EFFECT OF 7E LEARNING CYCLE MODEL ON STUDENTS'ACADEMIC ACHIEVEMENT IN BIOLOGY IN SECONDARY SCHOOLS IN KENYA: A CASE STUDY OF CHESUMEI SUB-COUNTY.

BY

JULIANA CHERONO

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DECLARATION

Declaration by the candidate

This thesis is my original work and has not been submitted for any academic award in any institution; and shall not be reproduced in part or in full, or in any format without prior written permission from the author and or University of Eldoret.

CHERONO JULIANA

_____ _____

SEDU/EDS/M/001/17 Date

Declaration by Supervisors

This thesis has been submitted with our approval as University supervisors.

_____ _____

Date

DR. DINAH SAMIKWO

Department of Science Education

School of Education

University of Eldoret, Kenya

_____ _____

Date

DR. STELLA KABESA

Department of curriculum and instruction

School of Education

University of Eldoret, Kenya

DEDICATION

This thesis is dedicated to my late parents Mr. and Mrs. Rotich who always had confidence in me and offered me encouragement and support in my education.

ABSTRACT

This study examined the effect of 7E Learning Cycle Model on students' academic achievement in Biology in secondary schools in Kenya. The first objective was to compare the effect of 7E Learning Cycle Model and Conventional Instructional Method on students' academic achievement in Biology, the second objective was to determine the influence of students' attitude towards 7E Learning Cycle Model on their academic achievement in Biology and the third objective was to establish challenges faced by teachers when using 7E Learning Cycle Model and how they affect students' academic achievement in Biology. Quasi-experimental design was adopted in this study. 7E Learning Cycle Model was applied to experimental group and Conventional Instructional Method to the control group. Target population for the study was 3421 form three Biology students and 61 Biology teachers. Data was collected from a sample size of 346 students and 18 teachers. The study employed stratified sampling, simple random sampling and purposive sampling procedures. Data collection instruments were Biology Achievement Test, Students' Questionnaire and Teachers' Questionnaire. Validity of the Biology Achievement Test was established by two Biology teachers. The validity of both students' and teachers' questionnaire were established by two supervisors. Reliability of Biology Achievement Test was established through test- retest technique using SPSS. A reliability coefficient of r = 0.83 was obtained. To establish the internal consistency of the questionnaire, Cronbach's coefficient alpha was employed using SPSS. Students' and Teachers' questionnaire, had a Cronbach's coefficient alpha of 0.89 and 0.84 respectively. Data was analysed using both descriptive (frequencies, percentages, mean and standard deviation) as well as inferential statistics (t- test) with the aid of SPSS and excel. The findings of the study showed that students in the experimental group performed better than students in the control group, students had positive attitude towards 7E Learning Cycle Model and that Biology teachers face challenges when using 7E Learning Cycle Model during instruction. The study therefore concluded that 7E Learning Cycle Model is an effective way of improving students' academic achievement in Biology. Based on the findings of the study, the researcher recommended that Biology teachers should employ 7E Learning Cycle Model in teaching, KICD should incorporate 7E Learning Cycle Model into Biology curriculum, Ministry of Education together with other education stake holders should organize in-service programs for teachers on the use 7E Learning Cycle model and also, they should provide adequate instructional resources.

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LIST OF ABBREVIATIONS AND ACRONYMS

7E LCM 7E Learning Cycle Model

BAT Biology Achievement Test

CIM Constructivist Instructional Methods

KCSE Kenya Certificate of Secondary Education

KICD Kenya Institute of Curriculum Development

KNEC Kenya National Examination Council

Mo DP Ministry of Devolution and Planning

NACOSTI National Commission for Science Technology and Innovation

SMASSE Strengthening Mathematics and Science in Secondary Education

SPSS Statistical Package for Social Sciences

SQ Students' Questionnaire

TQ Teachers' Questionnaire

USA United States of America

DEFINITION OF OPERATIONAL TERMS

Academic achievement: Scores obtained by students in Biology Achievement Test after instruction on the topic "Classification." The scores are the percentage mark and their respective grades. In this study poor performance ranges from E to D+, average performance ranges from C- to C+ and good performance ranges from B- to A.

Biology Achievement Test (BAT): Test designed to measure knowledge that learners have on Classification. Pre-test as well as post-test were viewed as achievement test.

Constructivist Learning Theory: A belief that learners actively construct knowledge based on prior experience.

Conventional instructional method (CIM): Ways of transmitting knowledge where the teacher plays a central role, knowledge is derived from a standard textbook and learners are largely passive. These were the major methods of instruction with the introduction of formal teaching.

Effect: Extent to which learners' performance in Biology Achievement Test is influenced by instructional method.

7E Learning Cycle Model (7E LCM): This is a model based on Learning Cycle. It emphasizes seven stages; Elicit, engage, Explore, Explain, Elaborate, Evaluate and extend, that teachers should adopt in teaching. These stages are interconnected where the learner's prior knowledge is elicited, carries out scientific investigation, build concepts after making conclusions and finally applying the concepts in new situations.

Instruction Manual: It is a guide for teaching the topic ‘Classification’ used by the teacher to direct instructional process using 7E Learning Cycle Model.

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CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 Introduction of the Chapter

This chapter deals with introduction to the study. It discusses the background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, hypothesis, justification of the study, significance of the study, assumptions of the study, scope and limitations of the study, theoretical frame work and conceptual framework

1.2 Background of the Study

Education is one of the instruments which can deal with the challenges of the 21st century. Before the 21st century, education systems across the world have been mainly focusing on students' acquisition of content and knowledge. During the late 20th century and early 21st century, the society underwent great changes in terms of economy and technology. Scientific revolution took place all over the world after the Soviet Union launched sputnik in 1957 (Melzer & Otero, 2015). Subsequently, United States of America (USA), Britain and other nations reviewed their science curricular and methods science of instruction (Ojimba, 2013). In USA, these reforms were aimed at ensuring that the traditional instructional methods, that did not prepare its citizens in science and technology, were replaced by learner centered methods that took into account construction of knowledge.

In 1981, USA secretary of Education constituted a commission which looked into the education quality in the country (Mintzes & Wandersee, 1998). The commission issued its report: A Nation at Risk: The Imperative for Educational Reform (1983). One of the major finding was that reform in education should center on creating a learning society by use of effective instructional methods that promote critical thinking and creativity among the youth.

In Africa, several studies have shown that teachers have utilized variety of instructional strategies to improve students' academic achievements. For instance, in order to address consistent secondary school students' low performance in South Africa, initiatives were put in place to improve education quality: prioritizing teacher training and development in instructional strategies that promote high order thinking among the students, involving stake holders in education planning and reviewing education policy.

Kenya government through Social pillar of Kenya vision 2030 pointed out Education and training as one of the ways of achieving its objective of transforming into a newly industrializing, middle income country providing a high-quality life to all its citizens by 2030 in a clean secure environment (MoDP, 2013). In order to become an industrialized country, Kenya Secondary School curriculum has placed emphasize on science, technical and practical education. In the Kenyan curriculum, Biology is among the science subjects offered in secondary schools. The study of Biology intents to equip the learner with knowledge, skills and attitude which are vital in enabling the learner protect and conserve the environment, population control, combating diseases and improvement of food production. Biology also enables students to enter into

careers in sectors such as education, health, agriculture and environment. The Kenyan government and other education stake holders have the responsibility of equipping schools with infrastructure, providing instructional resources and sound curriculum. Schools have also been given responsibility of ensuring that classrooms have been equipped with instruction facilities and resources, conducive teaching and learning environment, participation of co-curricular activities while at the same time ensuring effective learning is taking place.

In the present-day, scientific revolution has been shaped by science and technology. Preparing a student who is able to compete globally is one of the major goals of teaching science. Hence, learners should develop skills, knowledge and attitudes that will enable them tackle issues of the 21st century. Constructivist instructional approach is being implemented in science classrooms where students develop their own knowledge on scientific concepts. Among the constructivist approaches are the learning cycles: 3E, 5E and 7E. 7E Learning Cycle Model (7E LCM) emphasizes eliciting students' prior knowledge and transfer of learning which are essential components in science education. Many studies in Science teaching have found positive effects of 7E LCM on students' achievement and skills. Students taught using 7E Cycle Model developed better understanding and retention of scientific concepts (Gok, 2014). According to the study conducted by Shaheen & Kayani (2015), experimental group showed more skills in solving science related problems than control group. Students subjected to 7E LCM performed better on Post-test scores than those taught using teacher centered methods (Shaheen & Kayani, 2015). Existing literature on effect 7E LCM on students' academic achievement has been done in

other parts of the world. It is as a result of this that this study was set to actualize it in Kenya. Therefore, this study was set to investigate the effect of 7E LCM as a remedy that might improve students' acquisition of skills, knowledge and attitude in Biology in Kenya.

1.3 Statement of the Problem

Biology instruction in most secondary schools in Kenya has generally been dominated by teachers mostly using Conventional Instructional Method which are mainly lectures, few demonstrations and drilling of students using past papers. These methods of instruction expose students to minimal group discussions and practical activities. Performance in Biology in Kenya Certificate of Secondary Education (KCSE) has been poor as indicated in Kenya National Examination Council (KNEC) (2019) report. The report showed that between the year 2009-2019 Biology has never reached a score of 50% (see appendix X). In Chesumei Sub-county, students' academic achievement in Biology has been equally poor (see appendix XII). According to Chesumei Sub-county Educational Report (2020), Biology performance in KCSE in 2017 was dismal, having attained a mean score of 18.33%. Subsequently, in 2019 the overall Biology mean score in KCSE was 23.58%.

Efforts have been made by the Ministry of Education to improve performance in Biology through organizing for teachers' workshops, seminars and SMASSE projects. Despite all these, there has been continued poor performance of the subject. Poor performance in Mathematics and science subjects is contributed by the following factors: negative attitude (Kingaru ,2014); high class enrolment (Wamkota & Masibo,

2017); poor teaching and learning methods (Jepketer, 2017; Oduol, 2018) and inadequate teaching and learning resources (Oduol, 2018; Wekesa, 2013). KNEC, (2018) mentioned that one of the major causes of poor performance in Biology was poor instructional methods. The report recommended that teachers should employ instructional methods in such topics as Classification, Genetics, Ecology, Reproduction, Transport, Evolution, Excretion among others that enable the students apply learnt concept to their day-to-day life.

This study therefore investigated the effect of 7E LCM as a learner centered instructional approach on students' academic achievement. 7E LCM has seven phases where instructional process is planned through a series of short activities that eventually leads to students applying learnt concepts to their daily life. This might improve students' academic achievement in Biology in Kenya.

1.4 Purpose of the Study

The purpose of the study was to investigate the effect of the 7E Learning Cycle Model on students' academic achievement in Biology in secondary schools in Kenya.

1.5. Objectives of the Study

1. To compare the effect of 7E Learning Cycle Model and Conventional Instructional Method on students' academic achievement in Biology.

2. To determine the influence of students' attitude towards 7E Learning Cycle Model on their academic achievement in Biology.

3. To establish challenges faced by teachers when using 7E Learning Cycle Model and how they affect students' academic achievement in Biology.

1.6 Research Questions

1. Is there any difference in Biology academic achievement between students taught using 7E Learning Cycle Model and those taught using Conventional Instructional Method?
2. How does attitude of students towards 7E learning cycle affect their academic achievement in Biology?
3. How does the challenges faced by teachers when using 7E Learning Cycle Model affect students' academic achievement in Biology?

1.7 Hypothesis

H_O1: There is no significant difference in Biology Achievement between students taught using 7E Learning Cycle Model and those taught using Conventional Instructional Method.

1.8 Justification of the Study

Efforts to improve on the quality of teaching and learning among learners is an issue of concern among all stake holders in education. Both international and local efforts are being made to improve the quality of learning in students. Teaching and learning in science are issues that has drawn the attention of stakeholders in education. This is because the role of science and technology is expected to play in socio-economic development of the nations of the world; Kenya's vision 2030 has called on the

improvement on the quality of education. Because of these, efforts to improve the quality of science are being undertaken. Factors affecting teaching and learning of science have been investigated. Teaching methods, approaches and strategies is the focus of some of the studies. This investigation sought to investigate the use of 7E LCM in an effort to establish its effect on student achievement and overall improvement in the quality of teaching science. Improved science teaching will translate to better achievement among learners and consequently better utilization of science in economic development.

1.9 Significance of the Study

1. Curriculum developers may provide in-service training to teachers on the use of 7E LCM during teaching and learning.
2. Policy makers in education may provide instructional resources
3. Teacher preparing institutions such as universities and colleges may train students on the application of 7E LCM during teaching and learning.
4. Developers of instructional materials such as books may incorporate 7E LCM in the books to enable its use during the instruction process.
5. Biology teachers may use 7 E LCM by during instruction.
6. Learners' prior knowledge is prompted and transfer of learning to their day-to-day life is emphasized when they are taught using 7E LCM. This may increase their conceptual understanding of Biological concepts hence improvement of their academic achievement in Biology. Hence might increase the number of students who qualify to pursue science related courses at the universities and colleges.

7. The findings of this study may prompt further research on Biology education methodology.

1.10 Assumptions of the Study

The study had the following assumptions:

1. The sample used was a representative of the whole population.
2. Teachers understood the use of 7E LCM Instruction Manual.
3. The teachers were not biased during interventions and students' post-test scores was due to instructional method used.
4. Participants in the experimental and control groups did not influence each other during the study
5. Data that was collected from the students was a true reflection of their understanding the topic of Classification.
6. All participants would cooperate during the study and would respond to the research instruments appropriately.

1.11 Scope of the Study

The study examined the effect of 7E LCM versus CIM on academic achievement in Biology. The study was conducted in secondary schools in Chesumei Sub-county, Nandi County. This was because the Sub-county has continually registered poor performance in KCSE Biology as indicated in Chesumei Sub-county education report (2020). Form three class was selected by the researcher to participate in the study because the topic 'Classification' which the researcher identified for the study is

taught in form three. The topic ‘Classification’ was used in the study because it is one of the topics indicated by KNEC (2018) report that should be taught and tested comprehensively as well as broadly to bring the students on board with critical issues of the 21st century.

1.12 Limitations of the study

The study was conducted in six different schools with 6 teachers who may affect intervention since it is difficult to control all the teachers. Even so, the researcher ensured that the teachers were adequately inducted on the instructional approaches to use. The other limitation was that the study was conducted in intact classes, hence findings may not be generalized to other schools unless they are of the same academic ability.

1.13 Theoretical Framework

The present study was based on constructivist learning theory. Constructivism is based on the notion that learners actively construct meaning from experience. Constructivist theory allows students to relate new ideas to pre-existing knowledge. Knowledge construction depends on available mental operations and existing thinking that may lead to the process of learning (Taber, 2019). In order for the students to actively construct knowledge, they should be allowed to ask questions, carry out scientific investigation, and evaluate themselves during the learning process (Boud, 2013). The teacher guides the learning process and ensures that students actively construct knowledge based on their’ prior understanding, for effective learning to take place (Kolb, 2014). Constructivism assumes that students are active during knowledge

construction, based on previous knowledge and learning experience, provided by the teacher who acts as a facilitator.

Piaget's individual cognitive constructivist theory and Vygotsky's social constructivist theory were used as a basis for this study. Piaget (1952) viewed individual cognitive development as a process that takes place due to biological maturation and interaction with the environment. Individual cognitive theory of Piaget (1952) laid out two approaches to construction of knowledge. First, schemas which are building blocks of knowledge, responsible for adaptation process: assimilation, accommodation and equilibrium are the same as the use prior knowledge in knowledge construction. Piaget viewed adaptation as a process that leads to intellectual growth. Learners are able to adapt if information they encounter in their day-to-day life are organized and re- organized continuously (Lefa, 2014). Adaptation takes place through assimilation and accommodation. Assimilation occurs when the existing schema is able to deal with a new situation, whereas accommodation occurs when existing schema fails to work and needs to be changed to deal with a new situation (Noor, Ahnis, Mazli, Shirin & Mazlen, 2019). Assimilation and accommodation require an active learner in order to discover problem-solving skills (Piaget, 1952).

Secondly, knowledge construction occurs when an individual passes through four cognitive development stages: sensory-motor, preoperational, concrete operational and formal operational. Concrete and formal operational stages have been applied in 7E LCM. At concrete stage, learning takes place through manipulation of objects, ideas and events that leads to the beginning of logical thinking and eventually can lead to learners constructing meaningful concepts. This leads to development of logical

thinking and abstract reasoning at the formal operational stage. At formal operational stage, the learner can be able to perform an array of activities that involves use of hypothesis, hence the learner should be put in a situation where they are compelled to solve problems (Lefa, 2014).

According to social constructivist theory by Vygotsky (1978), learning takes place when an individual builds knowledge based on socio-cultural environment and prior knowledge. He emphasized that peer collaboration leads to cognitive development. Consequently, in social constructivist classrooms, teachers should allow learners to actively construct knowledge collaboratively with individuals such as peers and adults including teachers. Learners actively construct their own understanding based on observation and interaction with their peers (Driver, Rushworth & Wood-Robinson, 1994). For the students to construct their own meaning of the world, they need guidance from the teacher (Driver, et al., 1994). Therefore, the teacher should facilitate the learning process in a logical manner. The kind of activities the learner is going to engage in, can lead to either acquisition of skills or practice of the acquired skills (Anderson, Reder & Simon, 1997). 7E LCM adopted in the study is a cognitive as well as social constructivist instructional approach. Therefore, the learners are able to actively construct their own understanding both at individual and social levels.

1.14 Conceptual Framework

This study was conceptualized with 7E LCM, students' attitude towards 7E LCM and challenges faced by teachers when using 7E LCM as the independent variable while

students' academic achievement as the dependent variable. Figure 1.1 shows the variables in the study.

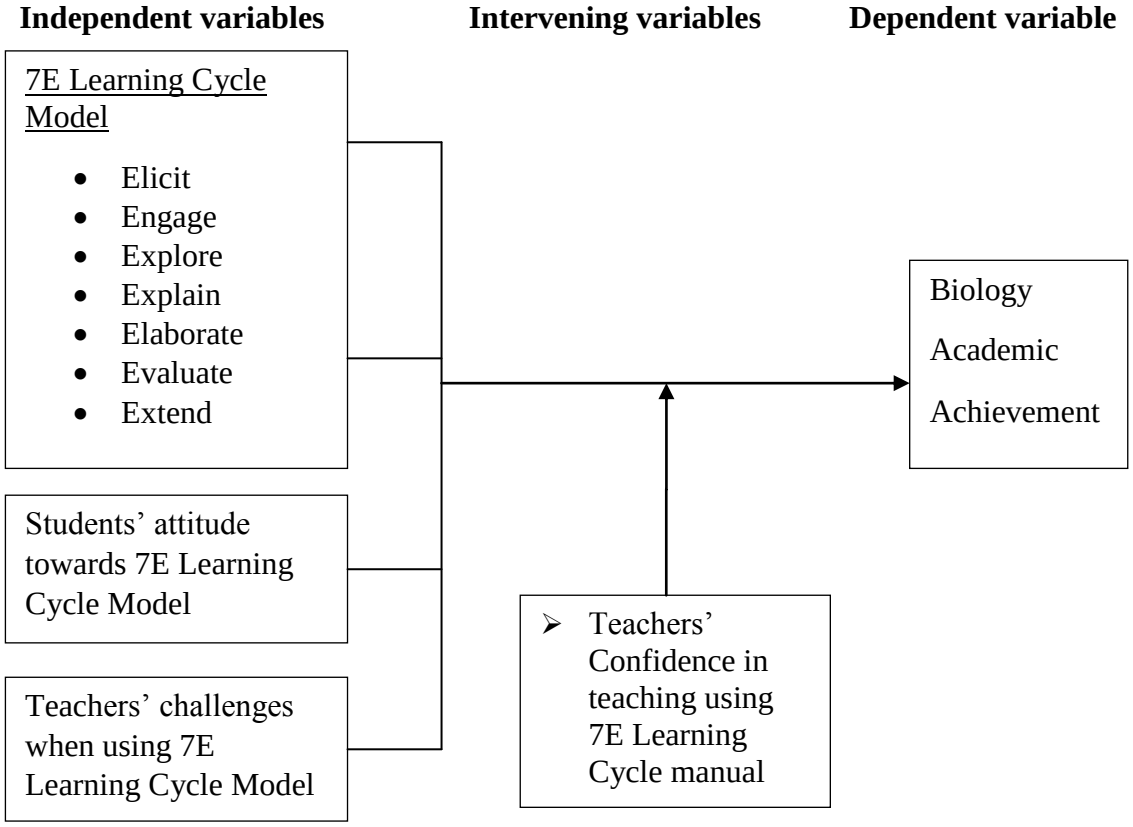

Figure 1. 1 : Conceptual Framework of the Study

(Source: Author, 2020)

1.15 Summary of the Chapter.

This chapter has dealt with introduction to the study, the need for use of proper instructional methods in the background of the study. Proof that there is poor performance in Biology has been given at the statement of the problem. Research objectives stated were used to guide the study. Justification on the use of 7E LCM in improving students' academic performance in Biology has been elaborated. Significance of the study, what the study assumed, its scope and limitation has been

discussed. Finally, theoretical frame work based on constructivism learning theory, conceptual framework that guided the study have been given.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction to the Chapter

This chapter deals with literature review and contains sections on the constructivism theory, constructivist instructional method and Conventional Instructional Method. It also has literature on studies that have compared students' achievement between students instructed using 7E Learning Cycle Model and those instructed using Conventional Instructional Method. Literature related to students' attitude towards 7E Learning Cycle Model has been discussed. Finally, literature on challenges faced by teachers when using 7E Learning Cycle Model has been reviewed.

