -providing animal cheek cells of an animal to each group. - Administer the procedure and requirements as per the practical manual book. Ask students to observe the parts of the animal cell as seen under a light microscope. Ask each group to present their	-Performing an experiment and writing down their conclusion.	-light microscope - animal check cells	-KLB secondary Biology Students book 3 Page 1-3 -KLB teachers book 3 pages 1-3 -Principles of biology vol. 2 pages 1-4

	observations. Harmonize each group's findings.			
10 MINUTES	**CONCLUSION** Summarizing the lesson by giving out the functions of the observed parts of the animal cell as seen under the light microscope and giving out an assignment comparing plant and animal cells.	Writing down the functions of observed parts of animal cell as seen under light microscope. -Taking down the assignment.		-Apple deklerk biology textbook

SELF- Evaluation: Questions asked were well responded to hence objectives made

WEEK 3

LESSON 1&2

TOPIC: THE CELL

Sub-topic: The components of plant cell as seen under the electron microscope.

OBJECTIVES:

- Identify the components of plant cell as seen under the electron microscope.

LESSON PRESENTATION

TIME	CONTENT	LEARNING ACTIVITIES	RESOURCES	REFERENCE
10 MINUTES	**INTRODUCTION** Teacher review the previous lesson by asking the learners on parts of the cell.	- Answering questions.	-Lesson notes.	Lesson notes -KLB students book 1
60 MINUTES	**BODY DEVELOPMENT** - Dividing the class into groups of eight students. -Providing electron photomicrographs of plant and animal cells to each group. Asking the learners to present their identifications of the micrographs - Assist the students to examine and interpret electron micrographs and relate the structures to their functions.	-Observing the micrographs of both plants and animal cell. - Interpreting the photomicrographs and writing down their functions.	-photocopied micrographs from their text books. -KLB BK 1 - Lesson notes.	-KLB secondary Biology Students book 3 Page 1-3 -KLB teachers book 3 pages 1-3 -Principles of biology vol. 2 pages 1-4

10 MINUTES	**CONCLUSION** Summarizing the lesson by giving out questions on plant and animal cell as seen under electron microscope.	Taking down the assignment given.	Lesson notes	-Get it right biology revision book.

SELF- Evaluation: The assignment given were well tackled hence objectives made.

LESSON 3-4

TOPIC: The Cell

Sub-topic: Cell specialization tissue organs and organ system using charts and models.

OBJECTIVES:

- Estimate cell size.
- State the differences between cells, tissues, organs and organ systems.

LESSON PRESENTATION

TIME	CONTENT	LEARNING ACTIVITIES	RESOURCES	REFERENCE
10 MINUTES	**INTRODUCTION** Teacher review the previous lesson by asking the learners to state pars of plant and animal cells.	- Answering questions.	-Lesson notes.	Mirror Biology Revision book
60 MINUTES	**BODY DEVELOPMENT** - Guide the learners on cell estimation and provide the notes on the same. -Define cell specialization. - Use of models and charts for both plant and animals to show the differences between cells, tissue, organs and organ system.	-observing the models and charts. - taking down the notes.	-charts of the cell, tissues, organs and organ cells. -models of the cell, tissues, organs and organ cells.	-KLB secondary Biology Students book 3 Page 1-3 -KLB teachers book 3 pages 1-3 -Principles of biology vol. 2 pages 1-4

10 MINUTES	**CONCLUSION** Summarizing the lesson by asking questions on identifying the cell tissues, organs and organ system and stating their function.	Taking down assignment.	Lesson notes	Mirror Biology revision book.

SELF- Evaluation: Questions asked were well responded to hence objectives made

LESSON 1-2

TOPIC: The Cell

Sub-topic: Cell specialization tissue organs and organ system using an organism on hands-on.

OBJECTIVES:

- Estimate cell size.
- State the differences between cells, tissues, organs and organ systems.

LESSON PRESENTATION

TIME	CONTENT	LEARNING ACTIVITIES	RESOURCES	REFERENCE
5 MINUTES	**INTRODUCTION** Teacher review the previous lesson by asking the learners to state the parts of the animal and plant cells.	- Answering questions.	-Lesson notes.	Lesson notes -KLB students book 1
30 MINUTES	**BODY DEVELOPMENT** - Guide learners on cells estimation. -Define cell specialization. -Illustration by dissecting a rat to display various organs systems. -Giving notes on the cell, tissue, organ and organ systems.	-Taking notes. - calculating cell estimation. - observing the illustrations while taking notes below.	- A rat -A light microscope. - Scalpel - Dissecting kits - Petri dish KLB BK 1	-KLB secondary Biology Students book 3 Page 1-3 -KLB teachers book 3 pages 1-3 -Principles of biology vol. 2 pages 1-4

5 MINUTES	**CONCLUSION** Summarizing the lesson by giving out the assignment of the parts of the cell as seen under the light microscope.	Taking down the given assignment.	-Get it right biology revision book.	-Apple deklerk biology textbook

SELF- Evaluation: Questions asked were well responded to hence objectives made

Appendix VIII: Teacher's Manual for Experimental Approach on the Cell in Biology

INSTRUCTIONS

Instruction approach on real specimen

Experiment number 1.

Observing an onion epidermal cell organelles

Materials:

- Onion epidermis
- Wet-mount supplies
- IKI (iodine-potassium iodide)
- Microscope

NOTE: The onion bulb is composed of layers of thick leaves. Bulbs are modified as storage organs for the plant. The leaves are the storage compartment of the bulb. They surround a short, central stem. The layer you want to observe is the covering of the leaf, called the epidermis.

1. Obtain a small sample of onion epidermis, taken from the inside of one onion bulb scale. This tissue is thin and has a tendency to curl at the edges. Be sure to place it flat on the surface of the slide. Add one to two drops of IKI solution to the onion epidermis. The iodine provides increased contrast and makes the nucleus easier to see.

2. Examine the slide with low power. Find a region of the sample where the cells are flat on the surface of the slide and the area appears focused. Switch to high power.

