# FFECTS OF ADVANCE ORGANIZERS ON STUDENTS' ACHIEVEMENT AND ATTITUDE TOWARDS LEARNING BIOLOGY IN SECONDARY SCHOOLS IN KILIFI COUNTY, KENYA

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**A thesis submitted to the Graduate School in partial fulfillment for the requirements of the Master of Education Degree in Science Education of Egerton University.**

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## DECLARATION AND RECOMMENDATION

### Declaration

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

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### Recommendation

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## DEDICATION

This thesis is dedicated to my dear wife Lucy, our son Dylan and my parents William and Rose.

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## ABSTRACT

Biology is one of the science subjects taught in Kenyan secondary schools. It provides a foundation subjectfor the health sciences, agriculture, biotechnology and environmental science. However, secondary school students in Kenya have continued to perform poorly in Biology in the KCSE national examination. This is an indication that most students do not acquire requisite knowledge and skills during Biology lessons. This is partly attributed to the instructional approaches used. The purpose of this study was to investigate the effects of using advance organizers on students' achievement and attitudes towards the learning of Biology in secondary schools in Kilifi County. Solomon Four, Non-Equivalent control group design was used in this study. The study targeted all secondary school students in 249 secondary schools in Kilifi County. The accessible population consisted of all form two students in Kilifi County. Sample size comprised 156 form two students from four co-educational secondary schools in Kilifi County. Purposive sampling technique was used to select four co-educational secondary schools. The four schools were randomly assigned to experimental groups (E1) and (E2) and control groups C1 and C2. The two experimental groups were taught using advance organizers while the two control groups were taught using conventional teaching methods. The instruments used to collect data were the Biology Achievement Test (BAT) and Students' Attitude Questionnaire (SAQ). The instruments were validated by five experts in science education from Egerton University. The reliability of section A and B of BAT were estimated using Kuder-Richardson 20 (K-R 20) and Cronbach's alpha coefficient respectively. They yielded a coefficient of 0.82 and 0.79 respectively. Reliability of SAQ was estimated using Cronbach's alpha coefficient and yielded a coefficient of 0.74. Thus the instruments used had a reliability coefficient above 0.70 which is the acceptable threshhold. The data collected was analyzed using descriptive statistics, One way Analysis of Variance (ANOVA) and t–test. The findings of this study show that learners taught using advance organizers performed better than those taught using conventional teaching methods. The findings also indicate that the use of advance organizers improves students' attitude towards learning Biology. It was also observed that Advance Organizers reduce gender differences in achievement and also enhances gender parity in attitude towards Biology. It is, therefore, recommended that the use of Advance Organizers be integrated in the teaching of Biology and other science subjects in secondary schools.

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## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **ADEA** | Association for Development of Education in Africa |
| **ANOVA** | Analysis of Variance |
| **ASEI** | Activity Students Experiment and Improvisation |
| **BAT** | Biology Achievement Test |
| **CEMASTEA** | Centre for Mathematics, Sciences and Technology Education in Africa |
| **CIEM** | Curriculum, Instruction and Educational Management (of Egerton University) |
| **DEO** | District Education Officer |
| **FAWE** | Forum for African Women Educationists |
| **GoK** | Government of Kenya |
| **JICA** | Japan International Cooperation |
| **KCPE** | Kenya Certificate of Primary Education |
| **KCSE** | Kenya Certificate of Secondary Education |
| **KICD** | Kenya Institute of Curriculum Development |
| **KIE** | Kenya Institute of Education |
| **KLB** | Kenya Literature Bureau |
| **KNBS** | Kenya National Bureau of Statistics |
| **KNEC** | Kenya National Examinations Council |
| **MOEST** | Ministry of Education, Science and Technology |
| **NACOSTI** | National Commission for Science, Technology and Innovation |
| **NAS** | National Academy of Sciences |
| **NCCA** | National Council for Curriculum Assessment |
| **NCST** | National Council on Science and Technology |
| **NETnet** | North East Texas Network Consortium Coordinating Office |
| **OECD** | Organization for Economic Cooperation and Development |
| **PDSI** | Plan, Do, See and Improve |
| **RoK** | Republic of Kenya |