2.2 Constructivist Theory

In the 21st century, instructional theories dictate that a learner should be active during knowledge construction. This is because the process of learning science is complex and requires active students during the learning process. Therefore, application of appropriate instructional theory and methods help a learner learn effectively (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, Asoko, Leach, Mortimer & Scott, 1994). Constructivist theory originated from two theorist in the early 19th century: Piaget (1976) and Vygotsky (1986). Piaget's theory explains how a learner actively constructs

knowledge while Vygotsky's theory cognitive development as being brought about by social and cultural interactions of the learner.

2.2.1 Cognitive constructivism

According to cognitive constructivism, a learner actively constructs knowledge based on mental representations (schema) as opposed to being passive absorber of knowledge (Piaget, 1970). Piaget argued that a child undergoes cognitive development in four stages. Pre-operational 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 (2-7years), 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 (7-upwards), 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 able to perform activities involving test of hypothesis therefore enhancing problem solving skills (Lazarus, 2010).

Piaget (1953), asserts that an individual actively constructs knowledge as they pass through the stages of development via 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 a classroom environment that prompts student's cognitive development through challenging activities that promotes assimilation and accommodation. Implications to Piaget's theory is that students should not be given assignments beyond their mental abilities; learner's existing intellectual framework should be understood so that learning process can take place; cognitive development to be elicited by organizing challenging activities in order to prompt problem solving skills; learners should be made active by use of instructional methods that challenges their ideas (Beard, 2013). One such instructional method is 7E LCM where a student's prior knowledge is prompted at the elicit phase through asking questions or posing scenarios. The teacher then corrects any misconception so that students develop ideas he or she intended. Eventually at the; engage, explore, elaborate and the extend phases, students are subjected to various challenging tasks that elicit their problem-solving skills. Consequently, new knowledge is incorporated into their mental structures (assimilation) or the mental structures have to be altered so that the new knowledge can fit in it (accommodation), hence better concept acquisition (equilibration) takes place.

2.2.2. 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 others, 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 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. 7E LCM is an instructional model in which students are engaged in a series of short activities collaboratively in group setting. 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.

2.3 Constructivist Instructional Method

Constructivist instructional method being student-centered allow students to actively construct knowledge which requires high degree of self-driven learning (Amineh &Asl, 2015. At the beginning instructional process in 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). Assessment 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, concept mapping and the learning cycles.

2.3.1 Learning Cycle

A Learning cycle is an instructional model that gives learners opportunity to construct knowledge based on cognitive development theory by Piaget (Lawson,1988). "Learning cycle is the inquiry learning process pattern for learners to investigate the scientific knowledge through science process skill and to search for knowledge or significant self-learning experience based on constructivist theory." (Nuangchalerm, Polyiem, & Wongchantra, 2011, p. 258). Various types of learning cycle models have emerged over the years: 3E (Karplus & Thier, 1967), 5E (Bybee, 1997) and 7E (Eisenkraft, 2003).

2.3.2 The 7E Learning Cycle Model

7E LCM has seven crucial stages: Elicit, Engage, Explore, Explain, Elaborate, Evaluate and extend (Eisenkraft, 2003). Balta and Sarac (2016) suggested that science teachers should embrace 7E Learning Cycle instructional model in teaching as it leads to improvement of students' academic performance. After new knowledge has been put together, existing learning model ought to be modified to maintain its usefulness (Eisenkraft, 2003). As science curriculum is quite dynamic, the highly successful 5E instructional model was expanded to 7E instructional model. The expansion of 5E Learning Cycle Model to 7E Learning Cycle Model is shown in table 2.1.

Table 2. 1: Expansion of 5E instructional model to 7E Learning Cycle Model

BSCS 5E Instructional Model	Eisenkraft 7E Learning Cycle Model
	Elicit (New phase)
Engagement	Engagement
Exploration	Exploration
Explanation	Explanation
Elaboration	Elaboration
Evaluation	Evaluation
	Extension (New phase)

Eisenkraft (2003) extended the 5E learning model into 7E learning Cycle model, with elicit and extend at the beginning and at the end respectively. This was not to make it complex but to ensure that teachers do not skip important elements for learning. 7E LCM is vital as it ensures that students' prior knowledge and experience are prompted. It also emphasizes "transfer of learning" which is the most important part in science education. Each phase of the instructional model involves various activities during the learning process.

7E LCM has seven stages that are interconnected and planned in such a manner that the learner carries out scientific inquiry by exploring instructional material and applying a learnt idea or a principle in a new situation. The 7E LCM steps are described as follows:

Elicit stage is where learners' prior knowledge is prompted to ascertain what they know about a concept to be taught (Eisenkraft, 2003). Existing knowledge forms a

base for active construction of new knowledge that can be applied to new areas (Adesoji & Idika, 2015). When misconceptions are not addressed the learners may develop ideas which are different from the ones the teacher intended. Students' prior knowledge may facilitate or impede the learning process (Brent & Felder, 2011). A teacher may prompt prior knowledge by asking questions such as "what do you think" and posing scenarios at the beginning of learning session (Naade, Alamina & Okwelle, 2018). From the learners' responses, the teacher will ascertain what they already know and any misconception will be corrected during the learning process. During this phase, the learners actively participate in trying to relate the given concept with their prior knowledge hence convey their own opinions and creativity.

Engage is a phase that is planned to capture learners' attention on what is to be learnt (Eisenkraft, 2003). This is achieved through the use of short activities that stimulates their thinking, thereby increasing their interest and eagerness to learn new concept (Naade, Alamina & Okwelle, 2018). The teacher ensures all students are given opportunities to express their opinions to their peers by use of techniques such as "think-pair-share".

During the explore stage, "learners are provided with the opportunity to observe and record data, isolate variables, design and plan experiments, create graphs, interpret results, develop hypotheses and organize their findings." (Eisenkraft, 2003, p. 57). Learners get work collaboratively in developing skills and concepts. During this phase, the teacher directs learners' investigation and ensures that the learners are active in building new concept.

During the explanation phase, “the teacher guides students toward coherent and consistent generalizations, helps students with distinct scientific vocabulary, and provides questions that help students use this vocabulary to explain the results of their explorations.” (Eisenkraft, 2003, p58). The teacher motivates the learners to describe concepts using their words at the same time listening critically to their peers. Learners are given the opportunity to actively construct their own knowledge as the teacher assesses their growing understanding of the new concepts.

Elaborate phase aids in expanding learner’s conceptual understanding. The learner applies learnt concepts to new areas through additional activities. “Transfer of learning” takes place as the learners apply learnt ideas to new contexts. Their practical skills are refined leading to deeper understanding of the concept. The teacher guides the learners as new questions and hypotheses to explore arise.

At evaluation stage, the teacher assesses learners’ conceptual understanding both formatively and summatively. The teacher does this through assessing the extent to which instructional objectives have been met. Students are also encouraged to evaluate themselves. The teacher can assess students through questions, mind maps and interpretation of data (Sharma, 2018). In 2016, Balta and Sarac suggested that during the evaluation phase students can be evaluated through as well as questions.

Finally extend phase was added to elaboration phase with the sole purpose of ensuring that science teachers implement transfer of learnt concepts. Transfer of concepts in a novice area helps learners retain ideas for a longer period of time. In this phase, students apply knowledge in a new context as well as its application to their everyday

life. (Kajuru & Kauru, 2011). 7E LCM gives more precise steps which ensures that students' prior knowledge and transfer of learning are not left out (Eisenkraft, 2003).

2.4 Conventional Instructional Method.

In today's classrooms, there are various types of Conventional Instructional Method (CIM) being used. One of the distinguishing characteristics of conventional learning environment is that the teacher is a central figure. The constituent of CIM are lectures, demonstrations, drilling by use of past exams and use of class text books. The teacher disseminates knowledge to passive learners where the learners are regarded as empty vessels. Students' questions are least accepted while learners' previous knowledge is not every time utilized during instruction process. Therefore, learners' wrong understanding of concepts is not sufficiently corrected. Individual class assignments and tests administered by the teacher form an integral part of assessment in a conventional instructional classroom. Students in a conventional instructional environment compete for teacher's attention, rewards and marks (Conley, 2012). Several researches have indicated that learners like to take part in a learning environment that bear a resemblance to real life environment. In addition, conventional learning environment make learners not to be active forcing them memorize concepts (Vighnarajah, Luan & Bakar, 2008)

2.5 Comparing Students' Academic Achievement between 7E Learning Cycle Model and Conventional 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 7E LCM

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 achievement between constructivist and conventional learning environments have shown better results in favour 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 7E LCM 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 7E LCM on science achievement among students on the 8^{th} standard. Achievement tests were given to control and experimental groups. Instructional method for experimental group was 7E LCM and control group was CIM. The study showed that learners instructed using 7E LCM performed better than those taught using CIM. A similar study conducted by Oludipe and Oludipe, (2010) showed that students who were taught using constructivist method of instruction performed significantly higher on pre-test and delayed post-test than those taught using traditional methods. Consequently,

constructivist group showed a higher mean score than the control group on their post-test as compared to their pre- test scores. Students in the constructivist group were able to retain 80% of the taught concepts while the control group had 10% retention of concepts. In 2017, Adak conducted a study which found that students instructed using 7E Model attained higher scores on achievement test than those instructed using conventional methods. In addition, students who were taught using 7E LCM improved on their performance at each intelligence level. Consequently, students' master content at higher cognition level was achieved. Based on their study, Naade, Alamina & Okwelle, (2018) established 7E LCM to be more beneficial than teacher centered methods. Students in the 7E LCM environment attained higher scores than those in the conventional classroom. Students' interest and enthusiasm are stimulated in the 7E Learning cycle environment as opposed to the conventional environments. 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 teacher takes a central role in during instruction. It was therefore concluded that student centered environments are not effective for all students.

It is the researcher's view that studies that involve learners are bound to result in 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 conventional methods with passive

involvement of the learners can also result in improved performance, this study therefore sought to establish the effect of 7E LCM on students' academic achievement in Biology among secondary schools in Kenya.

2.6 Students' Attitude Towards 7E Learning Cycle Model and Academic Achievement.

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 an unobservable and can only be comprehended in form of manifested behaviour. Attitude encompasses a span of emotional behaviours for instance, prefer, accept and value (Welch, 2010). Attitude expressed in form of understanding and behaviour come out due to learning environments. When planning lessons, 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 negative attitude (Slavin, 2009).

A study conducted in Utah by Loveland (2014) showed that, students enjoyed having class activities in groups than traditional lecture class. Students enjoyed classes when the approach involved; class activities, learner centered activities and group work. Students engaging in activities ensured that issues and questions that arise could be addressed by the teacher as the lesson progressed, thus doing much without lecture.

The study also found that during group work activities, students share ideas and therefore become peer tutors. As the students share ideas, they had opportunity to further understand the concept. This eventually led to increase in class performance. The researcher found that having the teacher facilitating learning at groups level, it allowed the students to ask questions without the fear of the whole class watching or listening as opposed to the lecture method where few students ask questions. However, the researcher found that as the semester progressed, students started becoming bored with group work activities citing that it had become monotonous but eventually the researcher found that varying instructional methods made them to be active throughout the lesson.

Hus, Abersek & Jancic, (2014) in their study proved that students' attitude towards curriculum, class hours and learning environment influenced their academic performance in science. The students were exposed experimental activities and research work hence, they were able to actively construct knowledge on their own which is the main principle of constructivism.

Studies carried out in Kenya by Ongowo, Indoshi & Ayer (2015) showed that students generally had high perception for student centered learning environment. However, the perception of low achieving schools towards student centered learning environment 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 showed that, students preferred a more constructivist learning environment where more opportunities are available. Students prefer a learning environment where they can be

able to take control of their own learning, inquire what is happening in class without any restrictions. Therefore, the learners can connect Biology with real world and construct Biological knowledge enhancing the learning process (Ongowo et al., 2015).

A study conducted by Mwanda, (2016) showed that both boys and girls expressed positive attitude towards constructivist learning environment. Learners are able to actively construct Biological knowledge collaboratively which enhances their understanding since they were able to learn from their peers.

2.7 Challenges Facing Biology Teachers when Using 7E Learning Cycle Model and Academic Achievement.

A challenge may be defined as something difficult which requires a struggle and determination in order for it to be done successfully. In this study, challenges are difficulties hindering Biology teachers from implementing 7E LCM.

Many Challenges are encountered by teachers during teaching of Biology. For instance, a study conducted by Loveland (2014) found that, creating an activity that would be accomplished in time was a challenge facing teachers. The researcher found that, there was a discrepancy in time in terms of accomplishing an activity, between slow and fast students. This was due to the fact that there were a few high scoring students who did not like working in groups, because they felt that other students slowed them down. The slow students needed to be able to accomplish critical tasks, while the fast students needed enough activities to be engaged the entire time (Loveland, 2014). In addition, the study found that overpopulated classes made it difficult for the teacher to walk with ease between desks as there was no enough space

to maneuver. This impaired the teacher from facilitating learning in the groups. Large groups also posed a challenge in that students worked at different paces. The study also concluded that constructivist approach to teaching is time consuming, as 5-10 hours per day is needed to reading text books, developing activities and work book. Kumar (2016), showed that teachers in Ethiopia experienced challenges in implementation of constructivist approach to teaching. These challenges were; lack of teachers' and students' interest and confidence in learning process, large class sizes together with students feeling uncomfortable while working with their peers. Owino, Osman and Yungungu (2014) revealed that one of the challenges faced by Biology teachers in Kenya was teacher characteristic; consistency of practical administration, directed class discussions, teacher making learning experience captivating and delivery of immediate response on assignments or tests. The study also found that instructional resources for instance charts, chemicals, specimens, apparatus, classrooms and laboratories were inadequate and therefore it became a challenge in implementing Constructivist method of teaching. These challenges become an impediment to academic achievement in Biology. Literature reviewed showed that 7E LCM has been utilized in other parts of the world and therefore this study purposed to actualize it in Kenya.

2.8 Summary of the Chapter.

Literature has been reviewed around the following areas: Constructivist theory which emphasizes that learners actively construct knowledge from experience, 7E LCM has been emphasized. CIM characterized majorly by lecture method which is a teacher centered method has also been discussed. Comparison between 7E LCM and CIM on

Learners' Academic Achievement has further been discussed. Effect of students' attitude towards 7E LCM and academic achievement has been emphasized. Finally, challenges teachers face when using 7E LCM has also been discussed.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction to the Chapter

This chapter presents an outline of the research design and methodology as discussed under the following sub sections; research design, study area, target population, sampling procedures, sample size, research study variables, research instruments, validity and reliability of the research instruments, administration of research instruments, data analysis and ethical consideration.

3.2 Research Design

The study used quasi experimental design. This design was utilized since form three students who participated in the study were found in intact classes, making random assignment to control and experimental groups impossible.

A pre-test was administered to all the students to determine their cognitive levels. Thereafter, intervention was administered to the participants where the experimental group participated in the 7E LCM while the control group participated in CIM. The research design layout is represented in table 4.1.

Table 3. 1: Research design

Stages	Experimental Group	Control Group
1. Pre- Test	Measurement of achievement in Biology before the intervention.	Measurement of achievement in Biology before the intervention.
2.Intervention	Teaching Biology through 7E Learning Cycle Model	Teaching of Biology through Conventional instructional method
3. Post-Test	Measurement of achievement in Biology after the intervention.	Measurement of achievement in Biology after the intervention.

The researcher prepared 7E LCM instructional manual to guide the teacher in the experimental group in lesson delivery. Lesson plans in the instructional manual on the format of 7E learning cycle developed by Eisenkraft (2003) were prepared. Each lesson progressed through seven stages: Elicit, Engage, Explore, Explain, Elaborate, Evaluate and Extend. Control group participated in CIM. Participants in the Control group adopted teacher centered instruction characterized mostly by lectures and demonstrations. Teachers in the control group designed their own lesson plans which guided them during lesson delivery.

At the end instruction period a post- test was administered. The data obtained from both groups were analysed both descriptively: means and standard deviation and inferentially: t-test and presented in form of tables. Student and Teacher questionnaire were also administered at the end of the instruction period. Student Questionnaire was

closed ended while the teacher questionnaire was both closed and open ended. Data obtained were analysed descriptively: percentages, means and standard deviations. The data was presented in form tables, graphs and charts.

3.3 Study Area

The study was carried out in Chesumei Sub-county located in Nandi County, in the Northern part of Rift Valley in Kenya. Nandi County occupies an area of about 2,884.4 square kilometers. Chesumei is one of the six Sub-counties in Nandi County (see appendix XIII) that occupies an area of 472.10 square kilometers. It borders Emgwen Sub county to the South and Mosop Sub county to the North. Chesumei Sub-county has been performing poorly in Biology in KCSE (see appendix XII). The same case applies to the other sub-counties in Nandi county (See appendix XI). As a young scholar, the researcher wished to contribute to the ongoing efforts to improve the quality of teaching and learning in home Sub-county, therefore conducting the research in Chesumei sub-county.

3.4 Target Population

In this study, target population was 3421 Biology students in form three and 61 Biology teachers in Chesumei Sub-County, Nandi County. All the 46 secondary schools within the Sub-county taught Biology in form three. The study identified form three class, because the topic classification mentioned by KNEC (2018) that required broader and deeper teaching, is taught in form three.

3.5 Sample Size of the Study

A sample size of 346 students was chosen based on Krejcie and Morgan (1970) table used for determining sample size for research studies, from target population of 3421 from three Biology students.

3.6 Sampling Procedures

The study used stratified sampling, simple random sampling and purposive sampling procedures. Researcher used stratified sampling to categorize the 46 schools into four strata: National, Extra County, County and Sub-county Schools. Strata and name of each school were written on pieces of paper. Schools falling under the same strata were grouped together and put into different containers. Simple random sampling was used to select one school each from the national and extra county while two schools each from the county and sub county categories were selected. The six selected schools were put into a container and mixed. Simple random sampling was further used to select schools which were to be assigned to experimental group and control group. The first three schools to be picked were assigned to the experimental group while the remaining three schools were assigned to control group. Subsequently, 171 students were selected into the experimental group while 175 students were selected into the control group making a total of 346 students selected for the study. To select teachers who participated in the study, purposive sampling was employed. Eventually, form a target population of 61 teachers who taught Biology in form three, 18 teachers were purposively selected to participate in the study. Sampling frame for the study is presented in table 3.2.