3. Try to locate the following structures and make a well labeled diagram on where they are located calculating its magnification. 10mks

   a. Cell wall
   b. Cytoplasm
   c. Nucleus
   d. Nucleolus

Activity 2

What are the functions of the following parts in the cell 4mks

a. Cell Wall ………………………………………………………………
……………………………………………………………………………………………
…………………………………...

b. Cytoplasm…………………………………………………………………………
………………………………………………………………………………………
……………………………………………………...

c. Nucleus……………………………………………………………………………
……………………………………………………………………...

d. Nucleolus
……………………………………………………………………………………………
……………………………………………...

Experiment number 2.

Observing a human cheek cells

Materials

- Glass microscope slides
- Plastic cover slips
- Paper towels or tissue
- Methylene Blue solution (0.5% to 1% (mix approximately 1 part stock solution with 4 parts of water))
- Plastic pipette or dropper
- Sterile, individually packed cotton swabs

Methods

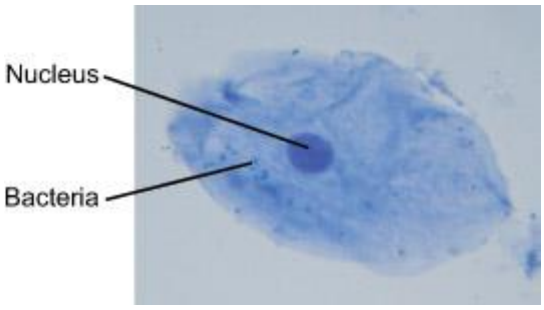
1. Take a clean cotton swab and gently scrape the inside of your mouth.

2. Smear the cotton swab on the center of the microscope slide for 2 to 3 seconds.

3. Add a drop of methylene blue solution and place a coverslip on top. Concentrated methylene blue is toxic if ingested. Wear gloves and do NOT allow children to handle methylene blue solution or have access to the bottle of solution.

4. Remove any excess solution by allowing a paper towel to touch one side of the coverslip.

5. Place the slide on the microscope, with 4 x or 10 x objective in position and find a cell. Then view at higher magnification.



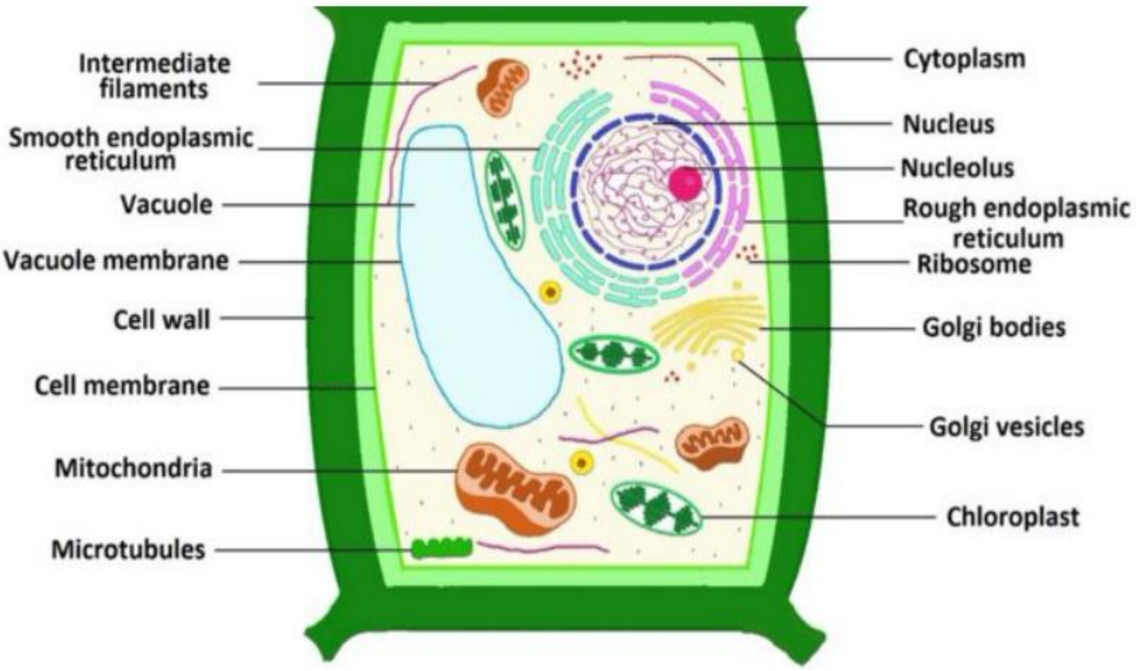
Methylene blue stains negatively charged molecules in the cell, including DNA and RNA. This dye is toxic when ingested and it causes irritation when in contact with the skin and eyes.

The cells seen are squamous epithelial cells from the outer epithelial layer of the mouth. The small blue dots are **bacteria** from our teeth and mouth.

Instruction approach on photomicrographs

The diagram bellow represents a photomicrograph of animal cell structure study it and answer the questions that follow

Plant cell micrograph



Name the parts labeled 6mks
state the functions of the part labeled 2mks

P…………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
…………………………………….

Q…………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
…………………………………

Name the organelle that

Stores chlorophyll in plant cell 1mk

………………………………………………………………………………………………
…………………………………………………………………………………..

Is responsible for the intracellular digestion 1mk

…………………………………………………………………………………………………

………………………………………………………………………………………

The diagram bellow represents a phomicrograph of a cell organelle .Study it and answer the questions that follow.