**SAQ** Student Attitude Questionnaire

**SMASE** Strengthening of Mathematics and Science Education

**SMASSE** Strengthening of Mathematics and Science in Secondary Education

**SPSS** Statistical Package for Social Sciences

**STI** Science, Technology and Innovation

**STEM** Science, Technology, Engineering and Mathematics

**TSC** Teachers' Service Commission

**UNESCO** United Nations Educational, Scientific and Cultural Organization

**WHO** World Health Organization

# CHAPTER ONE
# INTRODUCTION

## 1.1 Background Information

Science aims at equipping learners with knowledge, attitude and skills necessary for population control, controlling and preserving the environment (United Nations Educational, Scientific and Cultural Organization [UNESCO], 1986). UNESCO (2017) argues that science should equip learners with knowledge, attitude and skills that would ensure sustainable societies. According to the Republic of Kenya (RoK, 2012a), courses like medicine require strong background in Biology. Emerging issues such as HIV/Aids, drug abuse and environmental pollution which have an impact on human lives have been incorporated in Biology (Kenya Literature Bureau [KLB], 2012). Biology provides knowledge which helps in optimization of sustainable use of natural and environmental resources (RoK, 2013). RoK further opines that Biology forms the foundation upon which a country's leadership in innovation and economic prominence rests. Biology enables human beings to demonstrate resourcefulness, relevant technical skills and scientific thinking necessary for economic development (Kenya Institute of Education [KIE], 2006). Biology also enables one to acquire agricultural skills, animal breeding and horticultural skills which can improve the economic situation of any country. Maundu, Sambili and Muthwii (1998), argue that if knowledge of Biology is applied well, then it can improve the welfare of humans.

Scientific skills gained from learning Biology are vital for economic growth in any society. Apart from inculcating environmental conservation skills, it also enables learners to acquire problem solving skills, interpersonal skills, project and time management skills and sharpening of one's scientific thinking (KIE, 2006). Biology as a science is, therefore, an important subject that would contribute towards the realization of Kenya's vision 2030. Thus, Biology has a role to play in contributing towards the country's social economic development. Developments in science and technology form the basis of national development (Keraro, 2002). Science is the avenue through which self-sustaining skills can be imparted to students in schools (RoK, 2012a). Ndirangu (2002), argues that industrialization is a pipe dream unless a solid foundation is laid in science and technology. For Kenya to realize her vision 2030, the country must adopt a better science, technology and innovation (STI) dissemination strategy (Republic of Kenya [RoK], 2012b).

Biological knowledge can be used to find solutions to four key societal needs: sustainable food production, ecosystem restoration, optimized biofuel production and improvement in human health (The National Academy of Sciences [NAS], 2009). According to Japan International Cooperation (JICA, 2012) environmental issues such as water and air pollution, and inappropriate disposal of waste is a concern throughout the world. This threatens the health of humans and other wildlife, and inhibits the sound development of economic activities. According to Kenya Medical Research Institute (KEMRI), (2014) malaria is the top killer disease in Kenya, as there were more than 46,000 malarial related deaths in the year 2013. Malaria is followed by Pneumonia. Most of the diseases encountered in Kenyan health facilities are preventable at household and community levels, if the public is well informed on the preventive measures (RoK, 2012c). According to the Ministry of Devolution and Planning (2013), there was a decline in the production of horticultural crops, tea and pyrethrum in Kenya in 2012. This decline would not persist had farmers applied relevant biological knowledge and skills.

Despite the benefits that accrue from studying Biology, students in Kenyan secondary schools have continued to perform dismally at Kenya Certificate of Secondary Education (KCSE) Examination (RoK, 2012a). Performance of Biology at KCSE examinations from 2011 to 2018 is shown in Table 1.

**Table 1:**
**Candidates' National Performance in Biology in KCSE from 2010 to 2018**

| **Year** | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|
| **KCSE Percentage Mean Scores** | 32.44 | 26.21 | 31.63 | 31.83 | 34.80 | 23.78 | 18.93 | 18.24 |

**Source: Kenya National Examination Council (KNEC) KCSE Annual Reports 2011, 2012, 2013, 2014, 2015, 2016, 2017 & 2018**

Table 1 shows that the highest Biology mean score at KCSE level was 34.80 in 2015.
This mean score is a D plus grade which is very low compared to the best grade which is A. Table 1 shows fluctuations in KCSE Biology performance at national level and drops to lowest mean at 18.99. It is evident that overall performance has been low. KNEC reports also indicate that students could not give correct answers for questions requiring knowledge on biological processes. This poor achievement can be attributed to inappropriate teaching

strategies, abstractness of science and lack of enough teaching-learning resources (Keraro, Okere & Anditi, 2013). For Kenya to attain vision 2030, the secondary education system must produce individuals who are innovative. This poor performance in Biology is also exhibited in Kilifi County. KCSE mean performance index for Kilifi County for the period 2011 -2018 has been summarized in Table 2.

**Table 2:**
**A Summary of KCSE Biology Performance in Kilifi County**

| **Year** | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|
| **KCSE Biology Performance in Kilifi County** | 26.01 | 23.35 | 29.73 | 29.48 | 32.17 | 27.23 | 26.92 | 25.74 |

**Source: County Director Ministry of Education Kilifi County 2016, 2017 & 2018**

Table 2 shows fluctuations in KCSE Biology performance in Kilifi County. It indicates that percentage mean score in Kilifi in Biology is below the national mean score. The Biology mean grade in Kilifi County from 2011 to 2018 is a D plain grade. The highest mean score is 32.17 recorded in 2015. This is still way below the maximum score of 100 marks. The lowest mean score was 23.35 recorded in 2012. The report from the county education office indicates an overall low performance. Kenya National Examinations Council (KNEC) (2013), points out that the 2012 Biology candidates performed poorly in questions involving biological processes and application of knowledge compared to those that required factual knowledge. Rotich and Mutisya (2013), contend that the persistent state of low academic performance in national examination in sciences has been a major concern to all stakeholders.