Table 3. 2: Sampling frame

Category	**National**	**Extra-county**	**County**	**Sub-county**	**Total**
Number of schools in each category	2	5	12	27	**46**
Number of schools selected	1	1	2	2	**6**
Biology teachers in each category	9	13	19	20	**61**
Number of Biology teachers selected	4	4	5	5	**18**
Number of students in each category	675	689	589	1468	**3421**
Number of students participated	52	54	110	130	**346**

3.7 Research Study Variables

Research study variables were; Independent variable, Dependent variable and Intervening variable.

3.7.1 Independent Variable

This is a variable that a researcher manipulated so as to establish its effect on dependent variable. Independent variables of the study were 7E LCM, attitude of students towards 7E LCM and challenges facing teachers when using 7E LCM. These were the variables that were manipulated and the outcome measured on students' academic achievement.

3.7.2 Dependent Variable

The dependent variable for the study was student's academic achievement in Biology. This was the variable that was measured due to the effect of the independent variable.

3.7.3 Intervening Variable

This is a variable which is caused by independent variable and is a determinant to the dependent variable. The intervening variable was teacher's confidence in teaching using 7E Learning Cycle manual. Teachers were sufficiently inducted on the use of 7E Learning Cycle Manual so that it does not affect the outcome of the study.

3.8 Treatment

After allocation of students into experimental and control groups, Biology teachers participating in the study were inducted on the purpose of the study. During the induction process, Biology teachers in the experimental group were given 7E LCM Manual that directs them on how to use 7E LCM to teach Classification. A pre-test was given to students in experimental and control groups before the instruction process. After the pre-test was given, an instruction process ensued and covered a period of 7 weeks. During the instruction period, topic of classification was taught as per Biology syllabus approved by KICD. Experimental groups were taught using 7E LCM while the control groups were taught using CIM.

One week after completion of the instruction, a post test was administered to the experimental the group.

3.9 Research Instruments

This study used Biology Achievement Test, Students' Questionnaire and Teachers' Questionnaire as the research instruments.

3.9.1 Biology Achievement Test

Participants in the experimental and control groups were given Biology Achievement Tests (BAT) on classification (appendix VI) to measure their achievement. Pre-test was administered before the commencement of instruction while post-test was administered one week after the instruction period. Pre-test was used establish the participants' cognitive level on classification before the instruction while post-test was used to measure the effect of treatment on the experimental group.

3.9.2 Students' Questionnaire

Students' Questionnaire (SQ) was administered on week after the end of the instruction period. It was used to gather information on students' attitude towards 7E LCM. The SQ was made up of 10 items that were closed ended (Likert type) (appendix VII).

3.9.3 Teachers' Questionnaire

The Teachers' Questionnaire (TQ) was used to obtain information about challenges teachers encounter when using 7E LCM during Biology teaching. The TQ contained both open and closed ended questions and designed into two sections; section A and section B (see appendix VIII). Section A contained teachers' demographic

information that included; their sex, age, highest academic qualification, teaching subjects and teaching experience. Section B was designed to obtain information on challenges teachers encounter during teaching when using 7E LCM and how they affect students' academic achievement in Biology. These included: students' ability to learn, teaching methods employed, availability of resources for the instruction and challenges teachers encounter when teaching classification in Biology using 7E LCM.

3.10 Piloting

Piloting was done prior to the study. Given that the study was an experimental procedure, a pilot test was carried out in a sample of form three students in Aldai sub county, who did not participate in the study. In order to verify if the 7E LCM instructional manual can be utilized effectively to teach Classification, a pilot study was done on three sub topics namely; binomial nomenclature, principles of classification and Kingdom Monera characteristics. The instruction was delivered within a period of 6 lessons. BAT, SQ and TQ were also pilot tested on the form three students in Aldai sub county. Test retest and Cronbach's coefficient alpha was used to determine the reliability of BAT and the Questionnaire respectively. From the pilot study, items identified as confusing or biased were modified and adjustment in timing was done to the research instruments. Results from BAT and the questionnaire was used to calculate their reliability coefficients.

3.11 Validity and Reliability of the Instruments

3.11.1 Validity

Validity is the degree to which a research instrument measures what it was intended to measure (Mugenda, 2008). Face validity and content validity of the instructional manual and BAT was established by having their format and appropriateness critiqued by two Biology teachers. Instructional objectives in accordance with Biology Syllabus were considered in designing the BAT in order to improve the content validity of the instrument. Validity of both SQ and TQ were confirmed by two supervisors and their opinions incorporated into final drafts before they were pilot tested.

3.11.2 Reliability

Reliability is a measure of the extent to which a research instrument can obtain similar results from the same population over time (Sekaran & Bougie, 2010). Reliability coefficient of BAT was determined by use of test-retest technique and analysed by use SPSS version 23. In this study, test 1 was administered to the participants, thereafter, test 2 was re-administered after three weeks to the same group of participants. In test 2, the respondents were given same test as test 1 but in different order of questions. The scores of the test 1 and test 2 were correlated and reliability coefficient obtained was $r = 0.83$. BAT was also developed with clear instructions for its administration so as to generate uniformity in understanding requirements of the test by those who participated in the study. The test was administered like any other Biology test so as to remove any fears from the students who participated in the study. Cronbach' coefficient alpha was used to determine internal consistency of the questionnaire using

SPSS version 23. Cronbach' coefficient alpha showed high correlation; 0.89 and 0.84 for SQ and TQ respectively which was greater than 0.5 suggesting that the items in questionnaire used to obtain data were reliable. Participants were given clear instructions so as to limit ambiguity to further achieve reliability of SQ and TQ.

3.12 Administration of the Research Instruments

All schools that participated in the study were visited by the researcher. Biology teachers in the experimental group were adequately inducted on the use of 7E LCM Instructional Manual (refer to appendix V). The teachers were inducted on how to administer BAT and SQ. The researcher administered the TQ to the teachers who participated in the study. The research was conducted within a period of nine weeks. Instructional groups were given pre-test before intervention was given. After administration of pre-test, instructional programs that took seven weeks was implemented where the topic classification was taught. Experimental group were taught by use of 7E LCM while control group were taught using CIM by their regular teachers. Post-test and SQ were administered by the regular teachers while TQ were administered by the researcher one week after completion of the instructional program. The researcher thereafter collected pre-test scores, post-test scores and questionnaire.

3.13 Data Analysis

Data was analysed using both descriptive and inferential statistics. For BAT descriptive statistics (mean score and standard deviation) was used to summarize, compare and explain results from experimental and control groups. Inferential

statistics (t -test) was employed to determine if the two groups differ significantly among themselves at alpha level of 0.05. Data obtained from the questionnaire were analysed descriptively (mean, standard deviation and percentages).

3.14 Ethical Issues of the Study

A formal request was made to all schools that participated in the study after obtaining permission to carry out the research from National Commission for Science, Technology and Innovation (NACOSTI). Also, the researcher informed the participants the purpose of the research. In addition, the researcher informed the participants that their participation in the research was voluntary and assured them that their responses will be kept confidential. Finally, participants were not expected to write any information that could identify them in either the tests they took or the questionnaire.

3.15 Summary of the Chapter

The study employed quasi-experimental design. The study was carried out in Chesumei Sub-county located in the North Rift part of Kenya. The target population for the study was form three students in Chesumei Sub-county, Nandi County. Chesumei Sub-county has a total of 46 Secondary Schools; with target population of 3421 students and 61 teachers. The study employed stratified sampling to categorize 46 schools into four strata. Simple random sampling technique was employed to choose one school each from the national and extra county while two schools each from the county and sub county categories were selected. Purposive sampling was employed to choose teachers from the four categories to participate in the study.

Research Study Variables identified included; independent variable, intervening variables and dependent variables. Moreover, research instruments for the study were Biology Achievement, Students' Questionnaire and Teachers' Questionnaire. The research instruments were subjected to validity and reliability to ascertain their ability to measure what they were designed to measure and to establish the consistency of giving the same results every time used respectively. Research instruments were administered to the participants and data collected was analysed both descriptively and inferentially. Finally, ethical considerations of research were adhered to during the course of the study.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSIONS OF THE FINDINGS

4.1 Introduction of the Chapter

This chapter presents data collected, analysis, interpretation and discussion of the findings based on the research objectives and hypothesis of the study. Data collected was presented in form tables, graphs and charts. The data was analysed descriptively: mean, standard deviation and percentages as well as inferentially: independent sample t-test to test the hypothesis at $\alpha = 0.5$ significance level. Finally, findings of the study were interpreted and discussed in view of the literature related to effect of 7E LCM on students' academic achievement in Biology among secondary schools in Kenya.

4.2 Demographic Characteristics of the Respondents

This section presents demographic characteristics of respondents especially those that have a great significance on data interpretation on various objectives of the study. The main demographic characteristics of the respondents presented in this section include: composition of research respondents, gender, age, highest academic qualification and teaching experience for teachers.

4.2.1 Research Respondents' Composition

The study sample comprised of 364 participants. Out of the total sample size, 346 were form three Biology students and 18 were Biology teachers. The number of

students in the experimental group were 171 while in the control group were 175. Experimental and control groups were not equal in size because the schools were taken as intact groups which had different number of students. The information regarding research respondents is presented in a pie chart as shown in Figure 4.1:

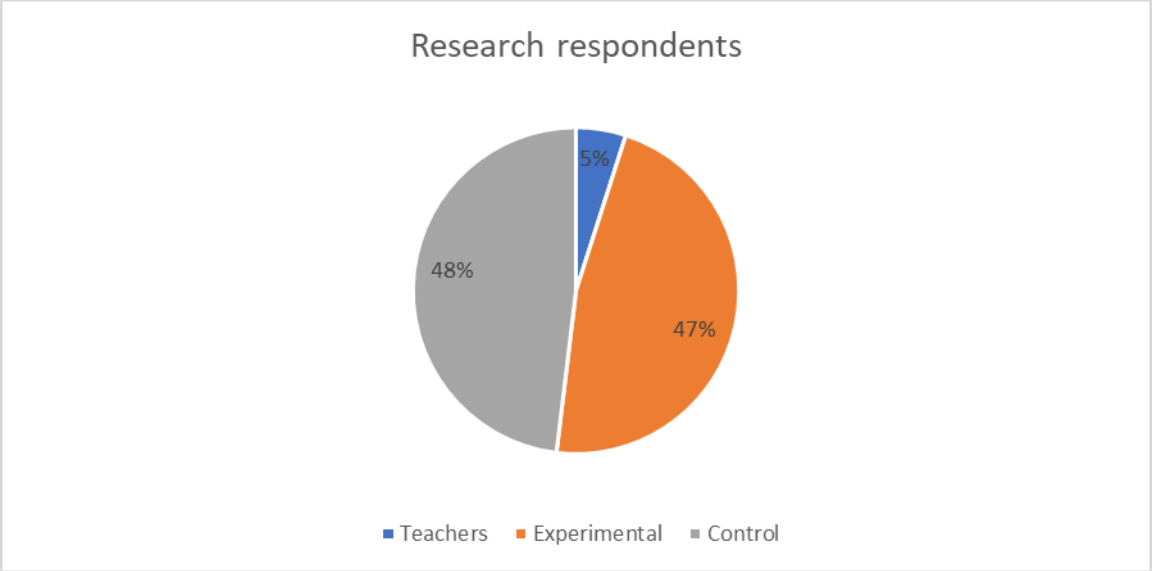

Figure 4. 1: Research respondents

4.2.2 Gender Distribution of Participants

The researcher aimed at determining gender parity in distribution of the participants. Table 4.1 Shows the gender distribution of the participants.

Table 4. 1: Gender distribution of participants

Respondents	Male		Female		Total
	Frequency	Percentage	Frequency	Percentage	
Students	182	52.6	164	47.4	346
Teachers	8	44.4	10	55.5	18

The data in table 4.1 shows that 52.6% of the students were male and 47.4% of the students were female. Among the teachers who participated in the study, 44.4% of teachers were male and 55.5% were female. The findings reveal near gender parity among both the students and the teachers.

4.2.3 Age Distribution of Teachers

The researcher sought to establish age distribution for teachers. The findings are summarised in figure 4.2

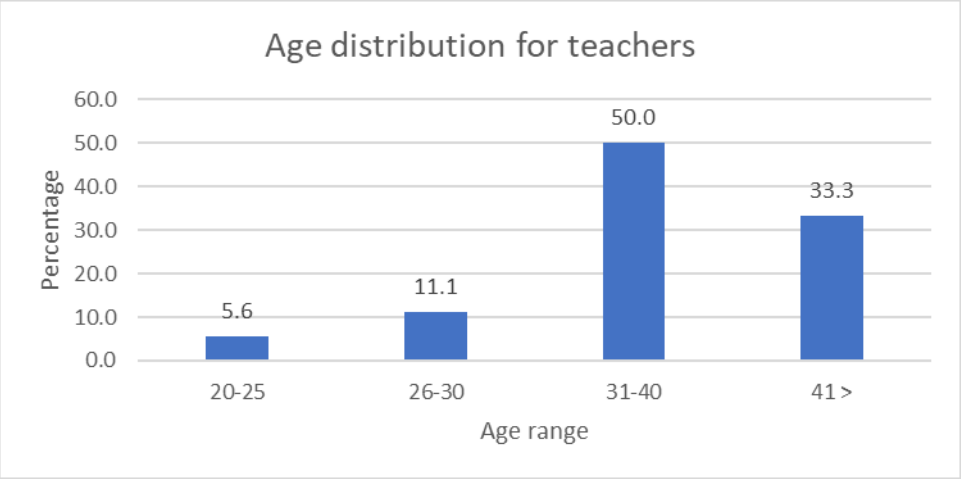

Figure 4. 2: Age distribution for teachers

As shown in figure 4.2, 5.6 % of teachers were aged between 20-25 years, 11.1% between 26-30 years, 50% between 31-40 years and 33.3% above 41 years. The findings indicate that large proportion of teachers were aged between 31-40 years.

4.2.4 Academic Qualification of Teachers

The researcher sought to establish the highest academic qualifications for the teachers. The findings have been summarised in figure 4.3

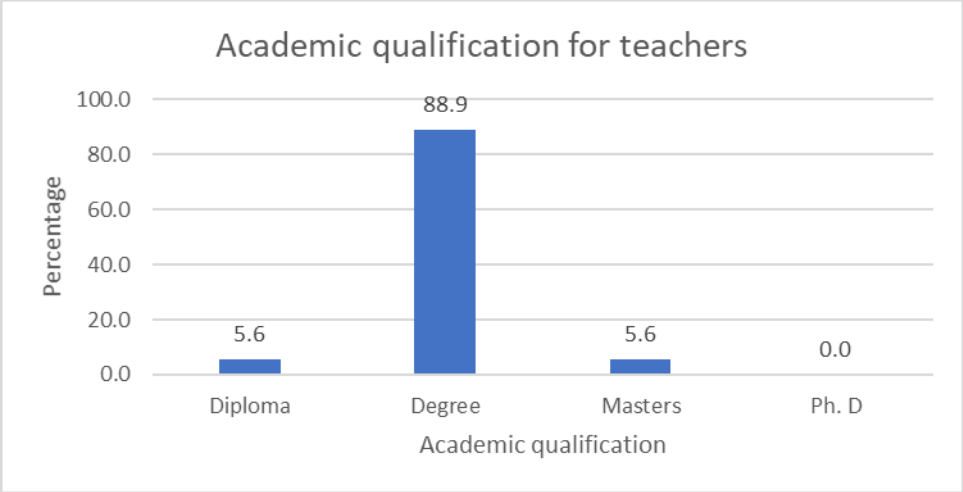

Figure 4. 3: Academic qualifications for teachers

Data in figure 4.3 indicate that majority of the teachers: 88.9% have a bachelor's degree as their highest qualification. Teachers who had diploma and master's degree were 5.6% each and no teacher had attained a Ph. D as their highest qualification.

4.2.5 Teaching Experience

The researcher sought to determine number of years the teachers who participated in the study have taught. Figure 4.4 Summarizes the findings of the study.

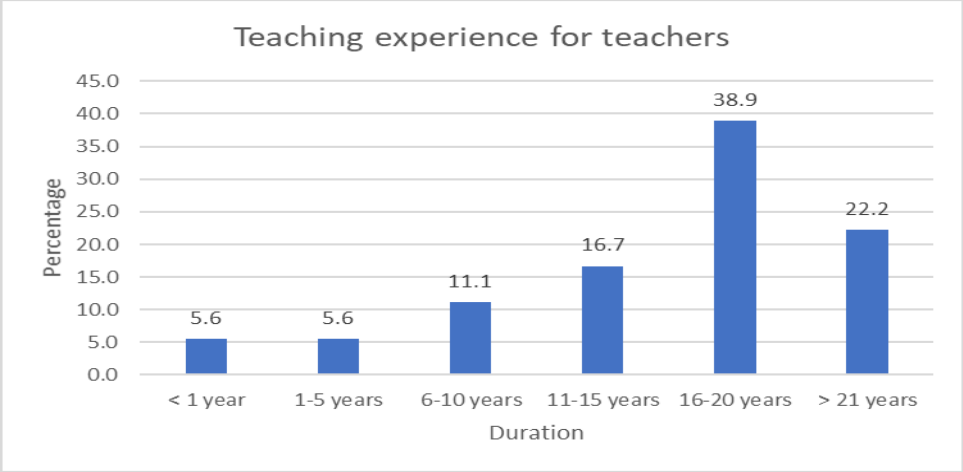

Figure 4. 4: Teaching experience for teachers

Findings in figure 4.4 shows that majority of the teachers 38.9% have taught between 16-20 years, 22.2% have taught for over 20 years while a few 5.6% have taught between less than 1 year and between 1-5 years. This was very useful because it meant that majority of teachers can be able to tell the challenges they encounter during the teaching process.

4.3 7E Learning Cycle Model and Students' Academic Achievement in Biology

The researcher sought to compare academic achievement in Biology between students who were instructed using 7E LCM and those instructed using CIM. Their pre-test and post-test scores were analysed and compared descriptively: mean and standard deviation as well as inferentially: independent sample t-test.

4.3.1 Pre-test Scores

Pre-test was administered at the beginning of the study to both experimental and control group. Table 4.2 shows the results.

Table 4. 2: Students' mean and standard deviation in pre-test

Type of Group	N	Mean	SD
Experimental group	171	11.95	5.07
Control Group	175	12.36	5.73

Results in table 4.2, show that the experimental group had a mean score of 11.95 and a standard deviation of 5.07 while participants in the control group had a mean score of 12.36 and a standard deviation of 5.73. The findings indicate that the two groups had close mean scores in their pre-test.

The researcher subjected the pre-test scores to t-test for both experimental and control groups in order to determine equality of their means. The results obtained are shown in table 4.3

Table 4. 3: T-Test for equality of means in pre-test

t-value	Df	P-value	Level of significance
0.715	344	0.475	0.05

Table 4.3 shows results in pre-test scores for equality of means between students instructed employing 7E LCM and those instructed employing CIM. The results are as follows: t (344) = 0.715; P=0.475 at α=0.05 significance level. P value of 0.475 was greater that alpha value of 0.05. Therefore, the null hypothesis which stated that there is no significant difference on the mean scores in BAT between students taught using 7E LCM and those taught using CIM was not rejected. This was inferred to mean that students on both experimental and control groups had equal cognitive ability.

4.3.2 Post- test Scores

Post-test was given to the participants one week after the instructional period. Results obtained are presented in table 4.4.

Table 4. 4: Students' mean and standard deviation in post-test

Type of Group	N	Mean	SD
Experimental Group	171	49.44	11.59
Control Group	175	26.08	9.99

Table 4.4 reveals that the participants in the experimental group had a mean score of 49.44 and a standard deviation of 11.59 while the control group had a mean score of 26.08 and a standard deviation of 9.99. The results show that the mean score of the experimental group was higher than those in the control group.