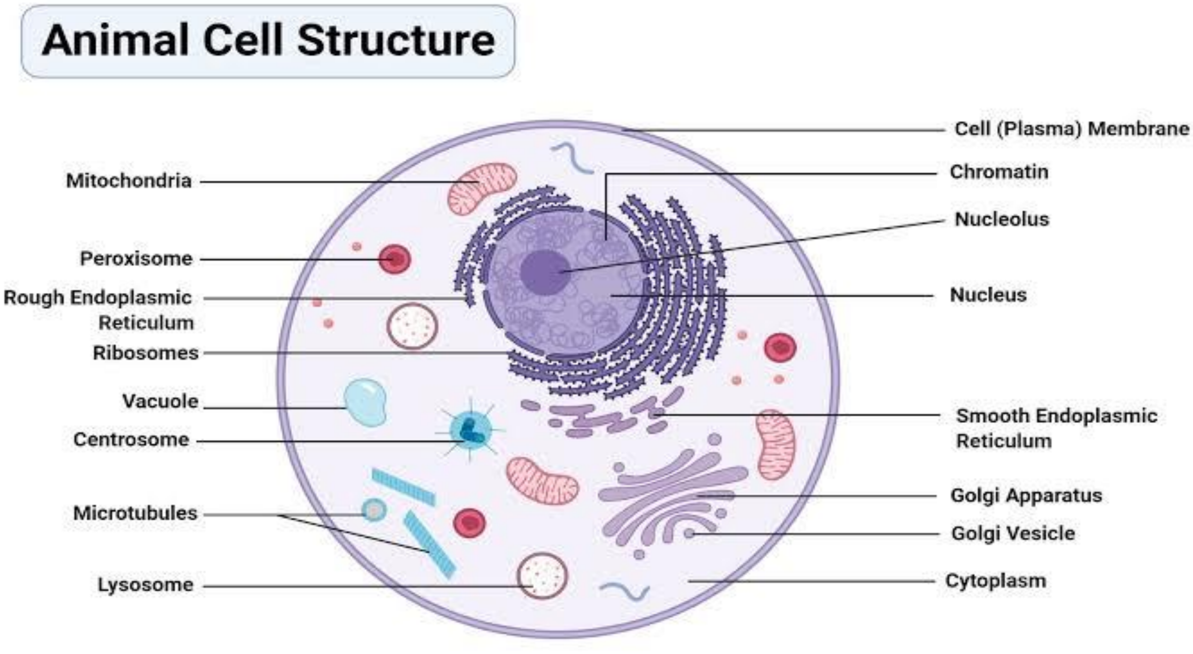


Figure: Animal Cell Structure, Image Copyright © Sagar Aryal, www.microbenotes.com

Name the structures labeled 5mks

E……………………………………………………………………………

F…………………………………………………………………………….

G……………………………………………………………………………..

H…………………………………………………………………………….

I……………………………………………………………………………..

State the functions of 2mks

E………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

…………………………………….

G………………………………………………………………………………………

………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………

With reference to the nucleus, state one difference between an animal and a bacteria cell.

1mk

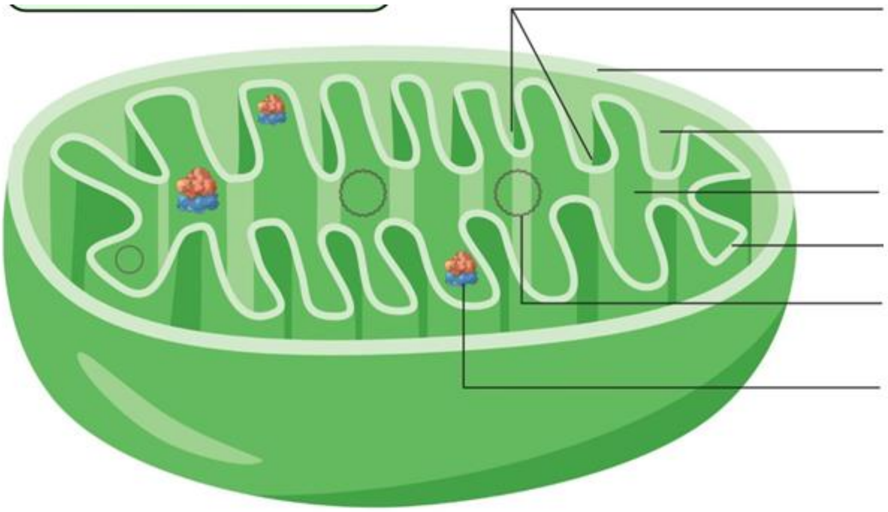
…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………

The diagram bellow represents a photomicrograph of a cell organelle. Study it and answer the questions that follow .



Identify the organelle 1mk

…………………………………………………………………………………………
…………………………

Name the parts labeled ABCD 4mks
A…………………………………………………………………………………………
…………………
B…………………………………………………………………………………………
…………………
C…………………………………………………………………………………………
………………….
D…………………………………………………………………………………………
………………….

State the functions adaptations of the organelle to its functions 2mks

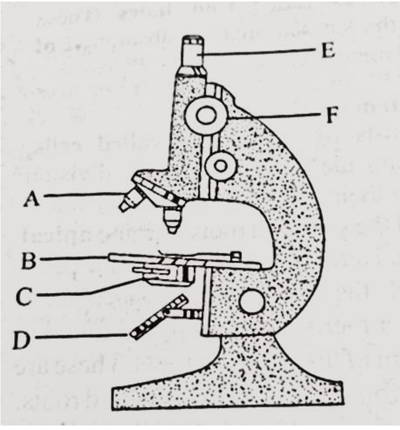
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

Appendices IX: Pretest Of Standardized Biology Evaluation Test (SBET)

THE CELL

EXAM
INSTRUCTIONS: ATTEMPT ALL QUESTIONS.

1. Below is the diagram of a light microscope. Study it and answer the questions that follow:



a) Name the parts labelled A-E and state the function of each.
A………………….

B…………………

C…………………

D………………….

E…………………..

b) Explain why it is not advisable to use the part labelled F when viewing objects with the high power objective.
……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

………………………

c) A cell was magnified 800 times using a light microscope whose eyepiece was X20. What was the magnification of the objective lens?
……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………

…………………………

2. Give reasons why microscopic sections require to be:
   (a) Stained
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………
   (b) Very thin
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………
   (c) Kept wet during processing
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………………………………………………………………
   …………………………

3. Name the cell organelle that:
   (a) Forms secretory vesicles
   ……………………………………………………………………………….
   (b) Controls passage of substances in and out of the cell
   ………………………………………………………………………………
   (c) Is the site of protein synthesis
   …………………………………………………………………………………
   ……………………………………………………………………………

4. State four functions of the following organelles:
   (a) Lysosomes

……………………………………………………………………………………

…………………………………………………………………………………

(b) Mitochondria
……………………………………………………………………………………

…………………………………………………………………………………

(c) Chloroplast
……………………………………………………………………………………

…………………………………………………………………………………

5. State the functions of Golgi apparatus.
…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………..

6. Name the tissue in plants responsible for:
(a) Transport of water and mineral salt
……………………………………………………………………………………

(b) Transport of sugars
……………………………………………………………………………………

(c) Growth
……………………………………………………………………………………

………..