According to GoK (2005), academic achievement in Kenyan secondary schools has been characterized by poor performance in national examinations especially in sciences. This poor performance in Biology is also exhibited by other African countries (Trends in International Mathematics, and Science Study [TIMSS], 2011). Low grades in Biology are interpreted to mean that students have not mastered the subject (Heneveld & Craig, 1996; World Bank, 2004). This poor performance prompted investigation of an alternative teaching method other than conventional methods which are widely practiced in Kenyan secondary schools.

According to Republic of Kenya (2009) Secondary schools in Kilifi County have been performing poorly in science based subjects at KCSE due to poor attitude towards science,

inadequate science facilities and inadequate number of Biology teachers in schools. Attitude influences students' performance. A positive correlation exists between students' attitude and academic achievement (Zimmerman, Bandura & Martinez, 1992). The quality of teaching shapes students' attitude towards learning a subject. The decision to continue studying Biology is highly dependent on the pupils' learning experience in class.

Oh and Yager (2004) argue that students' negative attitude towards science are related to conventional teaching methods employed in science instruction. They further point out that students' positive feelings are associated with methods which engage them. Girls' participation and achievement in Biology in Kenya is below average (Forum for African Women Educationalists [FAWE], 2007; UNESCO, 2018). FAWE (2009) points out that poor achievement among female students is attributed to a combination of factors; including cultural practices, attitude and teaching methods which do not take into account individual needs of the girls. Gender disparity in Biology achievement and attitude also exists. Males attain higher scores in sciences than females at KCSE level (KNEC, 2016).

**Table 3:**
**Overall candidates' KCSE Biology Mean Score by gender from 2010-2017**

| Gender | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|
| Female | 27.0 | 30.1 | 24.36 | 30.15 | 29.84 | 32.87 | 28.31 | 17.98 |
| Male | 31.2 | 34.5 | 27.86 | 32.99 | 33.71 | 34.80 | 30.07 | 19.91 |

**Source: KNEC 2011, 2012, 2013, 2014, 2015, 2016, 2017 & 2018**

Table 3 shows that performance of boys at KCSE level is better than that of girls. In 2010 and 2012, girls scored a mean grade of D (between a score of 25-29 percentage score) which is far much lower than the maximum score which is 100 marks. At no time within the same period have girls performed better than, or at par with boys.

Karlinger (1970) contends that attitude is related to feeling, perceiving and behaving toward a cognitive object. Attitudes associated with science affect students' participation in science subjects (Linn, 1992). Attitude towards science also affects achievement (George, 2000). Studies have shown that nearly fifty percent of secondary students lose interest in science (Weinburgh, 1998). Participation in science has also been affected, as the number of students preparing for science related careers is on the decline (Chapman, 1997). Otieno (2017)

concurs that one in four university graduates from 2012 to 2015 studied STEM courses. Studies have shown that there is a significant drop in students' interest in science subjects (Ciomos, 2010). Gender differences in Biology achievement at KCSE as shown in Table 3 could as well be attributed to gender disparity in attitude towards Biology. Gender differences in students' attitude towards Biology and other science subjects also exists at higher levels of education (CEMASTEA, 2017). UNESCO (2017) argues that gender differences in Science, Technology, Engineering and Mathematics (STEM) education and participation become visible at secondary school level.

Teachers may have contributed to poor performance in Biology at Kenya Certificate of Secondary Education (KCSE) Examination (RoK, 2005). According to GoK, although majority of the teachers are graduates or approved teachers, they lack adequate pedagogical skills to effectively teach Biology. Most of the teaching approaches used in Kenyan schools are mainly expository and fact oriented. The approaches encourage students to be passive learners during the teaching and learning process (Kiboss, 1997). The main learning activities are reading from the textbook or copying from the chalkboard and often, students may be asked to answer a few stereotyped questions posed by teachers (Kiboss, 2000). Challenges which negatively affect the performance of science subjects in Kenya include teaching methodologies, inadequate mastery of content on the part of teachers and poor attitude on both students and teachers (Association for Development of Education in Africa [ADEA], 2008).