4.3.3 Hypothesis Testing

The hypothesis (H_{O1}) stated: There is no significant difference in Biology Achievement between students taught using 7E Learning Cycle Model and those taught using Conventional Instructional Method. The hypothesis was tested by conducting a t-test on Biology achievement scores and results presented in table 4.5.

Table 4. 5: T-test for equality of means in post- test

t-value	Df	P-value	Level of significance
-20.082	344	0.000	0.05

Table 4.5 shows t-test results for equality of means in post-test for the instructional groups. From the results in the table: t (344) = -20.082; P= 0.000 at α = 0.05

significance level. From the results, P value was less than alpha indicating that there was a significant difference on the mean scores in BAT between students taught using 7E LCM and those taught using CIM. Therefore, the null hypothesis was rejected.

4.3.4 Discussion of the Findings

Pre-test scores analysis revealed that students in the experimental and control groups had similar mean score. In addition, t-test results show that there was no significant difference in the means scores between the experimental and the control group since the p value of 0.475 was greater than α=0.05 significance level. These results imply that the two instructional groups had equal ability before intervention which was very significant to the study. On the other hand, post-test scores indicated that students in the experimental group who were taught using 7E LCM had a higher mean score than those in control group who were taught using CIM. T-test also revealed that there was a statistically significant difference in post-test achievement among the two groups since the p value of 0.000 was less than α=0.05 significance level.

The 7E LCM was found to have a positive effect on students' academic achievement in Biology probably to the fact that the instruction was carried out through a series of seven phases. Eisenkraft, (2003) suggested that elicit phase was crucial for understanding learners' prior knowledge in order to determine what they know. If there are any misconceptions they can assessed and corrected so that the learners do not develop concepts that the teacher did not intend. Learners actively construct knowledge based on prior understanding and experiences (Adesoji & Idika, 2015). At the engage, explore, explain elaborate and extend phases, students were able to

actively construct knowledge. Students were actively involved in knowledge construction by carrying out scientific investigation through a series of short activities that were done individually and in groups setting. These activities prompted their curiosity and eagerness to learn leading to efficient acquisition of knowledge and skills. On the other hand, at the extend phase which supports the process of transfer of learning, an important component in science education, ensured that the learners apply learnt concepts to new context and real-life situations. This may have elicited critical thinking skills hence enabling the students to solve problems that involved high order thinking. On the contrary, control group who were taught using CIM were not actively involved in the learning process and were just mere listeners as the teacher took the central role during the instruction.

Similar studies conducted by other researchers are in agreement with these findings. Research conducted by Balta & Sarac, (2016) found that 7E Learning Cycle enhanced educational effects in science teaching. Students instructed using 7E LCM performed better than students instructed through CIM. Results from the study conducted by Kajuru & Kauru, (2011) showed that the mean score of those exposed to 7E LCM in teaching of science was statistically different from the mean score of those exposed to the traditional methods. Students taught using 7E LCM showed gains in learning achievement (Nuangchalerm, Polyiem, & Wongchantra, 2011). Studies conducted by Shaheen & Kayani, (2015) found that students taught using 7E instructional model performed better than those taught using traditional methods in terms of their achievement in Biology. Similarly, a study conducted by (Sharma, 2018) showed that

7E LCM was more effective than CIM as it enhanced students' critical thinking skills, and positive attitude towards science.

4.4 Attitude of Students Towards 7E Learning Cycle Model

The researcher sought to find out overall attitude of students towards 7E LCM using a questionnaire. Responses of all the students who participated in the study were analysed and results presented in table 4.6.

Table 4. 6: Students' overall mean and standard deviation on attitude towards 7E Learning Cycle Model

N	Mean	Standard deviation
346	3.41	1.42

The results presented in table 4.6 show that the students attained an overall mean score of 3.41. This is an indication that the students had an overall positive attitude towards 7E LCM.

4.4.1 Students' Attitude to Specific Areas of 7E Learning Cycle Model

The researcher focused on determining students' attitude towards specific areas of 7E LCM. Students' responses to items on the questionnaire were analysed and the results presented as percentages of participants who responded on various scales of response categories.

4.4.2 Students' Attitude Towards Group Activities

The researcher sought to determine students' attitude towards group activities in a Biology class. Results on their attitude towards group activities are shown in figure 4.5

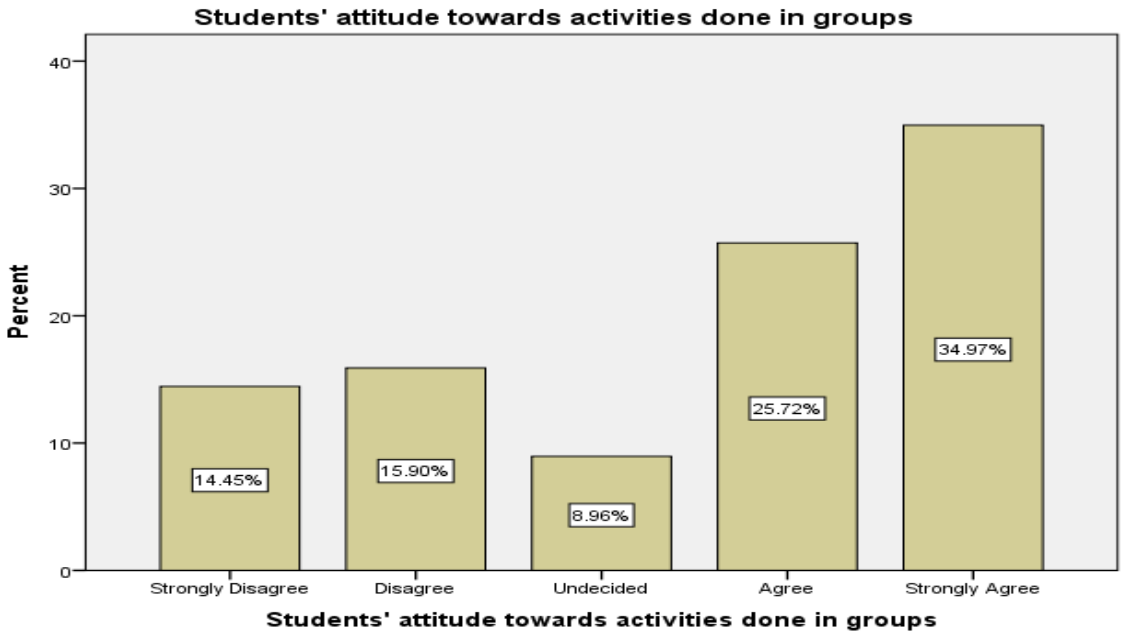

Figure 4. 5: Attitude of students towards class activities done in groups

Findings in figure 4.5 show that majority of the students: 60.69% agreed with the statement that classes can be interesting in a Biology class if they performed activities in groups, 30.35% disagreed while 8.9% were undecided.

4.4.3 Attitude of Students Towards Being Given Notes to Copy

The researcher sought to determine attitude of students towards copying notes from the teacher.

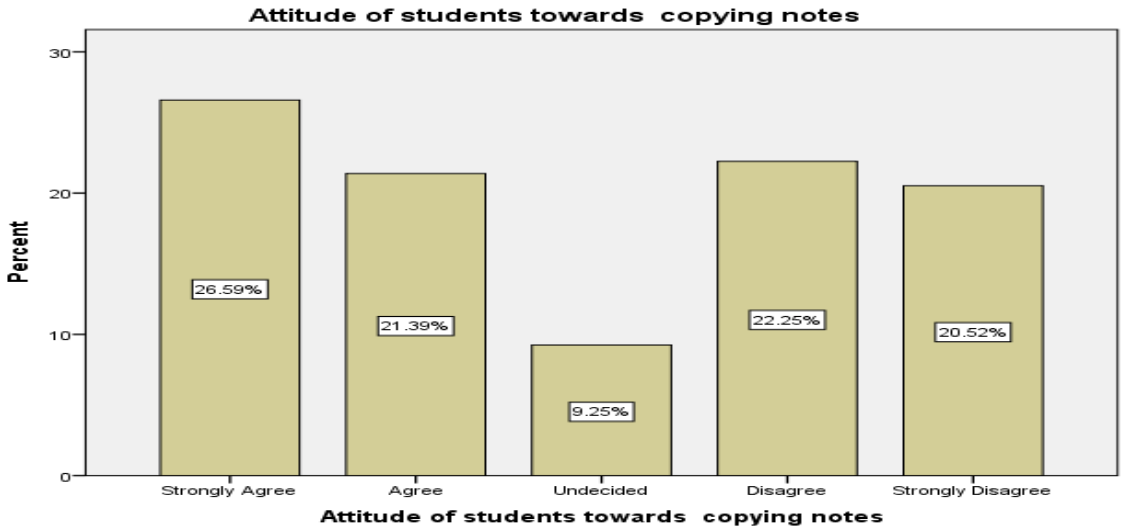

Figure 4. 6: Attitude of students towards being given notes to copy

As shown in figure 4.6, majority of the participants 47.98% agreed with the statement that they should be given notes to copy while 42.77% of the participants disagreed with the statement.

4.4.4 Attitude of Students Towards Responding to Questions from Peers

The study sought to determine students' attitude towards responding to questions from their peers. Figure 4.7 shows the results of the responses.

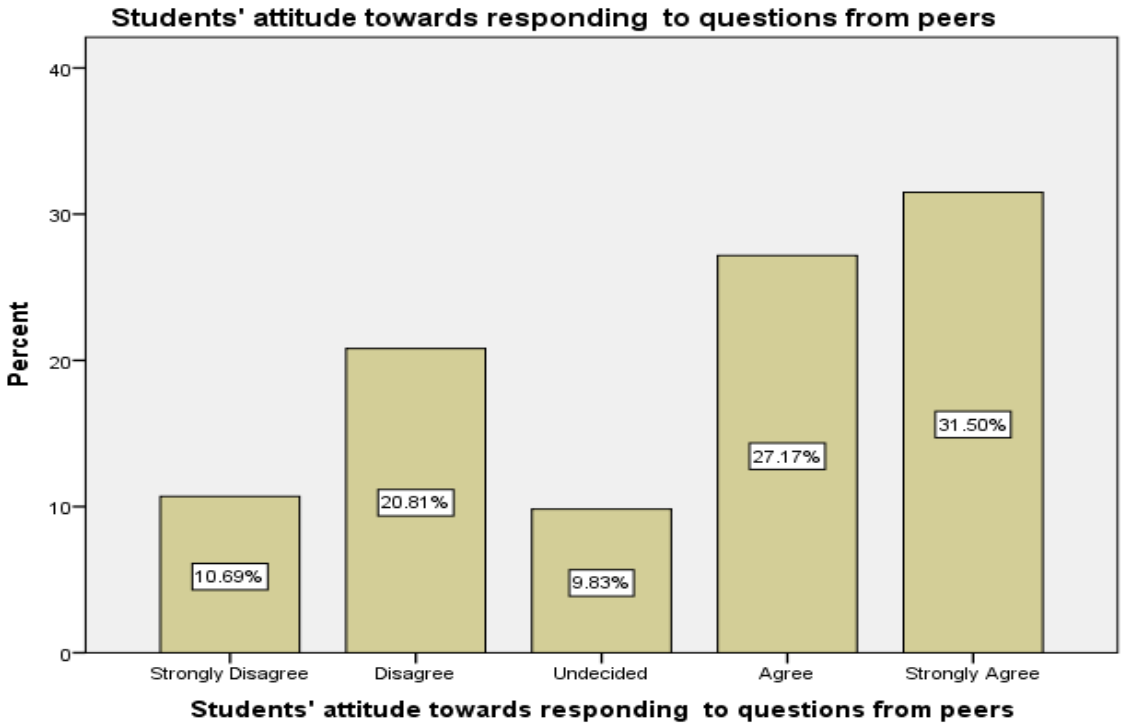

Figure 4.7: Attitude of students towards responding to questions from peers

As presented in figure 4.7, the results show that 58.67% of the students agreed with the statement that they should be allowed to respond to questions from their classmates while 31.5% disagreed with the statement. The undecided participants category was made up of 9.83%. These results suggest that they prefer responding to questions from their classmates.

4.4.5 Attitude of Students Towards Teachers Eliciting Prior Knowledge

The researcher sought to determine students' attitude towards eliciting prior knowledge from other students in a Biology class. Figure 4.8 shows the results participants' responses.

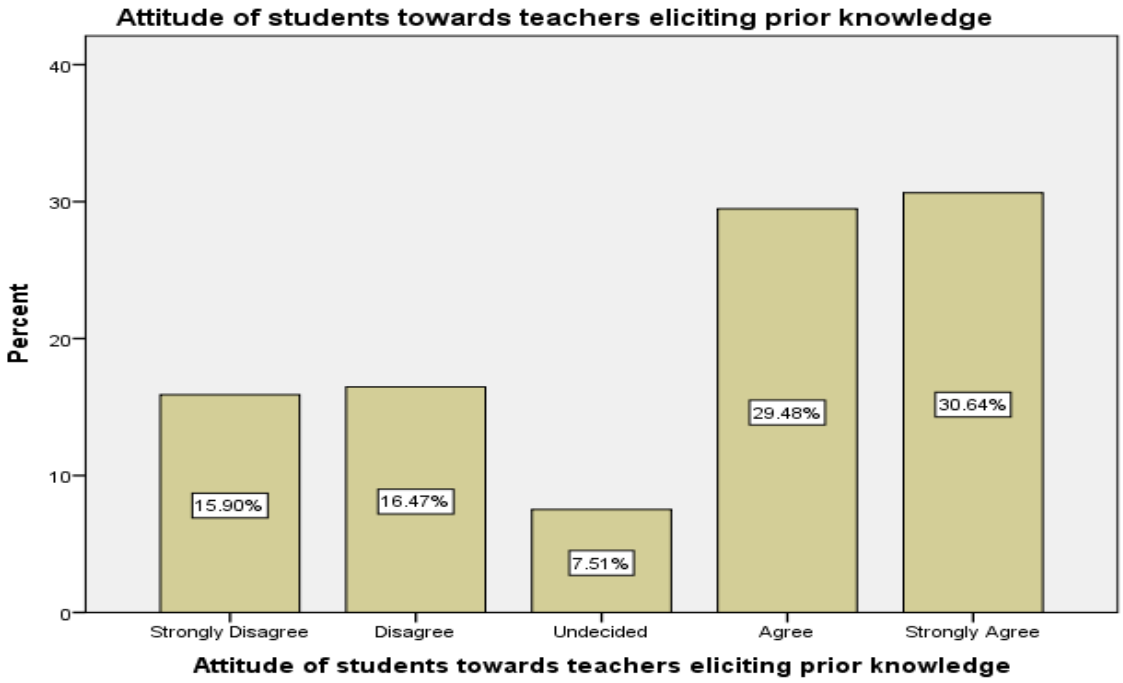

Figure 4. 8: Attitude of students towards teachers eliciting prior knowledge

As shown in figure 4.8, the results indicate that 60.12% of the students agreed with the statement that teachers should ask questions before the beginning of a lesson. 32.37% of the participant disagreed while 7.51% remained undecided.

4.4.6 Attitude of Students Towards Relevance of Discussion Groups in Learning of Biology

The researcher sought to determine students' attitude towards relevance of discussion groups in learning of Biology. Figure 4.9 presents the results.

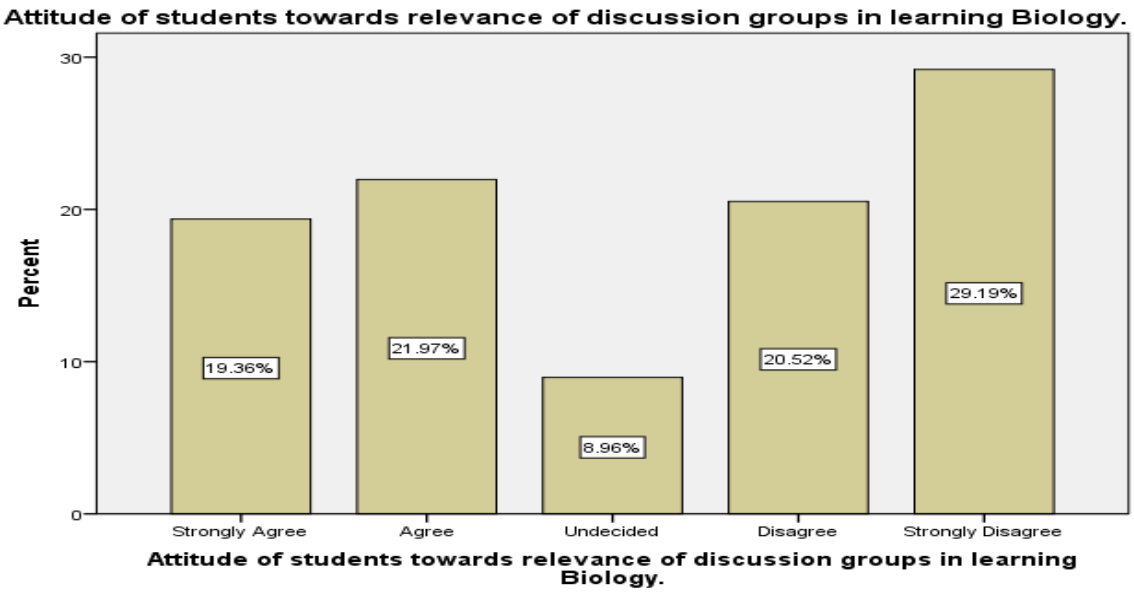

Figure 4.9: Students' attitude to importance of discussion groups in learning Biology

As presented in figure 4.9, 41.33% agreed with the statement that discussion groups help them a little in learning Biology, 49.71% disagreed with the statement while 8.96% were undecided. This indicates that majority of the participants disagreed with the idea that discussion groups have little help in learning of Biology.

4.4.7 Attitude of Students Towards Importance of Learning Biology

The study sought to determine students' attitude towards the importance of learning Biology. Figure 4.10 indicates the results from the responses.

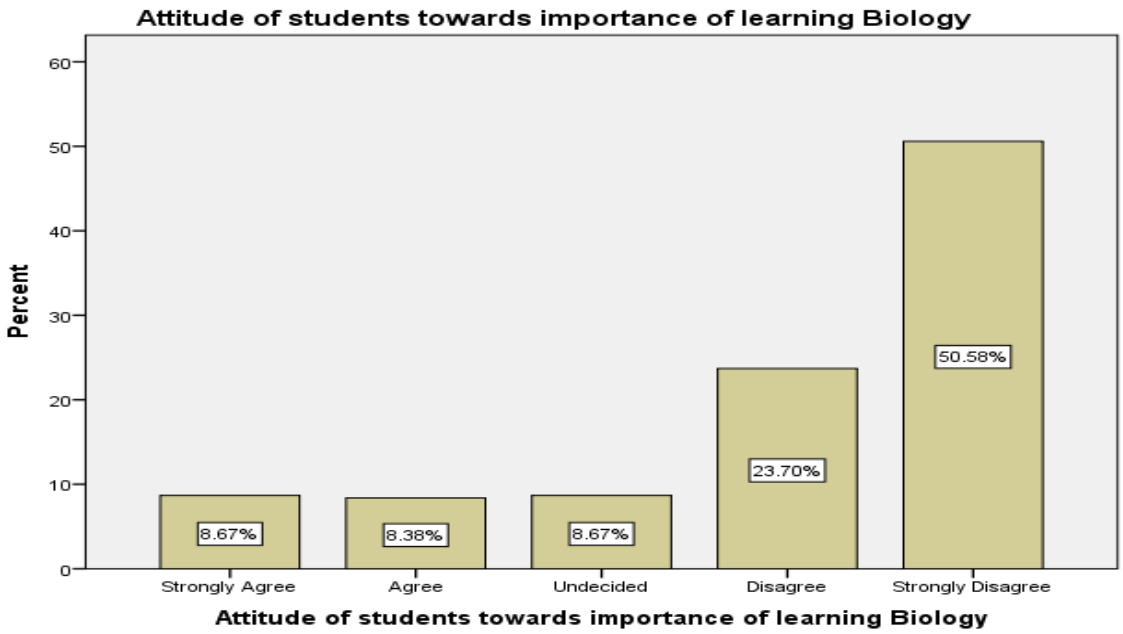

Figure 4. 10: Students' attitude to the importance of learning Biology

As shown in figure 4.10, majority of the participants; 74.28% disagreed with the statement that learning Biology is to enable them pass examinations only while 17.05% were agreed with the statement.