7. State **three** functions of endoplasmic reticulum.
…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………

8. (a) State **four** difference between an electron and light microscope.
…………………………………………………………………………………………

…………………………………………………………………………………………

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…………………………………………………………………………………………

………………………………………………………………………………………

(b) Give **one** advantages of using a light microscope over an electron microscope.

…………………………………………………………………………………………

……………………………………………………………………………

9. (a) Give the formula of working out the magnification of a microscope.
…………………………………………………………………………………………

…………………………………………………………………………………………

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…………………………………………………………………………………………

……………………………………………………………

(b) Calculate the magnification that is obtained when an object is viewed with a X10 eyepiece and a X100 objective.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………

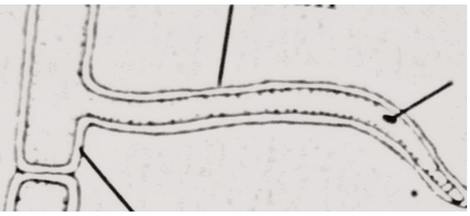
(d) A student observed a row of 16 epidermal cells in a microscope field that was 8 mm in diameter. Calculate the average length of each cell in micrometers. Note:1 mm =1000um.
………………………………………………………………………………………

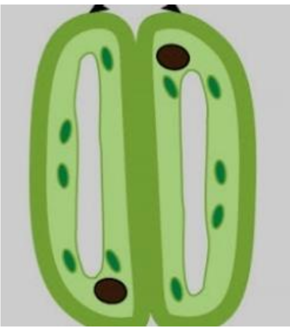
………………………………………………………………………………………

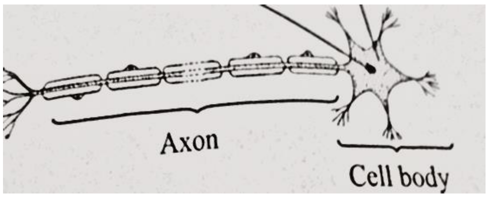
………………………………………………………………………………………

………………………

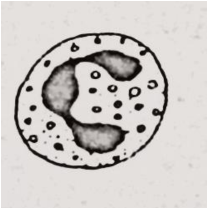
10. The diagram below represent **five** different types of cells. Identify each cell and state its function.

A


B


C


D


E


11. State the function of the following parts of a light microscope:
   (a) Fine adjustment knob
   ……………………………………………………………………………………
   ……………………………………………………………………………

(b) Eye piece
………………………………………………………………………………………

……………………………………………………………………………………

(c) Diaphragm
………………………………………………………………………………………

……………………………………………………………………………………

12. State the functions of the following organelles:
(a) Ribosomes
………………………………………………………………………………………

…………………………………………………………………………………..

(b) Nucleus
………………………………………………………………………………………

……………………………………………………………………………………

(c) Nucleolus
………………………………………………………………………………………

……………………………………………………………………………………

13. Name the cell organelles responsible for the following:
(a) Respiration
………………………………………………………………………………………

…..

(b) Photosynthesis
………………………………………………………………………………………

…………………………………………………………………………………..

14. Name the part of the cell that is useful in maintaining support of herbaceous plants.
……………………………………………………………………………………………

…………………………………………………………………………………..

15. Apart from magnifying objects state the functions of a microscope.
……………………………………………………………………………………………

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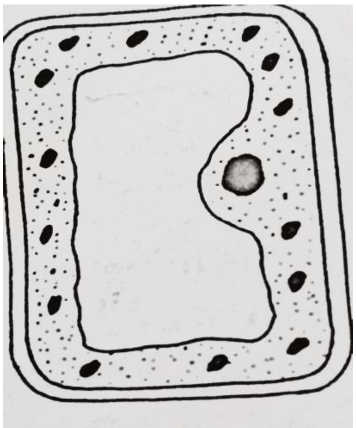
16. The diagram below shows a cell as seen under the light microscope. Study it and answer the questions that follow:



(a) Suggest the kingdom of the organism from which the cell was obtained.
………………………………………………………………………………

………………………………………………………………………………

……………………………………………………………………….

(b) Give the reason for your answer in (a) above.
………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………..

(c) If the same cell was observed using an electron microscope, name any other five organelles not in the diagram that would be observed.
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………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………….

(d) Give the main function of the cell sap.

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………..

17. Name the organelles that are involved in the following:

(a) Synthesis of protein

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………..

(b) Formation of ATP

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………

(c) Regulations of what gets in and out of cells

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………..

(d) Fixation of carbon (IV) oxide to form sugars.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………

(e) Detoxification

………………………………………………………………………………………

………………………………………………………………………………………

(f) Process of secretions.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………

18. Name the tissues that carry out the following functions in plants:
   (a) Protecting the inner more delicate tissues
   ………………………………………………………………………………

   …………………………………………………………………………………

   ……………………………………………………………………………

   (b) Filling the spaces between other tissues
   …………………………………………………………………………………

   ……………………………………………………………………………

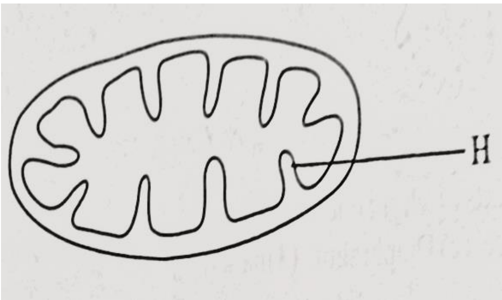
   (c) Making new tissues
   …………………………………………………………………………………

   ……………………………………………………………………………

   (d) Manufacture of food
   …………………………………………………………………………………

   ……………………………………………………………………………

19. The diagram below shows an organelle that is found in most cells. Study it and answer the questions that follow:



(a) Give the full name of the major chemical compound that is formed in the organelle.
…………………………………………………………………………………

……………………………………………………………………………

(b) Name the gas that is required by the organelle in order to form the compound you stated in (a) above.
…………………………………………………………………………………

……………………………………………………………………………

(c) Give the name of the infoldings labelled H and state their function.
…………………………………………………………………………………

…………………………………………………………………………………

(d) In which cells, spermatozoa or ova would you expect to find a high concentration of organelles? Give your reason.
…………………………………………………………………………………

……………………………………………………………………………

20. Name **two** organelles that you would expect to be abundant in glandular organs.
…………………………………………………………………………………

……………………………………………………………………………

21. Give **two** functions of xylem tissue starting with the one.
…………………………………………………………………………………

……………………………………………………………………………

22. Name **three** plants tissues that are involved in support.
…………………………………………………………………………………

…………………………………………………………………………………

………………………………………………………………………

23. Give **two** functions of the cell membrane.
…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………

24. (a) State the major function of mitochondria.