The teaching strategies employed currently do not help the learners to answer questions which approach the curriculum topics from various angles and perspectives (KNEC, 2018). The teaching strategies used in most Kenyan secondary schools are expository because most schools do not have science laboratories and those that have, are inadequately equipped and in most cases poorly maintained (CEMASTEA, 2017; Tsuma, 1998). Poor school infrastructure have impacted negatively on teaching and learning of Biology. CEMASTEA further points out that the pathetic state of Kenyan secondary school laboratories do not allow active involvement of learners leading to poor performance in Biology. The poor teaching methods have prompted some teachers to take textbooks and past examination papers as the major source of guidance for what should be taught in the classroom (Changeiywo, 2000; Kiboss, 1997).

According to the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) (2010) a situational analysis carried out in 2009 in a bid to monitor the implementation of Activity Students Experiment and Improvisation (ASEI) - Plan, Do, See and Improve (PDSI) paradigm and discovered that the approach was not well entrenched in most Kenyan secondary schools. Rotich (2013), points out that ASEI is concerned with a shift from chalk and talk to students' oriented learning with focus on meaningful activities. Rotich further argues that PDSI targets teachers and lays emphasis on early planning of lessons, ensuring that the lesson is conducted effectively and making the necessary improvements during or after the lesson. CEMASTEA (2009) observed that despite the fact that most teachers had by then undergone four SMASSE basic cycles of INSET, their teaching was seen to be still teacher centered. Teachers engage the conventional teaching method simply because in most cases they do not prepare early enough for lessons. According to CEMASTEA, most students did not like learning science because of the methodology used for instruction. Students claimed that they are only motivated to study Biology because of careers attached to it (CEMASTEA, 2010). This could have resulted into students developing negative attitudes towards the subject. Negative attitude contributes to low achievement in both internal and national exams.

According to CEMASTEA (2010), 55.5% of lessons did not have apparatus distributed early only 22.2% of the lessons had apparatus arranged. From the situational analysis it was observed that 63.8% of the lessons had no experiments while only 36.2% involved experiments. All these factors have contributed to poor performance in Biology at KCSE nationally and Kilifi County is not an exception. These factors could also have contributed to students developing negative attitude towards Biology.

For Kenya to realize her vision 2030, the education system should provide knowledge, skills, competencies and values that enable learners to move seamlessly into the world of work ,with further academic, technical and vocational education adding to what has been acquired through the education system (Ministry of Education, Science and Technology [MOEST], Sessional paper no.10 July 2012). According to Republic of Kenya (2012b), realization of vision 2030 calls for more training in science and technology related courses. UNESCO (2017) argues that performance in STEM subjects can be improved by a more engaging instructional approach. KNEC (2018) contends that suitable pedagogical practices ought to be adopted to enhance retention.

Advance organizers is a strategy that would improve students' achievement. Advance organizers are instructional tools that enable learners' to connect new information to already known material and also construct their own ideas. Mayer (2010) contends that advance organizers are presented material that introduce learners to what they will be learning thus allowing them to utilize the relevant prior knowledge. An advance organizer is an organizational frame work that teachers present to students prior to teaching new content to prepare them for what they are about to learn (Githua & Nyabwa, 2008). Advance organizers are given at the beginning of a lesson to unfold and reinforce or direct students thinking (Eggen, Kauchak & Harder, 1979). Ausubel (1967) argues that advance organizers presented at the beginning of a lesson act as a link between material to be learned and the learner's cognitive structure. Advance organizers act as a roadmap that guides a student over the new content to be learned (Eggen et al., 1979). These tools help a learner to determine the relationship between new ideas and old ideas themselves.

Ausubel (1968) argues that advance organizers are relevant introductory materials presented in advance in any format of text, graphics or hypermedia. Advance organizers are organizational cues, tools that help connect the known to the unknown, a framework for helping students understand what they will be learning (Northeast Texas Network Consortium Coordinating Office [NETnet], 2002). According to Chiang (2005), research in cognitive psychology has revealed that learning will be easier when information is coded by using both visual and verbal codes. Advance organizers entail the use of a small amount of verbal, visual or graphic written information that is presented to learners in advance of new material that is to be learned within an instructional session (Leifrancois, 1997).

Ausubel (1969) argued that by providing students with deliberately prepared, slightly abstract passages in advance of the main material to be learned, student learning of subsequent material was facilitated. In order for the acquisition of new knowledge to take place and to be meaningful, prior knowledge or schema needed to be activated within these structures by means of an introduction to instruction (Ausubel, 1978; Ivie, 1998; Joyce & Weil, 1986; Kalmes, 2005; Postrech, 2002).

Chuang and Liu (2014) argue that with the emergence of multimedia technology, multimedia have served as supportive instructional interventional components in multimedia learning environment, new and different forms of information are available for use as advance organizers.This study focused on the use of advance organizer in teaching gaseous exchange.