4.4.8 Attitude of Students Towards Teachers Asking Challenging Questions in Biology

The researcher sought to determine students' attitude towards teachers asking students challenging questions. Figure 4.11 presents the results of the responses.

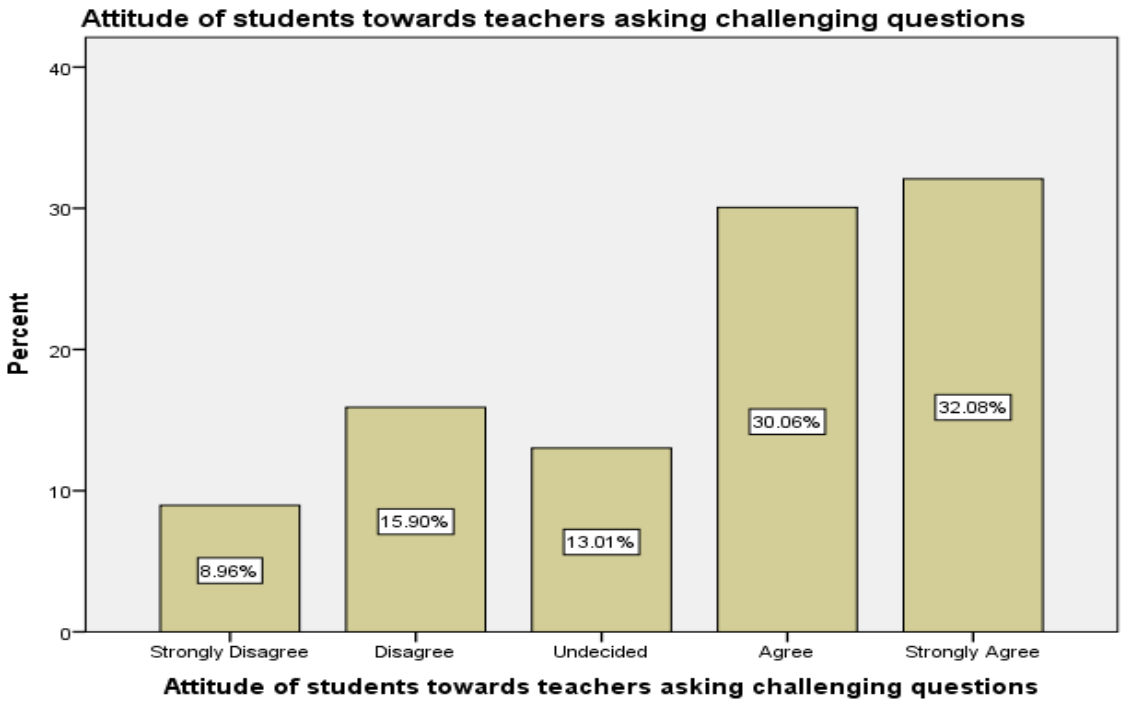

Figure 4. 11: Students 'attitude to teachers asking challenging questions

As shown in figure 4.11, 62.14% of the students agreed with the statement that they should be asked challenging questions while 24.86% disagreed with the statement.

4.4.9 Attitude of Students Towards Looking for Answers to Biology Questions from the Library

The study sought to determine students' attitude towards looking for answers to assignments from the library. Figure 4.12 presents the results of the responses.

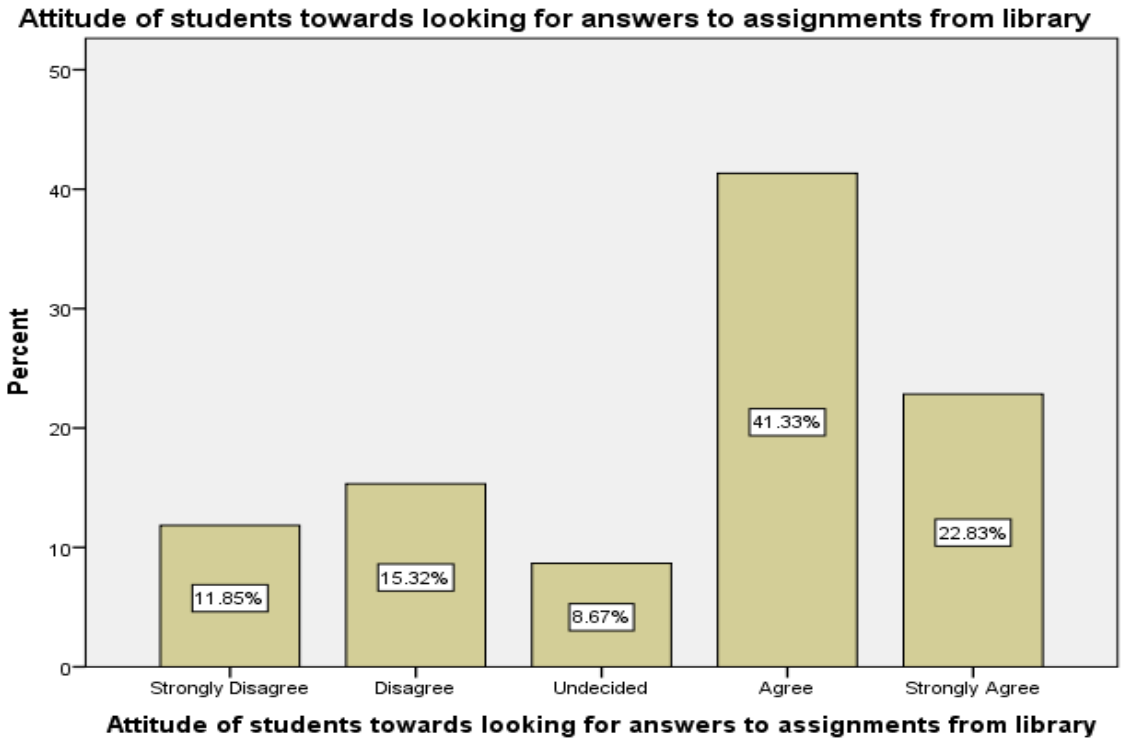

Figure 4. 12: Attitude of students towards looking for answers to assignments from library

As presented in figure 4.12, the results reveal that 64.16 % of the students agreed with the statement that they should be given assignments that requires them to carry out investigation in the library while 27.17% disagreed.

4.4.10 Attitude of Students Towards Being Allowed to Ask Many Questions

The researcher sought to determine students' attitude towards being allowed to ask many questions in class. Figure 4.13 shows results of the participants' responses.

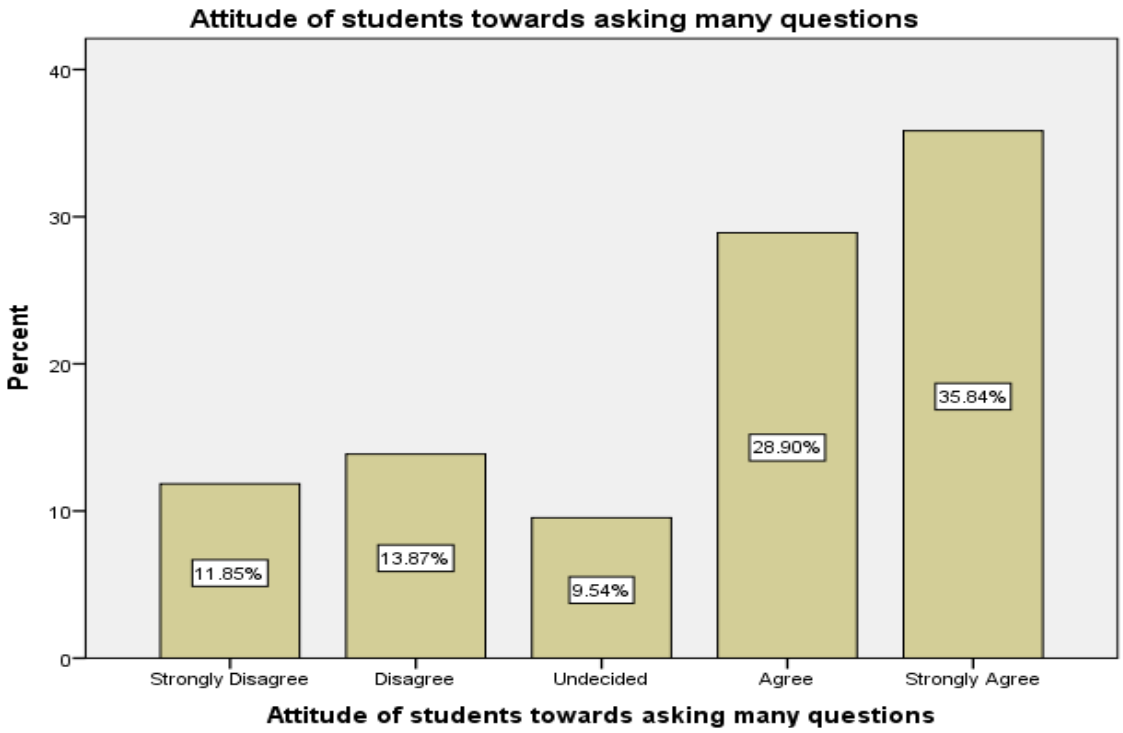

Figure 4. 13: Attitude of students towards asking many questions

As presented shown figure 4.13, the results show that 64.74% of the students agreed with the statement that the teacher should allow them to ask as many questions as they can while 25.72% disagreed.

4.4.11 Attitude of Students Towards Sitting Arrangement

The study sought to determine students' attitude towards their sitting arrangement. Figure 4.14 presents the results.

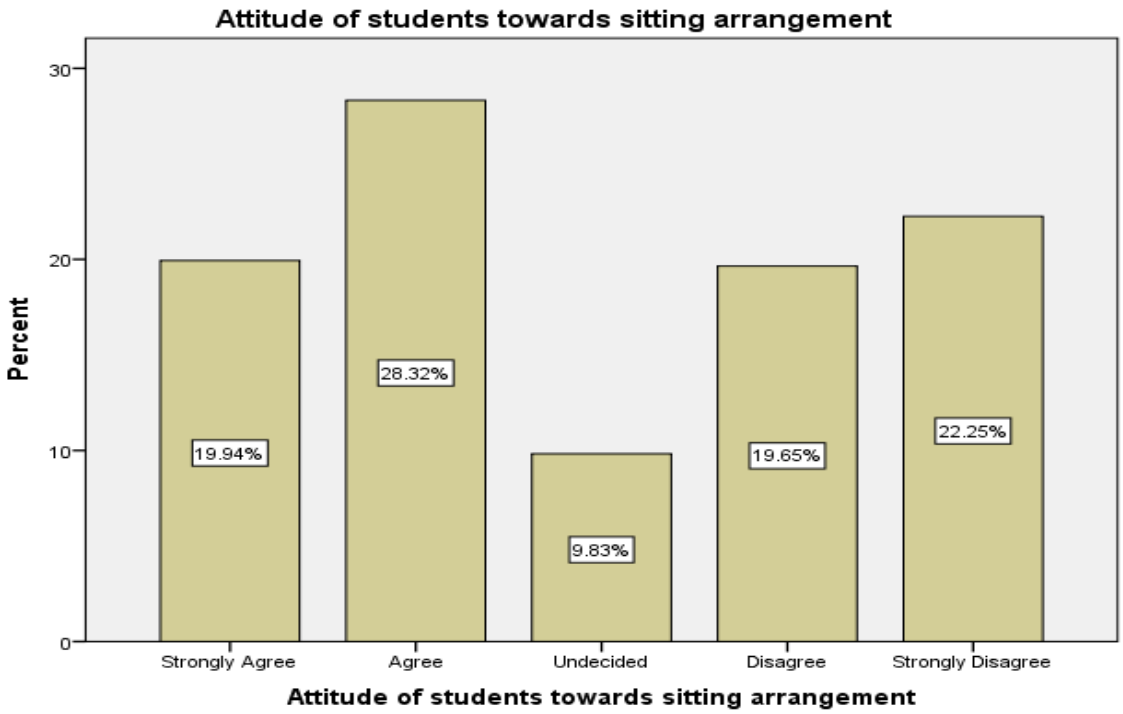

Figure 4. 14: Students' attitude to siting facing the front of the class

As presented in figure 4.14, 48.26% of the students agreed with the statement that they should sit facing the front of the class in all Biology classes. While 41.9% were disagreed with the statement.

4.4.12 Discussion of the Findings

To determine the students' attitude towards 7E LCM, a Likert type questionnaire was designed to gather data. Analysis of the students' attitude questionnaire revealed that students' general attitude towards 7E LCM was positive. The study also found out that students preferred certain aspects of 7E LCM. For instance, engaging in group activities, responding to questions from their peers, Biology teacher eliciting prior knowledge before teaching, importance of discussion groups in learning of Biology,

extending Biology knowledge gained in class outside the classroom, responding to challenging questions, looking for answers to assignments from the library and students asking questions in areas they need clarification in Biology class. These aspects facilitated active construction of knowledge through active participation of the students. In 2014, Hus, Abersek & Jancic studied attitude of students towards constructivist classroom. Their study found that students preferred constructivist classroom as it provided them with opportunity to collaborate with each other through short activities. The findings of Cigdem and Gulcin (2014) concluded that students prefer constructivist learning environment to traditional learning environment. The study also established that students prefer learning environment which make them to become more active. This was further echoed by Sakala (2012), who established that students preferred learner centered methods to teacher centered methods. The study found that the learning environment was interesting and helped the students share ideas- a form of collaborative learning.

On the contrary the study found that most participants agreed with the fact that students should be given notes to copy by their teachers as well as sitting facing the front of the class. This might imply that students are used to being given notes to copy by their teachers. This is a characteristic feature in most Biology classrooms where teacher centered approach to teaching are being used. This approach is in contrary to the 7E LCM. By use of 7E LCM students are given opportunity to build their own knowledge therefore increasing comprehension of the new concept during learning process (Naade, Alamina & Okwelle, 2018). On the other hand, most students agreed with the statement that they should always sit facing front of the class. The results

might imply that students are always expected to sit facing the front of the class. Sitting facing the front of the class is a common phenomenon in many conventional classrooms.

4.4 Challenges Faced by Teachers When Using 7E Learning Cycle Model in Teaching

To find out challenges Biology teachers face when using 7E LCM. An open and closed ended questionnaire was administered by the researcher to 18 Biology teachers who participated in the study.

4.5.1 Students' Ability to Learning Biology

The study sought to find out students' ability to learn Biology. The results obtained are indicated in figure 4.15.

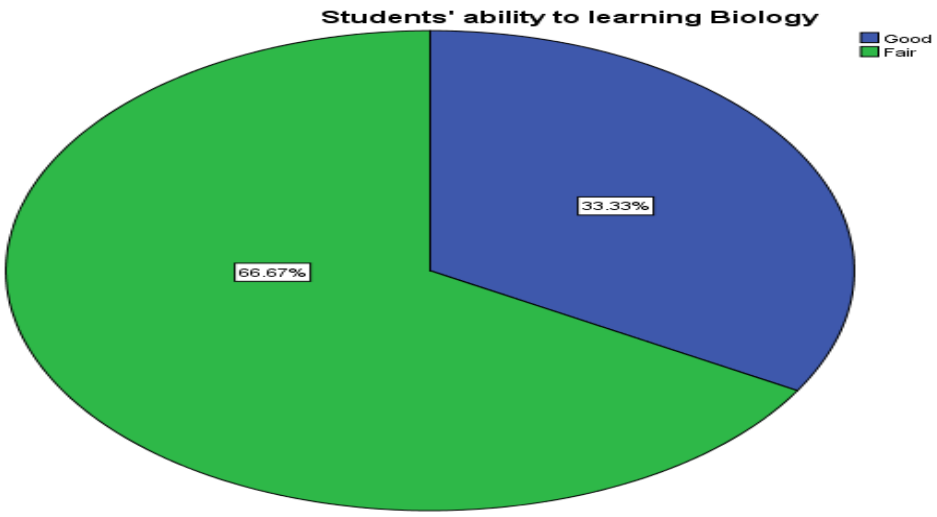

Figure 4. 15: Students' ability to learn Biology

According to the results in figure 4.15, 66.67% of the participants indicated that students' ability to learn Biology was fair while 33.33% indicated that students had a good ability to learn Biology. The results show that majority of the teachers are of the opinion that students to learn Biology was fair. This was implied to mean the students had the ability to perform better if appropriate measures were employed to improve their performance.

4.5.2 Common Methods Used by Biology Teachers in Teaching Classification

The researcher sought to find out common methods Biology teachers always apply in teaching classification and the reasons for choosing the method. The results are presented in table 4.7.

Table 4. 7 Common methods used by Biology teachers in teaching Classification

Type of method **Use by teachers**	**% of teachers Using the Method**	**Reasons for Using the Method**
Lecture method with a few demonstrations	67%	➢ Timely syllabus coverage ➢ Inadequate instructional materials
Lecture method only	28%	➢ Heavy work load ➢ High student enrolment
Lecture method with group discussions, practical activities and presentations.	5%	➢ Students become Peer tutors ➢ Improves learner's concept understanding.

Results in table 4.7 show that 67% of the teachers use lecture method with a few demonstrations, 28 % use lecture method and only 5%, one teacher who participated in the study, indicated that a combination of lecture, practical and discussions was used in teaching classification.

4.5.3 Availability of Instructional Resources Used in Teaching and Learning of Classification.

The study sought to ascertain availability of instructional resources in classification. The responses are presented in table 4.8.

Table 4. 8: Instructional resources used in classification.

Instructional resources	Schools having		Schools not having	
	Number	Percentage	Number	Percentage
1. Microscope	9	75.00	3	25.00
2.Mounting pins or needles	6	50.00	6	50.00
3. Hand lens	10	83.33	2	16.67
4. Glass slide	9	75.00	3	25.00
5. Preserved specimens	2	16.67	10	83.33
6. Variety of Biology Textbooks	11	91.67	1	8.33
7. Specimen Bottles / Polythene bags	12	100.00	0	0.00
8. Flip charts or manilla paper	10	83.33	2	16.67

Results in table 4.8 indicate that all schools (100%) had specimen bottles or polyethene bags, 91.67% of the schools had variety of Biology text books, 83% had hand lens /flip charts, 75% of the schools in the study had Microscope, 50% had mounting pins or needles and 16.67% of the schools had preserved specimen.

The researcher sought to ascertain the availability of preserved specimen for teaching classification. Table 4.9 presents the results of the responses.

Table 4. 9: Preserved specimen availability and number

Number of preserved specimens in school	Number of schools with preserved specimen	Percentage
0	0	0%
1	0	0%
2	1	5.5%
3	1	5.5%
4	0	0%
5	0	0%
More than 5	0	%

Results in Table 4.9 indicate that only 5.5% of the schools that participated in the study had 2 and 3 preserved specimens in their schools while the rest of the schools had no preserved specimens used for teaching classification. These results show that the preserved specimens were not available in most schools or were inadequate in the schools.

4.5.4 Challenges Teachers Encounter During Teaching of the Topic of Classification.

The researcher sought to find out challenges teachers encounter during teaching of classification. The results are presented in figure 4.16.