…………………………………………………………………………………………

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………………………………………………………………………..

(c) Muscle cells contains more mitochondria than adipose tissue cells. Give a reason for the observation.

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………..

(d) Highly active cells have mitochondria with abundant cristae. Give the importance of this.

………………………………………………………………………………………

………………………………………………………………………………………

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Appendices X: Marking Scheme Pretest Of Standardized Biology Evaluation TEST (SBET)

The Cell
EXAM
INSTRUCTIONS: ATTEMPT ALL QUESTIONS.
1

(a) A- objective: forms a magnified image of the specimen.
B-stage: platform over which the slide carrying the specimen is placed.

C-condenser: concentrates and directs light to the specimen n stage.

D-Mirror: reflects daylight into the microscope.

E- Eyepiece: magnifies further the image formed by the objective.

(b) It may cause the objective to crush the slide carrying the specimen or even destroy the lenses in the objective.
(c) 800÷20=40

2. (a) Make parts of the specimen distinct, clear hence more visible.

(b) To allow light to pass through

(c) Keep the cell turgid.

3. (a) Golgi bodies/apparatus (b) Cell membrane (c) Ribosomes

4. (a) Breakdown of worn out cell organelles or sometimes the whole cell when old and worn out; involved in intracellular digestion.

(b)Site of respiration or ATP/ energy production.

(c) Site of photosynthesis

5. Processing/packaging of synthesized cellular materials; Secretion /transport of packaged materials; production of lysosomes.

6. (a) Xylem (b) Phloem (c) Meristematic tissue.

7. (a) Synthesis and transport lipids and steroids.

(b) Attachment sites for the ribosomes.

(c) Transport of proteins within the cell.

8. (a) - An electron microscope uses beam of electrons whereas light microscope uses a beam of light.

- An electron microscope has a higher magnification than light microscope.
- An electron microscope has higher resolution than light microscope.
- An electron microscope uses electromagnetic lenses whereas a light microscope uses glass lens.

(b) Can be used to view live specimen /organisms.

9. (a) Eye piece magnification X objective lens magnification.

(b) 10 X 100 = 1000

(c) Diameter of the field in m = 8 X1000 = 8000 μm

Average length of each cell = 8000 ÷16 = $500\mu m$

10. A- Hair root cell: Absorption of water and mineral salt.

B- Guard cell: Controls opening and closing of the stomatal pore.

C- Neurone or nerve cell: Transmission of nerve impulse.

D- Spermatozoa or sperm cell: fertilizes the ovum.

E-Leucocytes or white blood cell: defense against diseases/ pathogens.

11. a) Moves the body tube up or down very slightly bringing the specimen into sharp focus.

b) Magnifies further the image formed by the objective.

c) Controls the amount of light reflected onto the condenser.

12. (a) Site of protein synthesis.

(b) Carries hereditary materials in form of DNA and regulates all other activities of the cell.

(c) Site of ribosomes synthesis.

13. (a) Mitochondria

(b) Chloroplast.

14. Sap vacuole.

15. Resolution (enabling two points that are close together to be viewed as separate objects).

16. (a) Plantae

(b) It has large central vacuole; it has cell wall; It has chloroplasts.

(c) Mitochondria; Golgi bodies, endoplasmic reticulum, ribosomes and lysosomes.

(d) -Stores sugar and salts

- Regulates osmotic pressure of the cell /involved in osmoregulation.

- Maintains turgidity and shape of the cell.

17. (a) Ribosomes (b) Mitochondria (c) Plasma membrane (d) Chloroplasts

(e) Smooth endoplasmic reticulum (f) Golgi bodies.

18. (a) Epidermal. (b) Parenchyma (c) Meristematic (d) Photosynthesis

19. (a) Adenosine triphosphate (b) oxygen

(c) Cristae. To increase the surface area for attachment of enzymes.

(d) Spermatozoa. They rely on their own means of propulsion while the ova are propelled by cilia present on the epithelial cells of the oviduct.

20. Rough endoplasmic reticulum and Golgi apparatus.

21. i) Transport of water

(ii) Support

22. Xylem, collenchyma and sclerenchyma.

23. Regulates what goes in and out of cells; encloses the cell's contents.

24. (a) Oxidation of food (respiration) to re lease energy which is used to form ATP.

(b) Muscle cells are more attractive and therefore, require to generate more energy.

(c) It increases the surface area for the attachment of enzymes responsible for respiration and ATP synthesis.

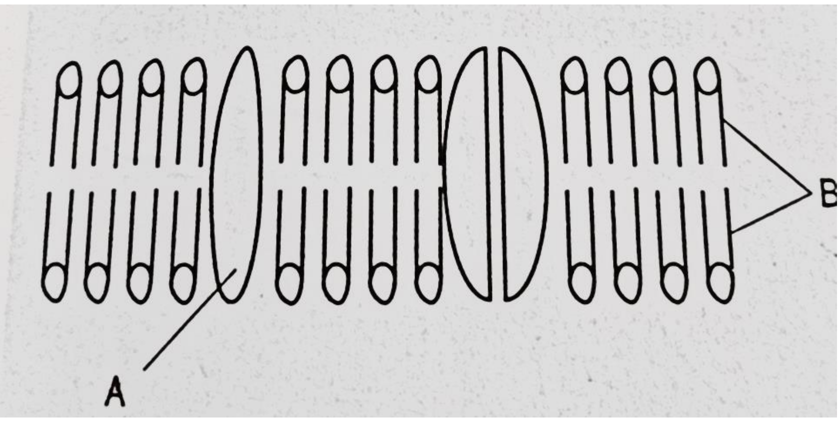
Appendices XI: Posttest Of Standardized Biology Evaluation Test (SBET)

CHAPTER: THE CELL
INSTRUCTIONS: ATTEMPT ALL QUESTIONS.