The topic gaseous exchange was chosen because most candidates were not able to respond satisfactorily to questions on gaseous exchange in 2012 KCSE Biology examination (KNEC, 2013). There are two kinds of Advance Organizers. Expository Advance Organizers which are useful when learners have no knowledge of what is going to be taught (Ausubel, 1968). This kind of Advance organizer could be a brief description of content to be taught. Learners require scaffolding to link new concepts to what they already know. Comparative Advance Organizers are useful when learners have existing knowledge similar to information being presented. This kind of organizers enable learners to compare existing knowledge with new knowledge. Expository advance organizers are used whenever the new material is totally unfamiliar while Comparative organizers are used when the material to be learned is not entirely new (Bajt, 2004; Keraro & Shihusa, 2008). Ausubel (2000) argues that comparative advance organizers are used on relatively familiar learning materials to integrate as well as discriminate between new ideas and existing ideas. Expository and comparative advance organizers will be used to teach gaseous exchange. In this study, a combination of charts, pamphlets and visual presentations were used as Advance Organizers. Advance organizers should present key terms, illustrations or models. Advance organizers are suitable for learners with different abilities (Ausubel, 1978). Advance organizers are efficient instructional tools since learners are able to know beforehand what is going to be learned (Eggen et al., 1979). Advance organizers are especially useful when the material is not well organized and learners lack knowledge needed to be able to organize it well for themselves.

### 1.2 Statement of the Problem

Biology is a science subject that requires a lot of attention for Kenya to realize her Vision 2030. Biology achievement in Kenyan secondary schools has been poor despite the various methods employed in teaching and learning of the subject. The poor performance of students in Biology is blamed on teaching approaches used by teachers. Since attitude is directly linked to performance, students' attitude towards the subject has also been negative. Most students find it difficult to apply skills learned. One of the strategies that could improve students' achievement and attitude in Biology is the use of Advance Organizers. Male students have continued to perform better than their female counterparts in KCSE examinations. Male students have also exhibited positive attitude towards learning Biology, unlike the female students. The use Advance Organizers could help restore gender parity in students' achievement and attitude towards learning Biology. However, few studies have been conducted to document the effectiveness of using advance organizers in the teaching

and learning of Biology in Kilifi County. Therefore, insufficient information is available on the effects of advance organizers on students' achievement and attitude towards learning Biology. This study, therefore, intended to fill the gap by using advance organizers in teaching Biology to form two students in Kilifi County as an intervention and determining its effects on student's achievement and attitude.

### 1.3 Purpose of the Study

The purpose of this study was to determine the effects of advance organizers on students' achievement and attitude towards learning Biology in secondary schools in Kilifi County, Kenya. This study also sought to establish whether gender differences in achievement and attitude towards Biology exist when students are taught using Advance Organizers.

### 1.4 Objectives of the Study

The study was guided by the following objectives. To:

(i) Determine the effects of advance organizers on students' achievement in learning Biology.

(ii) Find out the effects of advance organizers on students' attitude towards learning Biology.

(iii) Determine whether there is any gender difference in achievement in Biology when students are taught using advance organizers.

(iv) Find out if there is any gender difference in attitude towards learning Biology when students are taught using advance organizers.

### 1.5 Hypotheses of the Study

$H_0$1 There is no statistically significant difference in achievement between students taught using advance organizers and those taught using conventional teaching methods.

H02 There is no statistically significant difference in attitude towards learning Biology between students' taught using advance organizers and those taught using conventional teaching methods.

H03 There is no statistically significant gender difference in achievement in Biology when students are taught using advance organizers

H04 There is no statistically significant gender difference in attitude towards learning Biology when students' are taught using advance organizers.

## 1.6 Significance of the Study

The findings of this study are beneficial to curriculum developers and curriculum implementers involved with students' learning of biological concepts. The findings of this study further provide useful information to lecturers of teacher education programs on the use of advance organizers so that they can train teachers on the best method of handling the subject. The findings would help teachers to choose teaching methods which will contribute ways of improving students' attitude towards learning Biology. Heads of departments and teachers would benefit from the suggestions in deciding appropriate teaching strategies which would improve students' achievement towards learning Biology. Improved achievement in Biology implies sustainable use of natural and environmental resources by the populace. The findings would help Biology teachers to evaluate their methods of teaching Biology in order to improve students' attitude and achievement. This study provides information which could help MOEST and National Commission for Science, Technology and Innovation (NACOSTI) formulate future science education policies aimed at enhancing students' achievement and attitude. NACOSTI is an agency within MOEST which promotes the adoption and application of scientific and technological knowledge necessary in attaining national development goals. This study came up with findings which would provide useful information to prospective authors in the field of education to incorporate the use of advance organizers during learning in their publications. The findings of this study would provide useful information to SMASSE facilitators and KICD so as to design in-service training, workshops and seminars for teachers on the best way of teaching Biology.