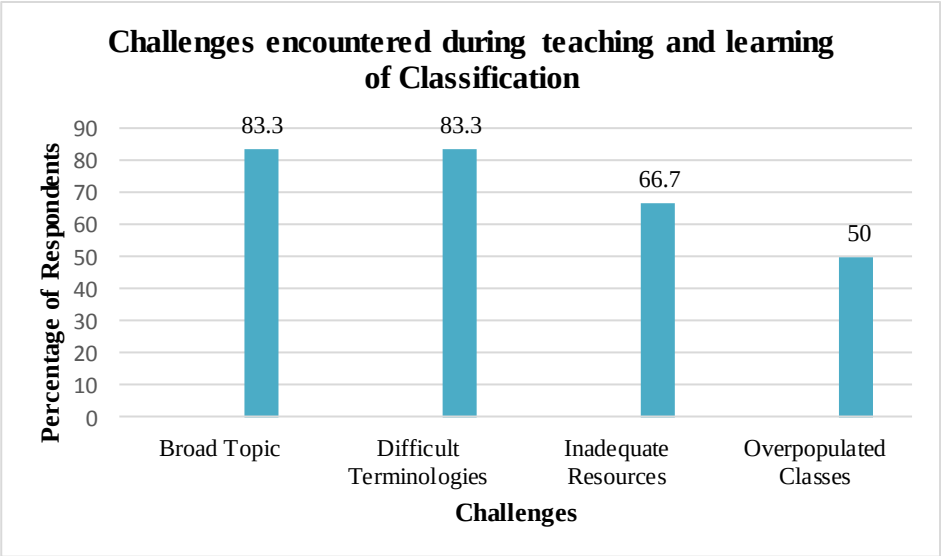

Figure 4. 16: Challenges encountered during teaching and learning of Classification.

Results in figure 4.16 shows that 83.3% of the teachers sampled out for the study indicated that classification as a topic was broad, 83% indicated that the topic had difficult terminologies. In addition, 66.7% of the teachers indicated that teaching and learning resources are insufficient while 50% of the teachers indicated that Biology classes being overpopulated contributed to difficulties in teaching and learning of the topic of Classification.

4.5.4 Discussion of the Findings

Study findings showed that most teachers (66.67%) indicated that students' ability to learning Biology was fair while 33.33% indicate that students' ability to learning Biology was good. There was no teacher indicating that the students' performance in Biology was poor. These findings show that the students had the ability to perform well in Biology.

Responses from the teachers also showed that seven teachers (67%) commonly used lecture method with few demonstrations. Reasons mentioned by the teachers were two. One, lecture method enabled them to cover syllabus on time as it allows students to revise content covered. Secondly, there were inadequate apparatus and equipment for practical lessons. These results might imply that Biology teachers commonly use lecture method. Moreover, 28% of the participants commonly used teaching method which commonly involved lecture, method. The teachers who participated in the study mentioned two reasons for using this method of teaching. Firstly, high workload made them to have limited time to organize for practical lessons. Secondly, high student enrolment made it difficult to organize for practical lessons as there was inadequate learning resources with limited space. This concurred with the study of (Sakala, 2012) where teachers in Zambia preferred lecture method due to overcrowded classrooms and inadequate learning resources. Only one teacher used teaching method which involved lecture, group activities, discussions and presentation. The reason mentioned by the teacher for using this particular way teaching was that, group activities enabled the students became peer tutors and therefore have opportunity to share ideas. This enabled them understand the concept being taught. Secondly, group discussion and presentation improve students' understanding of the concept being learned.

In addition, the researcher found that, most schools have inadequate teaching and learning resources for the topic of classification. Most schools lacked preserved specimens or if available they were inadequate. Preserved specimens are essential in teaching and learning of classification, because the topic involves classification of living organisms. Most of these organisms required for the instruction are not

available in every locality, making preserved specimens substitutes for the real specimen. The unavailability or inadequacy of the preserved specimen make Biology teachers not to be able to organize for practical lessons in classification.

Analysis of responses given by the teachers indicated challenges they encounter while teaching the topic classification. These challenges were considered impediment to teaching and learning of Classification. The main challenges were four which included: 1) The topic of classification being broad; 2) Having difficult terminologies; 3) Inadequate resources; 4) Overpopulated classes which makes it hard for the teacher to organize for practical lessons. Other challenges included; low students' entry behavior which makes it hard for them to grasp concepts and student absenteeism due to class interruption from school activities. This finding concurs with Sakala (2012), whose study found that teachers prefer lecture method of teaching due to inadequate resource, students' low entry behavior, and overcrowded classes.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction of the Chapter

This chapter provides the summary of the major findings as presented in chapter four as per the study objectives: to compare the effect of 7E LCM and CIM on students' academic achievement in Biology, to determine the influence of students' attitude towards 7E LCM on their academic achievement in Biology and to find out how challenges faced by teachers when using 7E LCM and how they affect students' academic achievement in Biology. Conclusions have been drawn based on the major findings. Finally, recommendations as well as recommendations for future research suggested.

5.2 Summary of the Findings

The following are the findings of the study and are presented as per the objectives of the study.

5.2.1 7E Learning Cycle Model and Conventional Instructional Method

This study was guided by a hypothesis that stated: There is no significant difference in Biology achievement between students taught using 7E LCM and those taught using. The findings of the pre-test showed that students who were taught using 7E LCM and those who were taught using CIM had close mean score. In addition, t-test result show

that there was no significant difference in the means scores between the two groups. These results imply that the two instructional groups had equal ability before intervention, which was very significant to the study. Post-test scores indicated that students in the experimental group who were taught using 7E LCM had a higher mean score than those in control group who were taught using CIM. T-test also revealed that there was a statistically significant difference in post-test achievement among the two groups in favour of experimental group who were taught using 7E LCM.

5.2.2 Students Attitude Towards 7E Learning Cycle Model

The second objective of the study was to determine the influence of students' attitude towards 7E LCM on their academic achievement in Biology. This was guided a research question which stated: How does attitude of students towards 7E learning cycle affect their academic achievement in Biology? In response to the question, the study found out that students had a positive attitude towards the 7E LCM. In addition, the study found out that students preferred certain aspects of 7E LCM. These included: engaging in group activities, responding to questions from their peers, Biology teacher eliciting prior knowledge before teaching, importance of discussion groups in learning of Biology, extending Biology knowledge gained in class outside the classroom, responding to challenging questions, looking for answers to assignments from the library and students asking questions in areas they need clarification in a Biology class.

5.2.3 Challenges Facing Teachers During Instruction Using 7E Learning Cycle Model

The third objective of the study was to establish challenges faced by teachers when using 7E LCM and how they affect students' academic achievement in Biology. The study therefore was guided by the research question: How does the challenges faced by teachers when using 7E LCM affect students' academic achievement in Biology? Majority of the teachers who participated in the study rated students' ability to learn Biology as fair. On the other hand, most teachers preferred to use lecture method with few demonstrations to teach. Reasons for the teaching method was that it enabled them to cover the syllabus on time as well as lack of sufficient teaching and learning resources. In addition, only one teacher who participated in the study used teaching method which involved lecture, group activities, class discussions and presentation. The teacher argued that this approach enabled the students became peer tutors hence improve students' understanding of the concept being taught. The study also found that most schools had inadequate teaching and learning resources for classification. Most schools lacked preserved specimen used in teaching and learning of classification. Finally, teachers were required to mention challenges they were facing in teaching Classification using 7E Instructional Approach. The challenges faced by the teachers are summarised as follows: Inadequate learning resources, broad topic; making it difficult to be covered as per the syllabus timeline, difficult terminologies, high class enrolment and frequent class interruptions.

5.3 Conclusion

Based on the evidence presented, the research has found that 7E Learning Cycle Model is more effective than Conventional Instructional Method. Students taught using 7E Learning Cycle Model performed better than those taught using Conventional Instructional Method. 7E Learning Cycle Model was more effective in promoting and arousing student's interest and enthusiasm in learning than Conventional Instructional Method. The interactive nature of the 7E Learning Cycle Model makes the student to be motivated and therefore arousing their interest, creating deeper and broader understanding of the concept being taught. Secondly, the findings revealed that students' attitude towards 7E Learning Cycle Model was positive. Lastly, the research findings established that teachers encounter challenges in implementing 7E Learning Cycle Model in teaching Classification, therefore, opting for Conventional Instructional Method. These challenges include: inadequate instructional resources, broad topic, difficult terminologies, high class enrolment and frequent class interruptions. These challenges should therefore be addressed by education stakeholders in order to ensure that teachers overcome these challenges.

This study therefore concludes that 7E Learning Cycle Model is an effective way of improving students' academic achievement in Biology and should therefore be adopted in teaching Biology in secondary schools in Kenya.

5.4 Recommendations

i. Biology teachers should employ 7E Learning Cycle Model that allow students to actively construct their own knowledge along with actively participating in class.

ii. Ministry of education and other education stake holders should provide in-service for teachers in the use of 7E Learning Cycle Model.

iii. Kenya Institute of Curriculum Developers (KICD) should incorporate constructivist approaches such as 7E learning cycle model into the Biology curriculum for teaching Biology in secondary schools.

iv. The KICD should increase the number of lessons covering the topic of Classification so that the topic can be adequately covered.

v. Ministry of Education and other education stake holders should provide adequate resources such as books and laboratory apparatus. This is because 7E Learning Cycle Model requires that students gain access to such resources so as to actively construct their own knowledge.

5.5. Suggestions for Further Studies

In this study, 7E Learning Cycle Model was used to measure students' academic achievement in Biology. Therefore, study recommends further investigation on other learning cycle models other than 7E Learning Cycle Model. The study also recommends studies be done on the effect of 7E Learning Cycle Model on students' critical thinking skills.

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APPENDICES

APPENDIX I: LETTER OF INFORMATION TO THE PRINCIPAL

University of Eldoret,
P.O. Box 1125-30100
ELDORET
13th January, 2020.

TO,
THE PRINCIPAL,

Dear Sir/Madam

RE: COLLECTION OF DATA

I am a postgraduate student in the department of Centre for Teacher Education, University of Eldoret. I am carrying out a research study entitled: "**Effect of 7E Learning Cycle Model on students' academic achievement in biology in secondary schools in Chesumei Sub-county, Kenya."**

This research is purely academic and any information provided shall be treated with confidentiality. I am kindly requesting for your permission to collect data for this study in your school. During the time of data collection, I will administer a questionnaire to Biology teachers and questionnaire together with Biology tests to Form Three students. The output of the study will be used to enhance academic achievement in Biology in Kenyan secondary schools.

Thank you for your cooperation.

Yours faithfully,

JULIANA CHERONO
SEDU/EDS/M/001/17

APPENDIX II: CONSENT LETTER TO THE PARTICIPANT

University of Eldoret,
P.O. Box 1125-30100
ELDORET
13th January, 2020.

Dear participant,

I am a Post graduate student in the School of Education, University of Eldoret. I am pursuing a Master's degree in Education Science. I would kindly appreciate if you spare a few minutes to fill the questionnaire provided. The main objective of this study is to establish the effect of 7E Learning Cycle Model on students' learning of Biology in Secondary Schools.

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.

Thank you in advance for accepting to participate:

Yours faithfully

CHERONO JULIANA

SEDU/EDS/M/001/17

APPENDIX III: NACOSTI RESEARCH LICENCE

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **628358**

Date of Issue: **06/February/2020**

RESEARCH LICENSE

This is to Certify that Miss.. JULIANA CHERONO of University of Eldoret, has been licensed to conduct research in Nandi on the topic: EFFECT OF CONSTRUCTIVIST 7E INSTRUCTIONAL APPROACH ON STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY OF SECONDARY SCHOOLS IN CHESUMEI SUB-COUNTY, KENYA. for the period ending : 06/February/2021.

License No: **NACOSTI/P/20/3686**

628358

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY &
INNOVATION

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APPENDIX IV: LETTER FROM THE SUB-COUNTY DIRECTOR OF EDUCATION

REPUBLIC OF KENYA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
State Department of Education- Chesumei Sub-county

Sub-county Director of Education

PO. BOX 1305-30300
KAPSABET
10th FEBRUARY, 2020

TO WHOM IT MAY CONCERN

RE: AUTHORISATION TO CARRY OUT RESEARCH- JULIANA CHERONO-LICENCE NO: NACOSTI/P/20/3686

The bearer of this letter Juliana Cherono is a student of university of Eldoret. She has been authorized to carry out research on "***Effect of 7E learning Cycle Model on students' academic achievement in Biology in secondary schools in Kenya: A case study of Chesumei sub-county.***

The research period runs up to 6th February, 2021.

Kindly accord her the necessary assistance.

S. C. D. E
CHESUMEI SUB - COUNTY
P. O. Box 1305-30300
KAPSABET

MWANDIHI D. ESEMERE
SUB-COUNTY DIRECTOR OF EDUCATION
CHESUMEI SUB-COUNTY

APPENDIX V: 7E LEARNING CYCLE MODEL INSTRUCTIONAL MANUAL

This instructional manual guides Biology teachers on Biology instruction by use of 7E LCM. The lesson objectives have been stated clearly. Guidelines on how each lesson will be conducted at each phase has been incorporated. Teachers are kindly instructed to stick to the instructions given.

Instruction to teachers participating in 7E Learning Cycle Model

The following instructions will act as a guide for implementing 7E LCM instruction:

1. Ask students provoking questions so as to establish their conceptual framework at the at the beginning of each learning session such as “what do you think?” as well as posing scenarios. This will enable the teacher assess any misconception and correct them.
2. When students ask questions, avoid giving them answers but rather redirect the questions to other students. If they do not give a clear answer, refer the students to the library to search for answers.
3. After students have formed groups, have them elect group officials.
4. Visit all groups during exploration and elaboration stages so as to see how they develop concepts and ensure that all students participate actively.
5. Allow the students to use textbooks during exploration and elaboration stages.

Sample Lesson plans

WEEK 1

Lesson 1

TOPIC: CLASSIFICATION.

Sub- Topic: Basic principles of classification

Objective: By the end of the lesson the learner should be able to:

1. Define classification, taxonomy and binomial nomenclature
2. Describe the general principles of classification
3. Explain binomial nomenclature and the basic procedures that are followed in binomial nomenclature

Learning Aids:

i. Local environment
ii. Potted plants
iii. Use of preserved specimens of plants and animals

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Ask students to name living organisms that are found in their environment	Students to name living organisms that are found in their environment
	Engage (3min)	Ask the students to partner with each other. Ask students to discuss about some of the general characteristics the living things	Students to partner with each other. Students to discuss about some of the general characteristics the living things
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Distribute activity sheet to each	Form group and choose their leader Group organisms with similar

		group Ask learners to group organisms with similar characteristics	characteristics
	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the group findings	Groups present their findings.
	Elaborate (10min)	Ask students to read about Binomial Nomenclature.	Read about Binomial Nomenclature.
Conclusion (5min)	Evaluate (3min)	Recaps the lesson Ask the students to explain the basic procedures that are followed in Binomial nomenclature.	 Respond to the question
	Extend (2min)	Ask the learners to explain why a lion and a leopard cannot interbreed yet they belong to the same genus	Explain the reason why a lion and a leopard cannot interbreed yet they belong to the same genus

WEEK 1

Lesson 2

TOPIC: CLASSIFICATION.

Sub- Topic: Kingdom Monera

Objective: By the end of the lesson the learner should be able to:

1. Explain the general characteristics of kingdom Monera;
2. State various bacterial shapes;
3. Draw the various bacterial shapes

Learning Aids:

- Wall charts on a typical bacteria cell and different types of bacteria

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Teacher uses a short-written quiz to test student's previous knowledge. i) Name five kingdoms used in classifying living organisms. ii) Which of the five Kingdoms is the most primitive?	Students provide short answers.
	Engage (3min)	Ask students to study a wall charts on a typical bacteria cell.	Students study a wall chart on a typical bacteria cell
Development (30min)	Explore (10min)	Group learners and ask them to discuss about general characteristics of Kingdom Monera	Form groups and discuss about general characteristics of Kingdom Monera

	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the group findings	Student present their findings
	Elaborate (10min)	Ask the students to explain various shapes of bacteria	Students explain various shapes of bacteria
Conclusion (5min)	Evaluate (3min)	Ask students to state general characteristics of bacteria Recaps the lesson	Respond to the question
	Extend (2min)	Ask the learners to explain ways in which bacteria affect our lives	Explain ways in which bacteria affect our lives

WEEK 1

Lesson 3&4

TOPIC: CLASSIFICATION.

Sub- Topic: Kingdom fungi

Objective: By the end of the lesson the learner should be able to:

1. Describe fungi and give some examples of the fungi
2. Explain the general characteristics of kingdom fungi

Learning Aids: Rhizopus

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Ask students to name examples of fungi	Students to name examples of fungi
	Engage (3min)	Ask the students to partner with each other identify presented fungi	Students to partner with each other. Students identify the Fungi
Development (30min)	Explore (10min)	Ask students to draw and label the structure of yeast	Form group and choose their leader Draw and label the structure of yeast
	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the group findings	Groups present their findings.
	Elaborate (10min)	Ask students to discuss about general characteristics of yeast	Discuss about general characteristics of yeast.

Conclusion (5min)	Evaluate (3min)	Recaps the lesson Ask students to state the characteristics of Kingdom Fungi	Respond to the question
	Extend (2min)	Ask the learners to suggest the importance of mushroom, yeast and penicillium	Suggest the importance of mushroom, yeast and penicillium

WEEK 1

Lesson 5

TOPIC: CLASSIFICATION.

Sub- Topic: Kingdom fungi

Objective: By the end of the lesson the learner should be able to:

1. Identify the various parts of Rhizopus
2. Explain how Rhizopus is adapted to its function

Learning Aids: Rhizopus

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Ask students to name examples of fungi	Students to name examples of fungi
	Engage (3min)	Ask the students to partner with each other identify presented fungi	Students to partner with each other. Students identify the Fungi
Development (30min)	Explore (10min)	Ask students to draw and label the structure of a rhizopus	Form group and choose their leader Draw and label the structure of a rhizopus
	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the group findings	Groups present their findings.
	Elaborate (10min)	Ask students to discuss about general characteristics of Kingdom Fungi	Discuss about general characteristics of Kingdom Fungi

Conclusion (5min)	Evaluate (3min)	Recaps the lesson Ask students to state the characteristics of Kingdom Fungi	Respond to the question
	Extend (2min)	Ask the learners to suggest the importance of bread mould to human beings	Suggest the importance of bread mould to human beings

WEEK 2

Lesson 1

TOPIC: CLASSIFICATION.

Sub- Topic: Kingdom plantae

Objective: By the end of the lesson the learner should be able to:

1. Explain the general characteristics of kingdom plantae
2. Name the three main divisions of kingdom plantae

Learning Aids: Plant

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Present students with a plant specimen and ask them to explain why they think it is a plant and not an animal	Students answer the question
	Engage (3min)	Ask students to draw a structure of a typical plant	Students to draw a structure of a typical plant
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Distribute activity sheet to each group Ask students to discuss about some of the general characteristics of plants	Form group and choose their leader Group organisms with similar characteristics
	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the group findings	Present findings

	Elaborate (10min)	Ask students to identify three divisions under Kingdom Plantae	Identify three divisions under Kingdom Plantae
Conclusion (5min)	Evaluate (3min)	Ask students to state the general characteristics of kingdom plantae	Respond to the question
	Extend (2min)	Ask the learners to explain the importance of plants to the environment and other living organisms	Explain the importance of plants to the environment and other living organisms

WEEK 2

Lesson 2

TOPIC: CLASSIFICATION.

Sub- Topic: Bryophyte

Objective: By the end of the lesson the learner should be able to:

1. Give examples of plants in division bryophyte
2. Explain the general characteristics of bryophytes
3. Draw and label the parts of a moss and liverwort

Learning Aids: Live specimens of liverworts and moss plants

Hand lens

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Ask students to describe what is green substance on the damp shaded surfaces	Students describe what is green substance on the damp shaded surfaces
	Engage (3min)	Ask the students to partner with each other. Ask students to observe and draw a structure of a moss plant using a lens	Students to partner with each other. Students observe and draw a structure of a moss plant using a lens
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Ask students to discuss general characteristics of Division Bryophyta	Form group and choose their leader Discuss general characteristics of Division Bryophyta
	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the group findings	Groups present their findings.