1. Name the organelle that performs each of the following functions. (2mks)
   (a) Carries out digestion and destruction of worn out cells organelles.
   ………………………………………………………………………………………………
   …

   (b) A site of photosynthesis.
   ………………………………………………………………………………………………
   ……

2. The diagram below represents a cell structure. Study it and answer the questions that follow.



   (a) Identify the structure.
   ………………………………………………………………………………………………
   ……..

   (b) Name the parts labelled A and B.
   ………………………………………………………………………………………………
   ………

   (c) State the function of the above structure in a cell.
   ………………………………………………………………………………………………
   ………

3. (a) State the two functions of a microscope.
…………………………………………………………………………………………………

…………………………………………………………………………………………………

……

(c) How is an object illuminated in an electron microscope?
…………………………………………………………………………………………………

…………………………………………………………………………………………………

……

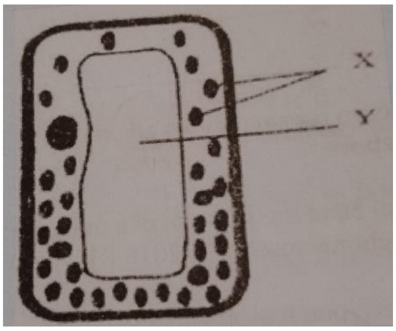
4. (a) Name the organelle that you would expect to be abundant in muscle cells.
…………………………………………………………………………………………………

(b) Give a reason for your answer.

…………………………………………………………………………………………………

…

5. The diagram below represents a cell. Study it and answer the questions that follow.



(a) Name the parts labelled X and Y
X…………………………..

Y……………………………

(b) Suggest why the structure labelled would be more on one side than the other.
…………………………………………………………………………………………

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…………………………………………………………………………………………

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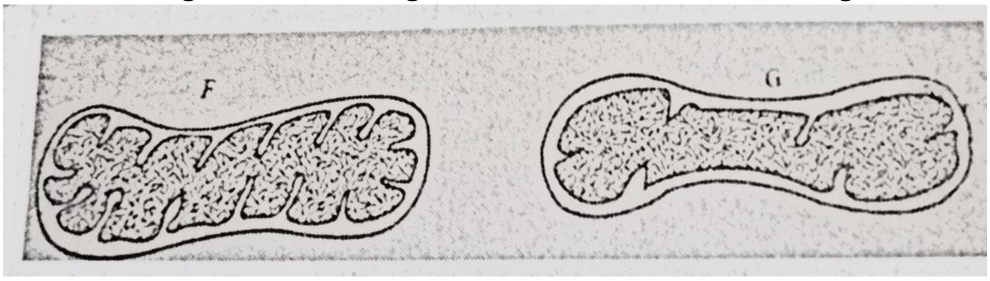
6. Below are diagrams of a cell organelle obtained from different organs of an animal



(a) (i) For each organelle state an organ in the urinary system where it is likely to be found.
F………………………

G…………………….

(b) Give reason for your answer in (a) (i) above.
…………………………………………………………………………………………

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…………………………………………………………………………………………

………

7. (a) Explain the term cell specialization.
…………………………………………………………………………………………

…………………………………………………………………………………………

…………

(c) State how each of the cells listed below is specialized to carry out its function;
i. Palisade cell
…………………………………………………………………………………………

………

ii. A sperm cell
…………………………………………………………………………………………

8. Name two structures that are found in plant cell but absent in animal cell.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………

9. (a) State two functions of the centriole.

…………………………………………………………………………………………

…………………………………………………………………………………………

……………...

(b) Which organelles would be abundant in?

(i) Skeletal muscle

…………………………………………………………………………………

………

(ii) Palisade tissue

…………………………………………………………………………………

………

10. State the function of the following organelles;

a) Rough endoplasmic reticulum

…………………………………………………………………………………

………

b) Nucleolus

…………………………………………………………………………………

………

11. (a) State the formula of calculating linear magnification of specimen when using a hand lens.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………..

(c) Give one functional advantage of use of the following microscopes.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

………………

12. Give two functions of vacuole.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………..

13. Give the function for the following process when preparing temporary slides:

(a) Sectioning

…………………………………………………………………………………………

…………………………………………………………………………………………

………

(b) Fixation

…………………………………………………………………………………………

…………………………………………………………………………………………

…………

14. Why are lysosome many in phagocytic cells?

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………..

15. State the function of the following parts of a microscope.

(a) Nose piece

…………………………………………………………………………………………

…………………………………………………………………………………………

………..

(b) Condenser

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………

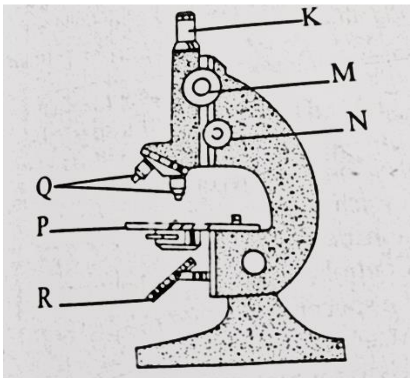
(c) Diaphragm

………………………………………………………………………………………………

………………………………………………………………………………………………

………

16. The diagram below shows a light microscope



(a) Name the parts labelled K and M

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

……………….

(b) State the function of the parts labelled P and Q

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………..……………………………………………………………

………………………………………………………………………………………………

……………………………

(c) A student was viewing a prepared slide of a plant cell under high power microscope. The feature of the cell were blurred. Which one of the labelled parts of the microscope would the student use to obtain;

(i) A sharper outline of the feature

…………………………………………………………………………………………

…………………………………………………………………………………………

………………

(ii) Give the formula used to calculate magnification in a light microscope.

…………………………………………………………………………………………

…………………………………………………………………………………………

……………….

(d) A student was preparing a section of a plant cell to be viewed under a light microscope. Give a reason for each of the following steps:

(i) Cutting very thin sections

…………………………………………………………………………………………

…………………………………………………………………………………………

……………….