## 1.7 Scope of the Study

This study focused on the topic gaseous exchange which is taught at form two level in Kenyan secondary education system (KIE, 2000). Gaseous exchange was chosen because it was considered difficult by students (KNEC 2015). Co-educational secondary schools in the county were selected to enable determination of gender differences in achievement and attitude. During the study, Kenya Institute of Curriculum Development (KICD) Biology syllabus for secondary schools was used as a guide for preparation of the teaching content, advance organizers module and advance organizers. This study involved the use of charts, concept maps and computer simulations as Advance Organizers. This study focused on the effects of advance organizers on students' achievement and attitude. This study focused on co-educational secondary schools in Kilifi County.

### 1.8 Limitations of the Study

Limitations of this study included:

i) This study could have been of great benefit had it involved a wider population, but because of the design only four sample schools were used. Because of this, the findings of this study were only generalized with caution to secondary schools in Kilifi County.

ii) The students involved in the study could not be randomly assigned to the four groups as school authorities do not permit reorganization of intact classes for research purposes once they are constituted. Hence, for schools with more than one stream, all the streams were subjected to the same treatment. However, for data analysis one stream was randomly chosen.

iii) Only co-educational schools were involved in the study and therefore, findings were limited to secondary schools with the same characteristics

### 1.9 Assumptions of the Study

In this study, the following assumptions were made:

i. Respondents gave honest responses in SAQ and BAT.

ii. Advance organizers have not been used in the teaching of Biology in secondary school in Kilifi County.

## 1.10 Operational Definition of Terms

The following are definition of terms according to their applications in this study:

**Achievement**: Successful accomplishment or completion (Collins dictionary.com, January 3, 2015. In this study, it means the score obtained by students in the Biology Achievement Test. Achievement also means performance.

**Advance Organizers:** These are verbal or visual information provided to learners before Teaching (Ausubel (1968). In this study, it means charts, pamphlets and computer simulation presented to students before the actual teaching to enable them integrate new information with existing knowledge, leading to meaningful learning.

**Assimilation:** This refers to the process of becoming a part or making someone become a part of a group, country and society (Cambridge dictionary.com. January 3, 2015). In this study, it means the process where learners fit knowledge of the world around into their existing understanding and experience.

**Attitude:** This refers to a mental and emotional entity that characterizes a person (Lovell, 1973). In this study, attitude is a mental and neutral state of readiness, organized through experience, exerting a directive and dynamic influence upon the individual's response to all objects and situations with which it is related.

**Co-educational Secondary School:** In this study, it refers to secondary schools in which boys and girls learn together.

**Concept Mapping:** In this study, it refers to the use graphical tools for organizing and representing knowledge in two dimensions.

**Conventional Teaching Method:** These are teaching and learning methods where knowledge is transmitted to passive learners (Kiruhi et al, 2009). In this study, it means the ordinary teaching and learning method. It also refers to lecture method, demonstration, field trip, project method and class discussion that have been widely practiced in Kenyan secondary schools.

**Effects:** A change which is a result of an action (Oxford dictionary). In this study it implies a change in behavior as a result of intervention.

**Gender.** It is a result of socially constructed ideas about the behaviour, actions and roles of a particular sex perform this is as a result of socially constructed ideas about a behavior, actions and roles a particular sex performs (World Health Organization [WHO],2012). In this study, it means the state of being male or female

**Instructional Approach:** In this study, it means a particular style of carrying out some activities through application of certain methods for purposes of imparting knowledge and skills to students (Nasibi,2003). In this study, it implies the student-student, teacher-student interaction during the teaching and learning process.

**Schema :** This is a drawing that represents an idea or theory and makes it easier to understand (Cambridge dictionary.com. January 3, 2015). In this study, it means the basic building block of intelligent behaviour.

**Subsumption:** Incorporating something under a more general category (Free dictionary.com January, 2015). In this study, it means the incorporation of new material into the existing cognitive structures.

**Teaching Method:** This means set procedures of teaching which tend to promote specific strategies of teaching (Kiruhi et al, 2009). In this study, it means the use of lecture method, discussion, practical work, field work and project work to impart knowledge and skills to students.

**Teaching Strategy:** it means a way of organizing and facilitating learning experiences (Nasibi, 2003). In this study, it means ways in which content to be learnt are organized and presented to promote learning.

**Performance:** it is the same as achievement.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.1 Introduction

This chapter reviews literature related to justification for Biology in the school curriculum and teaching methods in teaching Biology in Kenyan secondary schools. Biology achievement in Kenyan secondary schools, gender difference in Biology achievement and the use of advance organizers in a classroom situation are also explained. Theoretical bases of advance organizers are also explained. Theoretical and conceptual frameworks used for this study are also outlined.