	Elaborate (10min)	Ask students to observe and draw a structure of a liverwort plant using a lens	Students to observe and draw a structure of a liverwort plant using a lens
Conclusion (5min)	Evaluate (3min)	Recaps the lesson Ask the students to i) Give examples of plants in division bryophyte ii) State the general characteristics of bryophytes	Respond to the question
	Extend (2min)	Ask the learners to discuss how bryophytes are reliable indicators of air pollution	Explain discuss how bryophytes are reliable indicators of air pollution

WEEK 2

Lesson 3&4

TOPIC: CLASSIFICATION.

Sub- Topic: Division Pteridophyta

Objective: By the end of the lesson the learner should be able to:

1. Describe and give examples of plants in division Pteridophyta
2. Discuss the general characteristics of organisms in division Pteridophyta
3. Draw and label the parts of ferns in sporophyte and gametophyte stage

Learning Aids:

- Local environment
- Hand lens
- Live specimens of fern plants

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit (2min)	Ask students to name the members of division Pteridophyta	Students to name members of division Pteridophyta
	Engage (10 min)	Ask students to draw and label a structure of a sporophyte fern	Ask students to draw and label a structure of a sporophyte fern
Development (30min)	Explore (20 min)	Ask students to discuss general characteristics of organisms in division Pteridophyta	Students to discuss general characteristics of organisms in division Pteridophyta
	Explain	Ask each group to presents its findings.	Groups present their findings.

	(20 min)	Harmonizes each of the group findings	
	Elaborate (20 min)	Ask students to draw and label a structure of a gametophyte fern	Students to draw and label a structure of a gametophyte fern
Conclusion (5min)	Evaluate (5 min)	Ask the students to i) Give examples of plants in division Pteridophyta ii) Discuss the general characteristics of organisms in division Pteridophyta	Respond to the question
	Extend (3 min)	Ask the learners to explain why ferns are considered to be more advanced than mosses	Explain the reason why ferns are considered to be more advanced than mosses

WEEK 2

Lesson 5

TOPIC: CLASSIFICATION.

Sub- Topic: Division Spermatophyta

Objective: By the end of the lesson the learner should be able to:

1. Describe the plants in division Spermatophyta
2. Explain the general characteristics of the seed bearing plants
3. Name the two main subdivisions of division Spermatophyta
4. Explain the general characteristics of subdivision Gymnospermaphyta
5. Explain the characteristics of the plants in class Conferales
6. Explain the general characteristics of the plants in class Ginkgoales

Learning Aids: Realia

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Ask students to name seed bearing plants	Students to name seed bearing plants
	Engage (3min)	Ask students to distinguish between familiar green plants which produce seeds through the flowers and those which produce cones	Students distinguish between familiar green plants which produce seeds through the flowers and those which produce cones
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Distribute activity sheet to each group which asks students to discuss general characteristics of Division Spermatophyta	Form group and choose their leader Students to discuss general characteristics of Division Spermatophyta

	Explain (10min)	Ask each group to presents its findings and harmonize each of the group findings	Groups present their findings.
	Elaborate (10min)	Ask students to discuss the general characteristics of sub division Spermatophyta	Students discuss the general characteristics of sub division Spermatophyta
Conclusion (5min)	Evaluate (3min)	Ask the students to explain: i) Name the plants in division Spermatophyta ii) State general characteristics of the seed bearing plants iii) Name the two main subdivisions of division Spermatophyta iv) Explain the general characteristics of subdivision Gymnospermaphyta v) Explain the characteristics of the plants in class Conferales vi) Explain the general characteristics of the plant in class Ginkgoales	Respond to the question
	Extend (2min)	Ask students to explain the adaptation of members of class Conferales to their habitat	Students to explain the adaptation of Conferales to their habitat

WEEK 3

Lesson 1

TOPIC: CLASSIFICATION.

Sub- Topic: Angiospermaphyta

Objective: By the end of the lesson the learner should be able to:

1. Describe the subdivision Angiospermaphyta and give examples
2. Explain the general characteristics of the plants in subdivision Angiospermaphyta
3. Discuss the general characteristics of plants in class Monocotyledonae
4. Discuss the general characteristics of plants in class Dicotyledonae

Learning Aids: Mature bean plant with mature pods, maize plant with roots.

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit (2min)	Ask students to name organism found in subdivision Angiospermaphyta	Students to name organism found in subdivision Angiospermaphyta
	Engage (3min)	Draw and label a structure of a maize and a bean plan	Students draw and label structures of bean and maize plant
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Ask students to describe general characteristics of sub division Angiospermaphyta	Form group and choose their leader Students to describe general characteristics of sub division Angiospermaphyta
	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the group findings	Groups present their findings.

	Elaborate (10min)	Asks them to distinguish between dicotyledonous and monocotyledonous plants	Distinguish between dicotyledonous and monocotyledonous plants
Conclusion (5min)	Evaluate (3min)	Ask the students to: i) give examples of members of Sub Division Angiospermaphyta ii) Explain the general characteristics of the plants in subdivision Angiospermaphyta iii) Discuss the general characteristics of plants in class Monocotyledonae iv) Discuss the general characteristics of plants in class Dicotyledonae	Respond to the question
	Extend (2min)	Ask the learners to give economic importance of dicotyledonous and monocotyledonous plants	Learners to give economic importance of dicotyledonous and monocotyledonous plants

WEEK 3

Lesson 2

TOPIC: CLASSIFICATION.

Sub- Topic: Kingdom Animalia

Phylum Arthropoda

Objective: By the end of the lesson the learner should be able to:

1. Explain the general characteristics of organisms in Kingdom Animalia
2. Give examples of organisms in the phylum Arthropoda
3. Explain the general characteristics of organisms in phylum Arthropoda
4. Name the five classes of organisms in phylum Arthropoda

Learning Aids: Cray fish, grasshopper, millipede, centipede, spider (freshly killed preserved or photographs of the organisms)., hand lens

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit (2min)	Ask students to name organisms that are found in the Kingdom Animalia	Students to name living organisms in Kingdom Animalia
	Engage (3min)	Ask the students form groups Ask students to discuss about some of the general characteristics Kingdom Animalia	Students to partner with each other. Students to discuss about some of the general characteristics Kingdom Animalia
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Distribute activity sheet to each group which asks them to observe the external feature of members of phylum	Form group and choose their leader Observe the external feature and list common features of the

		Arthropoda: Cray fish, grasshopper, millipede, centipede, spider (freshly killed preserved or photographs of the organisms) and list common features of the specimens.	specimens
	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the group findings	Groups present their findings.
	Elaborate (10min)	Ask students to discuss general characteristics of Phylum Arthropoda	Students to discuss general characteristics of Phylum Arthropoda
Conclusion (5min)	Evaluate (3min)	Ask the students to: i) Name organisms found in kingdom Animalia iii) Name organisms in the phylum Arthropoda iv) State the general characteristics of organisms in phylum Arthropoda v) Name the five classes of organisms in phylum Arthropoda	Respond to the question
	Extend (2min)	Ask the learners to name five classes of Phylum Arthropoda	Learners to name five classes of Phylum Arthropoda

WEEK 3

Lesson 3&4

TOPIC: CLASSIFICATION.

Sub- Topic: Class Crustacea

Objective: By the end of the lesson the learner should be able to:

1. Give examples of organisms in class Crustacea
2. Identify the parts of some organisms that belong to class Crustacea
3. Explain the general characteristics of the organisms in class Crustacea

Learning Aids: Daphnia, crayfish, crab and prawn live specimen or photograph.

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Ask students to give examples of organisms in class Crustacea	Students to name living organisms that are found in class Crustacea
	Engage (3min)	Ask the students to partner with each other. Ask students to draw and label a structure of a crab	Students to partner with each other. Students draw and label a structure of a crab
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Distribute activity sheet to each group Students discuss the characteristics of members of class Crustacea	Form group and choose their leader Students discuss the characteristics of members of class Crustacea
	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the group findings	Groups present their findings.

	Elaborate (10min)	Ask students to draw and label the structure of a crayfish	Students to draw and label the structure of a crayfish
Conclusion (5min)	Evaluate (3min)	Ask the students to: i. Give examples of organisms in class Crustacea ii. Identify the parts of a crab. iii. Explain the general characteristics of the organisms in class Crustacea	 Respond to the question
	Extend (2min)	Ask the learners to explain some of the economic and ecological importance of crustaceans	Explain some of the economic and ecological importance of crustacean genus

WEEK 3

Lesson 5

TOPIC: CLASSIFICATION.

Sub- Topic: Class Chilopoda

Objective: By the end of the lesson the learner should be able to:

1. Describe the organisms in class Chilopoda
2. Describe the organisms in class Diplopoda
3. Explain the general characteristics of the organisms in class Chilopoda
4. Explain the general characteristics of the organisms in class Diplopoda
5. Identify the parts of the centipede and a millipede

Learning Aids: Centipede, millipede, hand lens

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Ask students to name organisms in Class Chilopoda and Diplopoda	Students to name living organisms that are found in class Chilopoda
	Engage (3min)	Ask students to draw and label the structure of a centipede	Students to draw and label the structure of a centipede
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Distribute activity sheet to each group Ask students to discuss the general characteristics of Class Chilopoda	Form group and choose their leader Discuss the general characteristics of Class Chilopoda
	Explain (10min)	Ask each group to presents its findings.	Groups present their findings.

		Harmonizes each of the group findings	
	Elaborate (10min)	Ask students to discuss general characteristics of class Diplopoda	Students to discuss general characteristics of class Diplopoda
Conclusion (5min)	Evaluate (3min)	Ask the students to i. Describe the organisms in class Chilopoda and Diplopoda ii. Differentiate between characteristics of class Chilopoda and Diplopoda	 Respond to the question
	Extend (2min)	Ask the students to discuss adaptations of centipede and millipede to their habitat	Students to discuss adaptations of centipede and millipede to their habitat

WEEK 4

Lesson 1

TOPIC: CLASSIFICATION.

Sub- Topic: Class Arachnida

Objective: By the end of the lesson the learner should be able to:

1. Give examples of organisms in class Arachnida
2. Identify the body parts of organisms in class Arachnida
3. Explain the general characteristics of organisms in class Arachnida

Learning Aids: Spiders, scorpions, ticks and mites.

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Ask students to name organisms found in class Arachnida	Students to name organisms found in class Arachnida
	Engage (3min)	Ask the students to partner with each other. Ask students to draw and label parts of a spider	Students to partner with each other. Students draw and label parts of a spider
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Distribute activity sheet to each group which instructs students to discuss common features between spiders, scorpions, ticks and mites	Form group and choose their leader Students discuss common features between spiders, scorpions, ticks and mites
	Explain (10min)	Ask each group to presents its findings.	Groups present their findings.

		Harmonizes each of the group findings	
	Elaborate (10min)	Ask students to discuss general characteristics of class Arachinida.	Students to discuss general characteristics of class Arachinida
Conclusion (5min)	Evaluate (3min)	Ask the students to: i. Name organisms in class Arachnida ii. Identify the body parts of organisms in class Arachnida iii. Explain the general characteristics of organisms in class Arachnida	 Respond to the question
	Extend (2min)	Ask the learners to explain why a lion and a leopard cannot interbreed yet they belong to the same genus	Explain the reason why a lion and a leopard cannot interbreed yet they belong to the same genus

WEEK 4

Lesson 2

TOPIC: CLASSIFICATION.

Sub- Topic: Class Insecta

Objective: By the end of the lesson the learner should be able to:

1. Describe the class Insecta organisms
2. Explain the general characteristics of organisms in class insect
3. State the economic importance of insects

Learning Aids: Beetle, bee, termite, grasshopper, housefly and butterfly

Hand lens.

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Ask students to name living organisms that are found in their environment	Students to name living organisms that are found in their environment
	Engage (3min)	Ask the students to partner with each other. Ask students to draw and label the structure of a grasshopper	Students to partner with each other. Students to discuss about some of the general characteristics the living things
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Distribute activity sheet to each group which guides students to identify common characteristics of beetle, bee, termite,	Form group and choose their leader Identify common characteristics of beetle, bee, termite, grasshopper, housefly, and

		grasshopper, housefly, and butterfly.	butterfly.
	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the group findings	Groups present their findings.
	Elaborate (10min)	Ask students to discuss general characteristics of Class Insecta	students to discuss general characteristics of Class Insecta
Conclusion (5min)	Evaluate (3min)	Explain the general characteristics of organisms in class insect	Explain the general characteristics of organisms in class insect
	Extend (2min)	State the economic importance of insects	Students state the economic importance of insects

WEEK 4

Lesson 3&4

TOPIC: CLASSIFICATION.

Sub- Topic: Phylum Chordata

Objective: By the end of the lesson the learner should be able to:

1. Describe the phylum Chordata
2. Explain the main characteristics of organisms in phylum Chordata
3. Name the main classes of phylum Chordata

Learning Aids: Fresh tilapia, freshly killed frog, freshly killed lizard, bird and rabbit.

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Ask students to name members of phylum Chordata	Students to name members of phylum Chordata
	Engage (3min)	Ask the students to partner with each other.	Students to partner with each other.
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Distribute activity sheet to each group Ask students to examine external features of Fresh tilapia, freshly killed frog, freshly killed lizard, bird and rabbit and state their common characteristics	Form group and choose their leader Students examine external features of Fresh tilapia, freshly killed frog, freshly killed lizard, bird and rabbit and state their common characteristics
	Explain (10min)	Ask each group to presents its findings.	Groups present their findings.

		Harmonizes each of the group findings	
	Elaborate (10min)	Ask students to discuss general characteristics of Phylum Chordata	Students to discuss general characteristics of Phylum Chordata
Conclusion (5min)	Evaluate (3min)	i. Name members of phylum Chordata ii. Explain the main characteristics of organisms in phylum Chordata	Respond to the question
	Extend (2min)	Ask students to name the main classes of phylum Chordata	Students to name the main classes of phylum Chordata

WEEK 4

Lesson 5

TOPIC: CLASSIFICATION.

Sub- Topic: Class Pisces

Objective: By the end of the lesson the learner should be able to:

1. Describe the class Pisces
2. Explain the general characteristics of class Pisces
3. Draw and label the structure of a tilapia fish

Learning Aids: Tilapia Fish, Sardine

References: KLB (2005), Biology Form 3 students' Book, 3rd Edition

Stage	**Steps**	**Teacher Activity**	**Learners Activities**
Introduction (5min)	Elicit(2min)	Show students a clip of a tilapia and ask them what class they think it belong	Students watch a clip of a tilapia and identify which class it belongs
	Engage (3min)	Ask the students to partner with each other. Ask students to draw and label the structure of a tilapia fish	Students to partner with each other. Students to draw and label the structure of a tilapia fish
Development (30min)	Explore (10min)	Group learners and ask them to choose their leader Distribute activity sheet to each group which guides students to identify similar external characteristics between tilapia and sardine fish	Form group and choose their leader Students identify similar external characteristics between tilapia and sardine fish
	Explain (10min)	Ask each group to presents its findings. Harmonizes each of the	Groups present their findings.

		group findings	
	Elaborate (10min)	Ask students to discuss general characteristics of class Pisces	Students to discuss general characteristics of class Pisces
Conclusion (5min)	Evaluate (3min)	i. Explain the general characteristics of class Pisces ii. Draw and label the structure of a tilapia fish	Respond to the question
	Extend (2min)	Ask the learners to explain why a lung fish can survive outside water for a long duration of time and not die	Learners to explain why a lung fish can survive outside water for a long duration of time and not die

APPENDIX VI: BIOLOGY ACHIEVEMENT TEST

Pre-Test Items Time: 1 Hour

1. Gender

Male ☐ Female ☐

2. Name of school _____

Instructions

Answer all questions with sincerity. Cheating is strictly not allowed

Do not write your name on this paper.

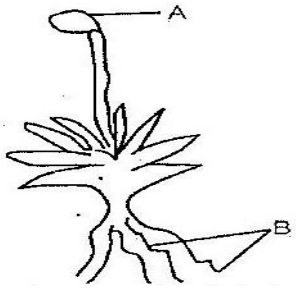
Answer the questions in the spaces provided

Questions

1. a) Define the term binomial nomenclature (1mk)

   b) Give two reasons why classification is important (2mks)

c) Below is a diagram of a plant. Use it to answer the questions that follow



(i) Name the parts labelled A and B (2 marks)

(ii) Name the division to which the plant belongs (1 mark)

2. i) a) What are two differences between fungi and algae?
(2mks)

b) Give one economic importance of fungi.
(1mk)

ii) Explain why ferns are considered to be more advanced than mosses (2mks)

4. a) State three characteristics of class Aves
(3marks)

b) Name a phylum to which a tick belongs to (1 mark)

c) Below is a list of organisms which belong to the class Insecta, Diplopoda, Chilopoda and Arachnida; Tick, Centipede, Praying Mantis, Tsetse fly, millipede and spider. Place the organisms in their respective classes in the table below. Give a reason in each case.
(4marks)

Classes	**Organisms**	**Reasons**
Insecta		
Diplopoda		
Chilopoda		
Arachinida		

5. (a) List two characteristics that mammals share with birds (2 marks)

(b) State two major characteristics that are unique to mammals (2 marks)

c) Discuss ways in which reptiles are better adapted to life on land than amphibians

(6mks)

Post Test Items Time: 1 Hour

1. Gender

Male ☐ Female ☐

2. Name of school _____

Instructions

Answer all questions with sincerity. Cheating is strictly not allowed

Do not write your name on this paper.

Answer the questions in the spaces provided

1 a) Explain the following terms; (3mks)

i) Classification

ii) Taxonomy

iii) Binomial nomenclature

b) The scientific name of the cat is *Felis catus* classify the cat into:

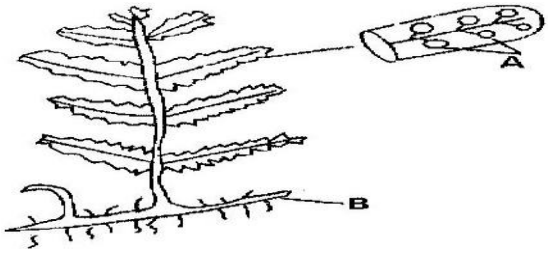
(3mks)

i) Kingdom _____

ii) Genus _____

iii) Species _____

2 a) The diagram below represents a fern



Name

(i) Parts labelled A and B (2 marks)

(ii) The division which the plant belongs (1 mark)

b) i) What is alteration of generations? (3 marks)

(ii Name two divisions in plant kingdom that shows alternation of generation (2 marks)

3 a) What two characteristics distinguish animals in phylum Chordata? (2 marks)

b) An animal has an exoskeleton, 8 jointed legs, segmented body and two body parts.

Name the phylum and class to which the animal belongs. (2mks)

Phylum _____

Class _____

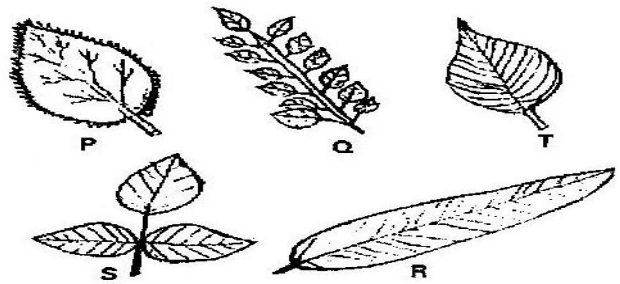
Write down the functions of exoskeleton in Phylum Arthropoda (2mks)

4. a) A millipede, grasshopper and crayfish all belong to phylum Arthropoda.