(ii) Staining the sections

…………………………………………………………………………………………

…………………………………………………………………………………………

……………….

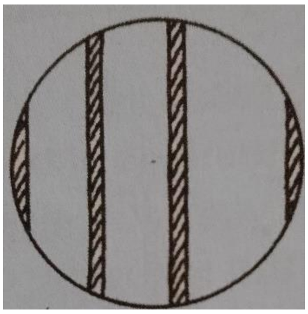
(iii) Putting the section in water

…………………………………………………………………………………………

…………………………………………………………………………………………

……………..

17. (a) A form one student, trying to estimate the size of onion cell observed the following on microscope's field of view



He counted 20 cells across the field of view. The diameter of the field of the field was $300\mu m$

.Calculate the size of the cell in micrometers.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………..………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………………………………..

(b) State the function of a diaphragm in a light microscope.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………..

18. Explain why it is important to stain specimen to be observed under light microscope.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………..

19. A student while carrying out an experiment observed 8 cells across the field of view of light microscope. If the diameter of the field of view is 5mm, calculate the average length of each cell in micrometers.

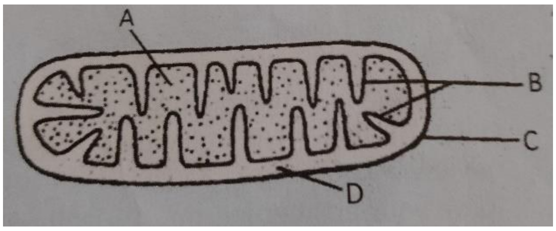
…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………..

20. The diagram below represent a cell organelle. Study it and answer the questions that follow.



(a) Identify the organelle
…………………………………………………………………………………………………

…....

(b) Name the part labelled B
…………………………………………………………………………………………………

…..

(c) State the function of part labelled A
…………………………………………………………………………………………………

…….

21. Two students were observing bacteria using two identical microscopes and identical slides. Student A saw 10 bacteria while student B saw 50 bacteria.
(a) Suggest a reason why they observed different bacteria
…………………………………………………………………………………………………

…………………………………………………………………………………………………

………….

(b) Basing your answer in (a) above which of the following combination would give a wider field of view?

(i) Eye piece X 10 and objective X20 or

(ii) Eye piece X10 and objective X40

22. Peter was using a light microscope to view onion cell with lens combination of eye piece lens X10 and objective lens X20

(a) Calculate the total magnification

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………..…………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………….

(b) If he changed the objective lens magnification to X40 , would the cells appear bigger or smaller? Explain

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………

23. (a) What is the function of a stage in a light microscope?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

………………

(b) Give the function of body tube in a light microscope.

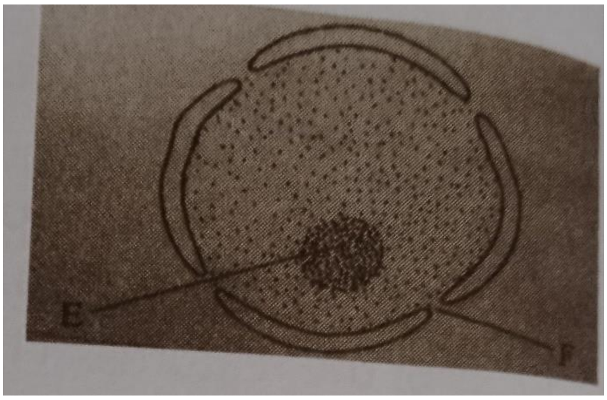
……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………………

……………………..

24. The diagram below represent a nucleus



(a) Name the structures labelled E and F
E…………………………………

F……………………………………

(b) State the function of F
………………………………………………………………………………

………………………………………………………………………………

……………….

(c) With reference to the nucleus, state one difference between an animal and bacteria cell
………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

………………………

(d) Name the plant cell organelle that

(i) Stores chlorophyll

………………………………………………………………………………

………

(ii) Responsible for intracellular digestion

………………………………………………………………………………

…….

(e) State the main function of the vacuole in the amoeba.

………………………………………………………………………………………

………………………………………………………………………………………

………………

Appendices XII: Marking Scheme For Posttest Of Standardized Biology Evaluation Test (SBET)

CHAPTER: THE CELL
INSTRUCTIONS: ATTEMPT ALL QUESTIONS.

1. (a) Lysosome

(b) Chloroplast

2. (a) cell membrane

(b) A- protein layer

B- Phospholipid bilayer

(c) – encloses the cell contents

- allows selective movement of substances in and out of the cell

3. (a)– Resolution- ability to show two objects as that are close to one another as separate objects.

- Magnification –image of an object

(b)By an electron beam

4. (a) mitochondria

(b) They require a lot of energy

5. (a) X-chloroplast

Y- Vacuole

(b) In bright light they move away to avoid bleaching/ to obtain optimum light intensity

6. F – kidney

G- Bladder

In kidney active reabsorption of solutes require energy organelle F has more cristae for attachment of more respiratory enzymes, bladder does not require as much energy hence less number of cristae and fewer respiratory enzymes attached.

7. (a) Phenomenon of a cell having a structure that enables it to perform specific function.

(b) (i) Has numerous chloroplast

(ii) Sperm cell: has long tail

Has acrosome

Has large nucleus full of DNA

Has numerous mitochondria

8. Cell wall

Chloroplast

9. (a) (i) Helps in spindle fibre formation during cell division

(ii) Formation of cilia and flagella

(b) (i) Mitochondria

(ii) Chloroplast

10. (a) Helps in transport of proteins

(b) Manufacture of ribosomes

11. (a) magnification = $\frac{(length\ of\ drawing/image}{length\ on\ the\ specimen}$

(b) (i) can be used when studying live specimen

(ii) Has higher power of resolution and higher power of magnification

12. Mechanical support

Storage of water and cell sap

Digestion (food vacuole)

13. (a) to make thin specimen that allow light to pass through

(b) To maintain the structure of specimen hard enough for thin sections to be cut.

14. They contain lytic enzymes that breaks down foreign material s which can be ingested.

15. (a) Holds the objective lenses in place enabling change from one objective lens to another.

(b) Concentrates the light on the object on stage

(c) Regulates the amount of light passing through the condenser.