## 2.2 Justification for Biology in Kenyan Secondary School Curriculum

The inclusion of Biology in the secondary school curriculum is aimed at enabling learners to understand and deal with problems of self, environment and the future (Republic of Kenya, 2012). Biological knowledge has made a lot of contribution in the industrial sector especially in beer brewing, mining, milk processing, bread baking as well as waste disposal processes (Namasaka, 2009). National Council for Curriculum Assessment (NCCA, 2001) points out that the Biology curriculum enables students to acquire manual manipulation skills and cognitive skills. NCCA contends that Biology also makes the students to apply biological knowledge in environmental, industrial, medical, waste management and other technological fields. NCCA further points out that a Biology curriculum should enable learners to appreciate nature and diversity of living organism. Biology should enable learners to communicate biological information in precise, clear and logical manner and develop an understanding of interrelationship between plants and animals. It also should enable learners to apply the knowledge gained to improve and maintain the health of an individual, family and community.

Biology also should enable learners to demonstrate: resourcefulness, relevant technical skills and scientific thinking necessary for economic development (KIE, 2006). Biological knowledge has been applied in the health sector to improve lives of human beings, produce vaccines, carry out organ transplants and to produce antibiotics. Knowledge gained from studying Biology has been applied in genetic engineering and plant and animal breeding to introduce high yielding, drought resistant and pest resistant genes to plants and animals (National Academy of Sciences [NAS], 2009). Brown (1995), argues that biological

knowledge is also applied in population control and forensic science. Biology education offers the learners a wide range of relevance to all aspects of life (Araoye, 2009).

## 2.3 Teaching Methods Used in Teaching and Learning of Biology in Kenya

These are methods used in presenting the subject matter with an aim of achieving different specific objectives (KIE, 2006). Methods of teaching refer to the processes or set procedures of teaching which tend to promote specific strategies of teaching (Kiruhi, Githua & Mboroki, 2009). They argue that each strategy of teaching is associated with particular methods of teaching that promotes a particular strategy. Various teaching methods can be used in teaching Biology namely:

### 2.3.1 Practical Work

Practical work involves engaging students in laboratory experiments. It enables the learners to develop manipulation, measuring, observation, recording, analyzing and interpretation skills (KIE, 2006). However, it has a number of limitations. Okere (1996), argues that it is improper for example to tell pupils to go the laboratory to verify laws which have already been stated in class by teachers, as this will inhibit their curiosity and creativity. Nasibi (2003), argues that practical work is costly in time and effort and that when pupils reach erroneous conclusion, re-teaching may be more difficult. Teachers also find it difficult to develop uniform, fair and reliable assessment rubrics to evaluate students' practical skills. A teacher covers small number of topics over a long period of time. Some experiments are dangerous and, therefore, there is the possibility of students being exposed to danger. This method may not achieve learning objectives especially if apparatus are inadequate

### 2.3.2 Class Discussion

This is a method of teaching where learners contribute ideas during their learning. Okere (1996) contends that discussion encourages good listening, broadens pupils' minds and also provides a cooperative means of bringing together facts so that conclusions can be drawn. For this method to be effective, all students should be encouraged to contribute ideas. Discussion method has a challenge of ensuring participation by all students. This method enhances acquisition of communication skills, but at the same time can be detrimental to those students who are always shy to take part in discussion. There is always the danger of either teachers or some students dominating the discussion sessions. This method is not appropriate for all topics, it can only be used to students who have basic knowledge in a topic. Discussion method requires the teachers' presence at all sessions to act as facilitators and resource

persons. Discussion in groups may not have much value unless it is followed by presentation report (Cheloti, 1996). This teaching method also requires skill to tactfully redirect learners who dominate without losing their trust and that of other group members. This method is time consuming and therefore, less content can be covered. Students are usually uncomfortable with the discussion method and, therefore, a number of different methods must be used to encourage students to trust their own opinions (Sola & Ojo, 2007).

### 2.3.3 Demonstration

Demonstration is used to show something works through accurate procedures and operations; and is always accompanied by explanation (Fenton, 1967). Okere (1996), argues that this is the method used by majority of science teachers in Africa due to lack of enough equipment and apparatus. Demonstration is a method that can be used to explain biological concepts and can be used for a whole class or part of the class depending on class size and number of the equipment and specimens (KIE, 2006). KIE points out that demonstration enables learners to acquire observation, recording and manipulation skills. Demonstration method is a suitable method especially when the apparatus to be used are explosives, poisonous and dangerous (Nasibi, 2003). Demonstration method has a number of limitations. According to Kiruhi, Githua and Mboroki (2009), demonstration method is not a suitable method of teaching higher level cognitive abilities because the learners are not involved in the actual investigation. Kiruhi et al. (2009) argue that during demonstration lessons students are required to make observations, pupils' involvement is low and it is weak in achieving higher cognitive and affective objectives. They further contend that the pace of this method is controlled by the teacher and it is also not suitable for achieving psychomotor objectives. Maundu, Sambili and Muthwii (1998) argue that demonstration like lecture method has an element of passive learning and some students may not observe all the necessary details. This method is not appropriate for a large group of learners. Demonstration is, therefore, not a suitable method for teaching Biology as it does not enhance interpersonal and communication skills.