Mention three major characteristics that they have in common. (3 marks)

b) List the main characteristics that are used to sub- divide arthropods into classes (2 marks)

5. Study specimens below and answer the questions that follow



A dichotomous key was constructed identify the plant leaves as follows

1. (a) Simple leaf..... Go to 2

(b) Compound leaf ..... Go to 4

2. (a) Leaf has serrated margin..... Hibiscus

(b) Leaf has smooth margin ..... Go to 3

3. (a) Leaf has smooth margin ..... Mango

(b) Leaf is ovate ..... Morning glory

4. (a) Leaf has many leaflets ..... Nandi Flame

(b) Leaf has 3 leaflets..... Bean

Identify steps followed for each of the leaves and state its identity (5mks)

Leaf	Steps followed	Identity
P Q R S T		

APPENDIX VII: STUDENTS' QUESTIONNAIRE

Directions

This questionnaire is designed to obtain information vital for the study. Please tick (√) the choice that indicates your opinion.
There is no wrong or right answer. What is required is your honest opinion
Key:

Strongly Agree – SA

Agree - A

Undecided -U

Disagree – D

Strongly Disagree - SD

NO.	ITEMS	SA	A	U	D	SD
1.	I enjoy Biology classes if many activities are done in groups.					
2.	My Biology teacher should give me notes to copy					
3.	My Biology teacher should allow me to respond to questions in class from my classmates					
4.	My Biology teacher should ask questions before we learn Biology.					
5.	Discussion groups does not help me learn Biology					
6.	What I learn in Biology is to enable me pass examinations only.					
7.	I should be asked challenging questions by my Biology teacher					
8.	My Biology teacher should ask questions that requires me to carry out research in the library					
9.	I should be allowed by my Biology teacher to ask many questions in class					
10.	I should sit facing the front of the class in all Biology classes.					

APPENDIX VIII: TEACHERS' QUESTIONNAIRE

This questionnaire is designed to collect information vital for the study. The information you give will be treated with confidentiality and will only be used for compiling this study report.

Kindly fill the questionnaire as instructed.

SECTION A: Teachers Biography

Please indicate your chosen response with a tick (√).

1. Sex: Male [ ] Female [ ]

2. Age (i) 20-25 years [ ] (ii) 26-30 years[ ] (iii) 31-40 years[ ] (iv) 41 years and above[ ]

3. Please indicate your highest qualification.

(i) Diploma [ ] (ii) Bachelor's Degree[ ] (iii) Masters [ ] (iv) Ph. D[ ]

4. How many years have you been teaching Biology?

(i) Less than 1 year [ ] (ii)1-5years [ ] (iii) 6-10 years[ ] (iv) 11-15 years[ ]

(v) 16-20 years [ ] (vi) 21 years and above [ ]

SECTION B: Factors affecting Instruction of Biology.

4. What is the ability of your students in learning Biology?

(i) Excellent [ ] (ii) Good [ ] (iii)Fair [ ] (iv) Poor [ ]

5. a) The following statements are teaching methods. Please tick (√) the method you commonly use in teaching classification.

(i) Lecture method

(ii) Lecture method with a few demonstrations

(iii) Lecture method, group discussions, group practical activities and presentations

b) Explain briefly why you prefer using the above method

……
……
……
…….

6. a) Please indicate if the following instructional resources are available by putting a tick (√)

No.	Instructional resource	Number available in school	Not Available
i.	Microscope		
ii.	Mounting pins or needles		
iii.	Hand lens		
iv.	Glass slide		
v.	Preserved specimens		
vi.	Biology Textbooks variety		
vii.	Specimen Bottles		

6. b) Do you have preserved specimens used in teaching classification in your school? If yes, please indicate the number available.

……
……
…….

8. Indicate four challenges you often encounter in teaching and learning of Classification.

……

……
……
……
……
……

Thank you for participating.

APPENDIX IX: NATIONAL CANDIDATES' OVERAL KCSE PERFORMANCE IN BIOLOGY

YEAR	CANDIDATURE	MAXIMUM SCORE	MEAN SCORE	PERCENTAGE
2009	299, 302	200	54.29	27.145
2010	317, 135	200	58.39	29.195
2011	363, 817	200	64.87	32.435
2012	389, 523	200	52.41	26.205
2013	397, 319	200	63.26	31.63
2014	432, 977	200	63.65	31.825
2015	465, 584	200	69.59	34.795
2016	509, 982	200	58.37	29.185
2017	545, 663	200	37.85	18.925
2018	589, 900	200	51.38	25.69

APPENDIX X: NANDI COUNTY KCSE PERFORMANCE IN BIOLOGY

YEAR	SUB COUNTIES KCSE PERFEOMANCE IN BIOLOGY (%)					
	MOSOP	EMGWEN	CHESUMEI	ALDAI	NANDI HILLS	TINDIRET
2019	22.58	22.92	23.57	21.83	24.67	25.25
2018	21.42	21.58	22.17	21.33	22.17	23.17
2017	18.08	18.17	18.33	18.17	17.25	21.17

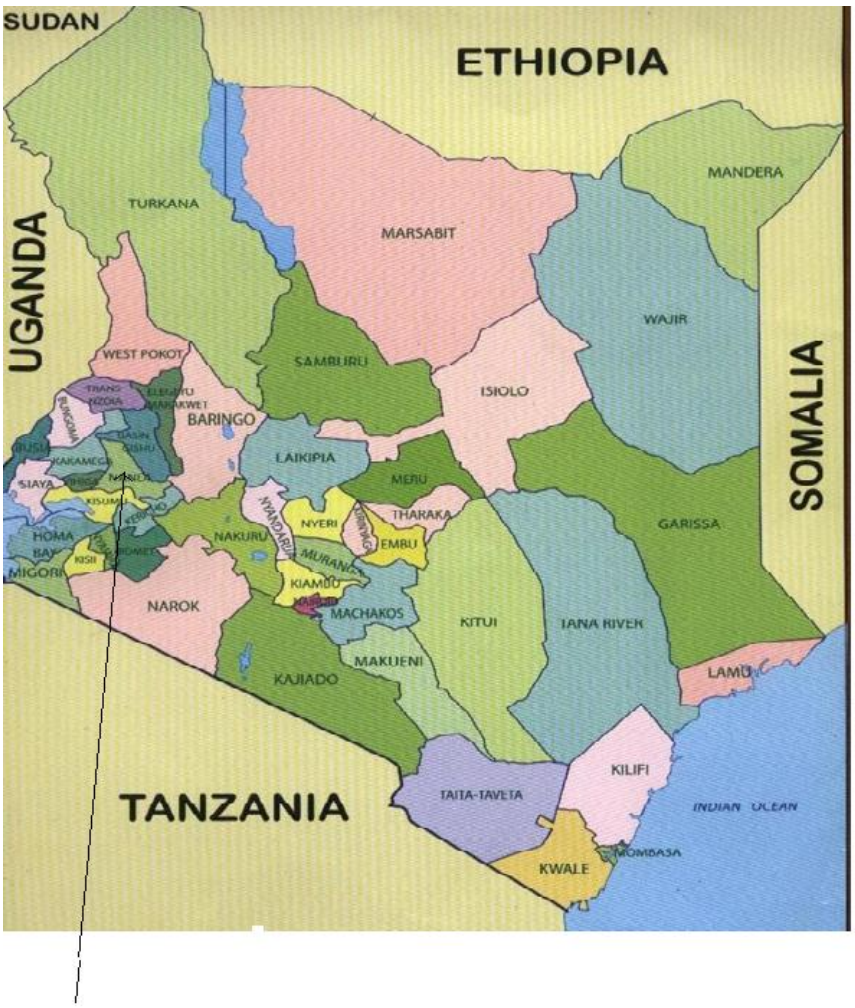
APPENDIX XI: CHESUMEI SUB-COUNTY KCSE BIOLOGY MEAN SCORES

NO	SCHOOL	2019	2018	2017	2016	2015
1	KAPSABET BOYS HIGH SCHOOL	7.83	6.37	5.54	8.24	11.69
2	ST JOSEPHS GIRLS HIGH SCHOOL CHEPTERIT	6.10	5.56	4.12	7.65	7.99
3	SEGERO BARATON ADVENTIST SCHOOL	5.17	5.00	4.50	2.88	5.64
4	LELMOKWO HIGH SCHOOL	4.95	4.09	2.92	4.36	6.95
5	ITIGO GIRLS SECONDARY SCHOOL	4.00	3.80	3.50	3.35	5.35
6	A.I.C KOSIRAI GIRLS HIGH SCHOOL	3.87	3.80	3.60	5.44	5.35
7	NAMGOI MIXED SECONDARY	3.65	3.92	3.81	3.81	6.06
8	KOSIRAI HIGH SCHOOL	3.46	2.74	2.20	5.44	5.35
9	KAPTEL BOYS HIGH SCHOOL	3.51	2.98	2.34	3.57	4.88
10	MWEIN ADVENTIST SECONDARY	3.55	2.51	2.83	2.25	3.46
11	ST. FRANCIS CHEPTARIT GIRLS' HIGH	2.95	2.50	2.40	2.99	3.46
12	KOMBE SECONDARY SCHOOL HIGH	2.50	2.50	2.30	2.12	2.57
13	ST. STEPHEN'S KIPTUIYA SECONDARY	2.87	2.54	1.14	-	-
14	AIC KAMOIYWO SECONDARY	2.23	2.08	2.10	2.68	2.99
15	ST. PAUL'S ACK GIRLS KAPTEL	2.60	2.50	2.30	2.32	2.56
16	AIC KAPKUTO HIGH SCHOOL	2.60	2.47	2.29	3.23	3.88
17	MOI HIGH SCHOOL SIRGOI	2.61	1.93	2.22	3.45	4.57
18	NDONYONGARIA	2.77	2.26	1.70	2.43	2.48

	SECONDARY					
19	AIC MUTWOT HIGH	2.67	2.07	1.69	2.12	2.47
20	KAPSISIYWA SECONDARY	2.69	2.16	3.00	3.23	4.35
21	AIC CHEPTWOLIO SECONDARY	2.78	2.27	1.58	2.99	3.01
22	ST. PATRIC NDAPTABWA SECONDARY	2.57	2.30	1.57	1.77	1.98
23	AIC KIPKONGORWO SECONDARY	2.50	2.40	1.55	-	-
24	KIMONDI SECONDARY	2.42	2.42	1.54	2.35	3.46
25	NGECHECK SECONDARY	2.42	2.30	1.56	3.25	4.88
26	ST JOHN THE APOSTLE HIGH CHEMUSWO	2.46	2.20	1.47	4.58	5.79
27	AIC KECHIRE HIGH SCHOOL	2.14	2.05	1.56	2.35	2.57
28	ST. JUDES KOKWET SECONDARY	1.42	2.82	2.31	2.10	2.58
29	SANIAK SECONDARY	2.39	3.09	2.07	3.23	4.99
30	KISAGET SECONDARY	2.05	2.80	2.15	-	-
31	KAPKECHUI GIRLS' SECONDARY	2.51	2.70	2.24	1.37	2.32
32	A.I.C. TAMBOIWO SECONDARY	2.42	2.77	2.26	3.46	4.55
33	ST. CANISIUS HIGH SCHOOL MATEKET	2.13	2.28	2.21	2.05	2.99
34	ST. PAUL KAMONJIL HIGH	2.19	2.04	1.19	2.03	2.45
35	MARTIN LEL SECONDARY	2.07	2.13	2.06	2.36	2.21
36	KAPCHEPKOK SECONDARY	2.27	1.67	1.92	-	-
37	ACK LAGAT HIGH OLMETUNYI	2.33	2.57	2.24	2.35	2.32
38	CHEMUNDU SECONDARY	2.20	1.94	1.55	2.35	2.43
39	CHRIST THE KING HIGH SECONDARY	2.27	2.17	1.58	2.35	2.21
40	KAMURGUIYWO SECONDARY	1.79	1.88	1.13	1.93	2.43

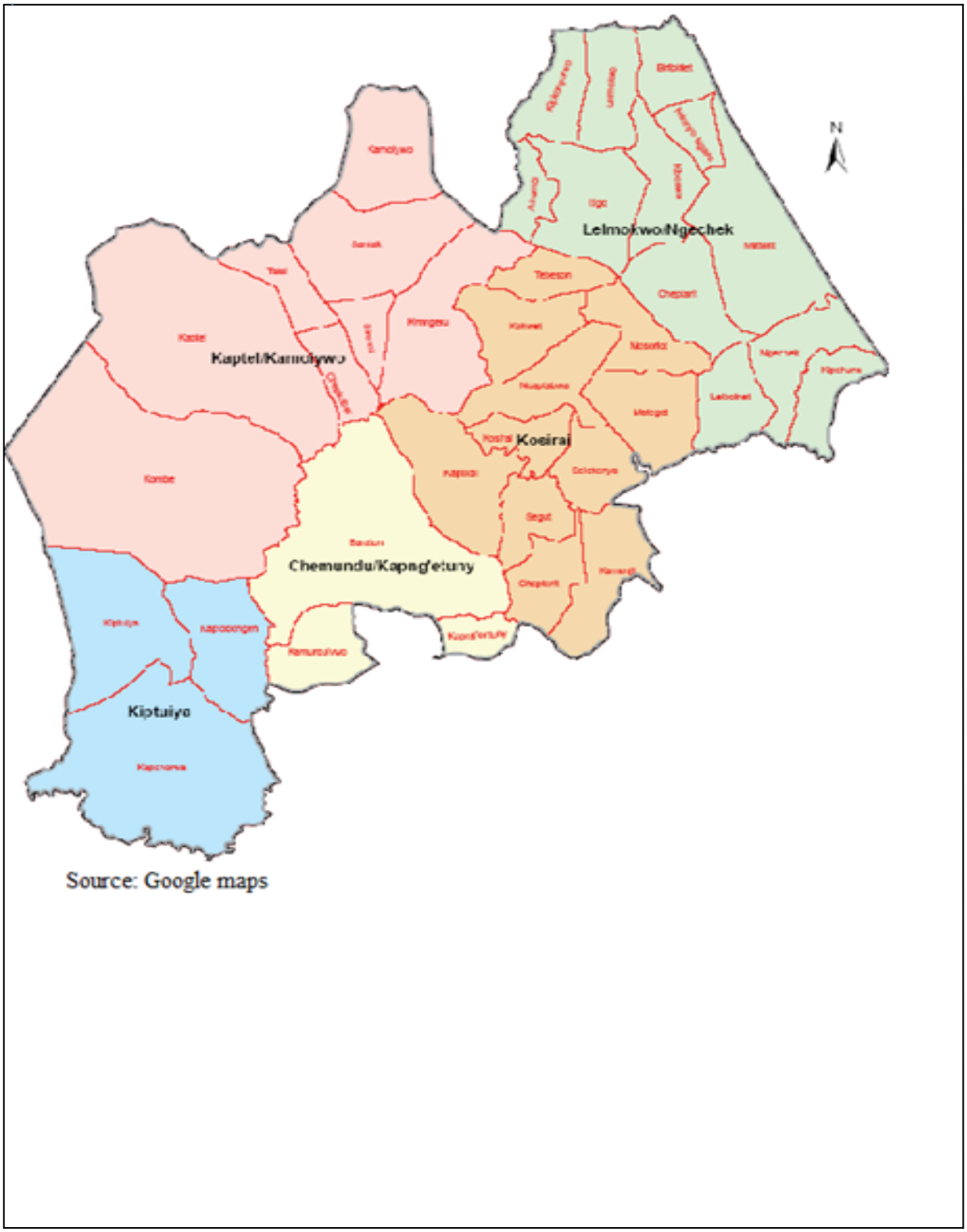
41	SAMOO SECONDARY	2.31	2.39	1.34	2.00	2.46
42	A.I.C MOSORIOT SECONDARY	2.00	2.06	1.88	-	-
43	KAPTILDIL SECONDARY	1.62	1.90	1.29	1.88	2.46
44	ST. SYLVESTER SIRONOI SECONDARY	1.84	1.79	1.34	-	-
45	A.I.C ITIGO MIXED SECONDARY	1.75	1.54	1.12	-	-
46	MARBEN SECONDARY	2.70	2.10	2.00	2.57	3.20
	AVERAGE MEAN SCORE	2.83	2.66	2.20	3.10	3.93
	MEAN SCORE (%)	**23.57**	**22.17**	**18.33**	**25.82**	**32.76**

APPENDIX XII: MAP OF KENYA SHOWING NANDI COUNTY

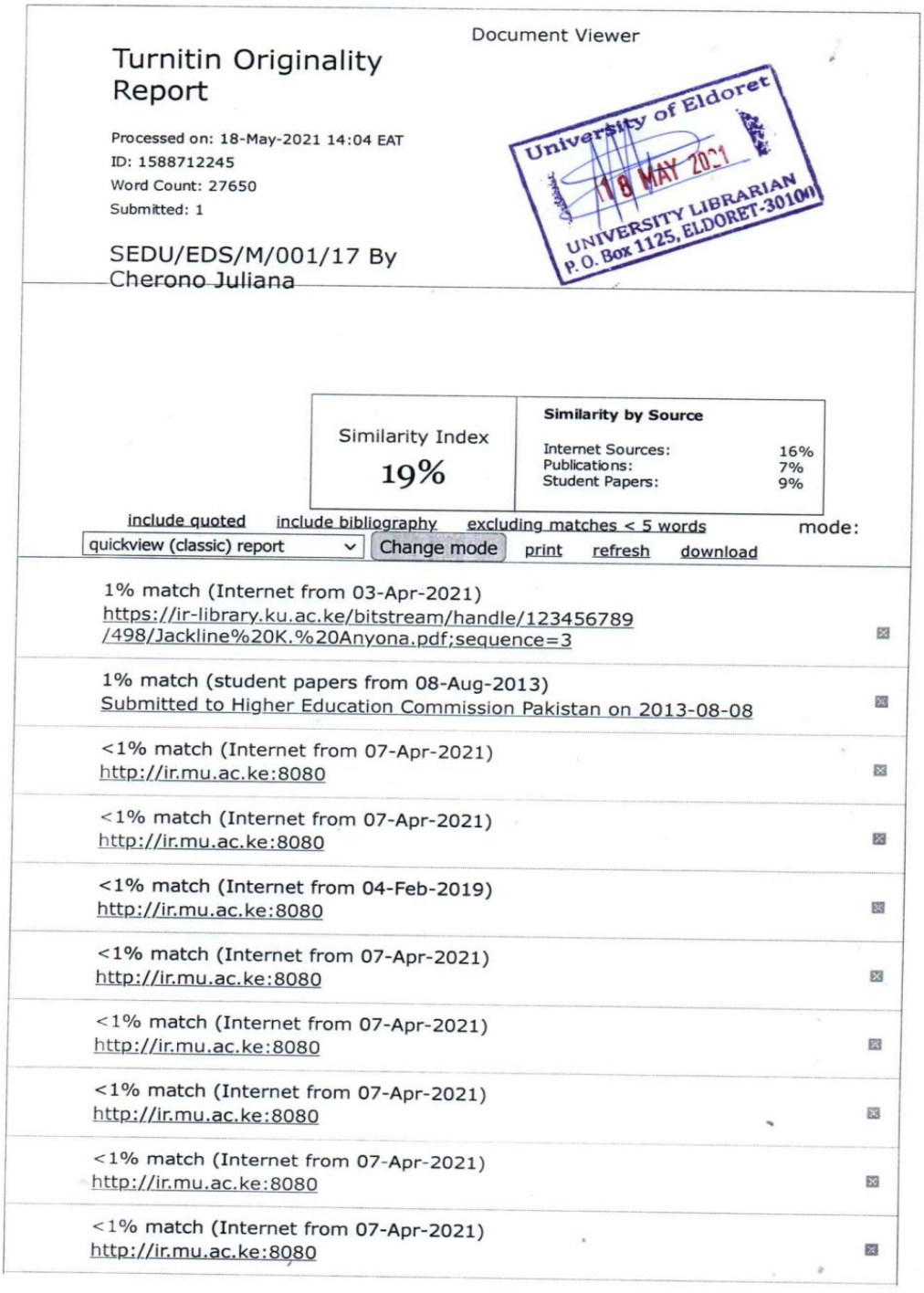


(Source: Kenya Counties maps 2013)

APPENDIX XIII: MAP SHOWING CHESUMEI SUB-COUNTY



APPENDIX IX: SIMILARITY REPORT



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