16. (a) K- eye –piece

M- Course adjustment knob

(b) P- Concentrates the light

Q- Magnifying the image

(c) (i) N

(ii) Magnification= eyepiece magnification X objective lens magnification

(d) (i) For light to pass through

(ii) To make the features more clear and distinguishable

(iii)For cells to remain turgid

17. (a) size of the cell = diameter of the field of view / Number of cells

$= \frac{3000\mu m}{20} = 150\mu m$

(b) Regulates the amount of light passing through the condenser.

18. Different structures absorbs stain differently hence become more visible

19. 1mm= $1000\mu m$

5mm= $5000\mu m$

Therefore

Average length of one cell = diameter of the field of view / Number of cells

$\frac{5 X 1000}{8} = 625\mu m$

20. (a) mitochondrion

(b) Cristae

(c) Site where respiration occurs

21. (a) They used objective lenses with different magnification power; student A used a higher magnification power which reduced the field of view while student B used low magnification power which gave a wider field of view.

(b) EyepieceX10, objective X20

22. (a) magnification= eyepiece magnification X objective lens magnification

10X20

(b) Bigger because of high magnification.

23. (a) the platform where the slide to be observed is placed while viewing

(b) to hold the eyepiece and the revolving nose piece.

24. (a) E- Nuclear pore

F- Nucleolus

(b) Allow passage of materials in and out of the nucleus

(c) Nucleus in animal cell is membrane bond while that of bacteria is not en closed within the nuclear membrane

(d) (i) chloroplast

(ii) Lysosome

(f) For storage and feeding on small food particles.

For excretion of excess water

Excretion.

Appendix XIII: Questionnaire for teachers

The information given in this questionnaire were treated with strict confidentiality.

Instructions

Please tick appropriately in box **[]** corresponding to your choices for structured questions.

Write the answers to the open ended questions in the spaces provided. Please tick **[]** the response that closely approximate your opinion about the statements provided.

SECTION A: TEACHERS BIOGRAPHY

What is your sex? Male [ ] Female [ ]

Please indicate your highest academic qualification?

M. Ed [ ] B. Ed [ ] B. SC [ ] Dip. Ed [ ] others (specify)…………

How many years of experience in teaching Biology do you have?

……………………………………………………………………………………

How many practical lessons do you administer per week? ……………………………………………………………………….

SECTION B: THE EFFECT OF TEACHING USING PHOTOMICROGRAPHS AND REAL SPECIMENS ON STUDENTS' BIOLOGY ACADEMIC PERFORMANCE.

Use (Strongly Agree (SA), Agree (A), Not Sure (NS), Disagree (D) and Strongly Disagree (SD) to represent your choice.

NO.	**Question**	**SA**	**A**	**NS**	**D**	**SD**
1	The teaching using real specimens is better than using photomicrographs					
2	The teaching using photomicrographs is better than using real specimens					
3	The evaluation using the real specimens is a satisfying approach					
4	Evaluation using photomicrographs is satisfying approach					

Extent of real specimen utilization

a) Does the use of real specimen lead to increase the chances of performing for practical in

Biology? Yes [ ] No [ ]

b) If yes, to what extent? ……………

Do you have any suggestions on the use of real specimens in teaching of Biology practical? .....………………………………………………………………………………

Thank you for your cooperation

Appendix XIV: Students' Questionnaire

The questionnaire is for the collection of crucial information necessary for the study and this were treated with strict confidentiality. It is meant for the provision of report study only. The answers provided honestly are all correct. Kindly corporate.

Instructions

Please tick your response appropriately in box provide.

Number.	Question	SA	A	N	D	SD
1.	I master the content when taught using real specimens other than photomicrographs?					
2.	I prefer evaluation on real specimens other than evaluation on photomicrographs?					
3.	Real specimen is used during the applicable practical lessons					
4.	The instructional method offered in teaching influence my performance					

7. Do you have preserved specimens used for teaching Biology practical lessons?

If yes, kindly indicate the number

…………………………………………………………………………………………

………………………………………………………………………………………

Do you think the provision of real specimens will improve performance of your Biology in KCSE? Yes [ ] No [ ]

What grade do you expect in K.C.S.E Biology if your preferred evaluation method is to be used?

A – B+ [ ] B – C+ [ ] C – D+ [ ] Below D+ [ ]

Gratitude is all yours for your participation.

Appendix XV: Observation checklist

Six science process skills (6sps)	**Photomicrograph**	**Real specimen**
Observing		
Experimental and inquiry-based learning		
Critical thinking and analysis		
Communication		
Problem solving		
Real world application		

Appendix XVI: National KCSE Performance In Biology

KCSE YEAR	PAPER	MAXIMUM SCORE	MEAN SCORE	STANDARD DEVIATION
2017	1	80	13.74	10.24
	2	80	16.43	10.37
	3	40	7.68	5.05
	Overall	**200**	**37.85**	**23.45**
2018	1	80	15.81	9.26
	2	80	11.92	8.67
	3	40	13.65	7.38
	Overall	**200**	**51.38**	**23.26**
2019	1	80	18.00	11.21
	2	80	18.00	10.03
	3	40	16.00	6.48
	Overall	**200**	**49.87**	**25.50**
2020	1	80	16.03	11.70
	2	80	19.83	11.75
	3	40	16.59	8.48

	Overall	**200**	**53.03**	**29.50**
2021	1	80	19.58	14.88
	2	80	21.73	13.87
	3	40	15.72	7.05
	Overall	**200**	**57.01**	**32.98**
2022	1	80	24.04	15.29
	2	80	19.87	12.83
	3	40	13.47	7.32
	Overall	**200**	**57.37**	**32.39**

Appendix XVII: National KCSE Performance In Biology

	SUB COUNTIES KCSE BIOLOGY ACADEMIC PERFORMANCE %					
YEAR	**MOSOP**	**CHESUMEI**	**EMGWEN**	**NANDI HILLS**	**TINDIRET**	**NANDI SOUTH**
2019	22.58	23.57	22.92	24.67	25.25	21.83
2018	21.42	22.17	21.58	22.17	23.17	21.33
2017	18.08	18.33	18.17	17.15	21.17	17.25