### 2.3.4 Field Trip

KIE (2006), points out that field trips are planned learning activities usually carried out outside the classroom to a particular area. Field trips have their advantages, but at the same time have a number of shortcomings. Nasibi (2003), contends that field trips make instruction vivid and real, arouse curiosity among learners and develop skills of analyzing and interpreting data. Field trip involves taking a group of students to a specific place for a

specific purpose. The purpose may be to observe a situation or some practices (Okere, 1996). If not planned well initially, field trips may not be productive. Field trips require a lot of planning; are time consuming, and are very expensive (Kiruhi, Githua & Mboroki, 2009). They further argue that the safety of the learner during the trip may not be guaranteed, learners are likely to shift focus away from the objectives and the focus of the learners on the objectives of the trip may not be guaranteed.

### 2.3.5 Project Method

Project work is an activity in which learners carry out their own research and present the results (KIE, 2006). This is a teaching method which allows learners to work on real life problems through project work which brings them into contact with the environment. According to Okere (1996), project method enables the learners to interact with the environment and arouses curiosity among the learners. Project work is any activity, individual or group, involving the investigation and solution of problems that is planned and carried to conclusion by a student or students under the guidance of the teacher (Callahan & Clark, 1990). According to Nasibi (2003), project method has the following limitations: requires a lot of planning and if not planned well initially, it may lose sight and vision and utilize that time to enjoy themselves or engage in other unproductive activities; this method is also expensive in terms of time and finances; learners may not comprehend what they are doing and grades given to learners do not always reflect the actual performance.

### 2.3.6 Lecture Method

This is an oral presentation intended to present information about particular subject. Lecture method involves the teachers standing in front of the classroom to recite information relevant to the lecture content. Nasibi (2003), points out that lecture method leads to the development of listening skills and it is also economical in terms of staff and time because limited personnel can be used to address many students. According to Kiruhi, Githua and Mboroki (2009), it is a deductive method of teaching in which the active teacher communicates information to a more passive learner who listens and makes notes.

This method restricts pupils to be passive listeners unless they are asked questions (Okere, 1996). Kiruhi et al. (2009) further point out the following as some of the limitations of lecture methods: students are not given opportunity to ask questions and it is also highly dependent on the skills of the teacher; lecture method does not cater for individual differences; it is not suitable for developing higher cognitive, affective and psychomotor objectives in learners and

is not suitable in enhancing interpersonal and communication skills. Okere argues that while using this method, the teacher is likely to deliver content at a faster speed than the pupils can comprehend since he is at a higher level of knowledge. He further argues that pupils may misunderstand some parts such as technical terms and since students are not actively involved in learning, they are likely to be inattentive. Nasibi and Kiio (1995) argue that this method leads to poor retention of learnt material and rote learning, encouraging cramming.

Various studies have been conducted on conventional teaching methods. A study by Ameu and Dantani (2012) in Nassarawa local government in Nigeria shows that lecture method is ineffective in teaching chemistry. This led to low achievement as compared to those taught using demonstration method. Another study by Stevens Andrew investigated the effects of field work on students' achievement and motivation in science education. A research study by Hafezimoghadam, Farahmand, Farri, Zare and Abbasi (2013) argue that combination of two conventional teaching methods has led to improved students participation during class instruction.

### 2.4 Biology Achievement in Kenyan Secondary Schools

Poor performance in Biology in Kenyan secondary schools has been of great concern (RoK,2012a). Performance of Biology at KCSE level is poor (Ongowo, 2013). A study conducted by Rotich (2012) in Bomet and Mwangi (2014) in Kinangop demonstrated that performance of students in Biology at KCSE level is still below average (50 percent). According to KNEC (2013) performance of Biology at KCSE level is far much below average (50%). Situma and Sawamwa (2010) argue that many students perform poorly in science subjects at KCSE level. Students who score grade A in science in Kenya Certificate of Primary Education [KCPE] examinations end up failing in the same subject at KCSE (The Blackboard, 2000, p 12). Students' achievement in Biology subject in senior secondary schools has been unsatisfactory over the years (Ali, Toriman & Gasim, 2014). National Biology performance at KCSE level has been poor (KNEC, 2016). Biology achievement among Kenyan secondary students at KCSE is low (Republic of Kenya, 2014). This low achievement in Biology prompted MOEST with the support of JICA to initiate SMASSE which emphasized on in-service training for serving teachers with an aim of improving teaching and learning methods (RoK, 2014). RoK further argues that due to dismal performance MOEST and JICA initiated projects of constructing and equipping science laboratories. Keraro, Okere and Anditi (2013) contend that cultural interpretations militate against pupils understanding of biological concepts. This leads to low achievement in

Biology. KNEC (2018) Opines that Biology performance in 2018 KCSE examinations was the lowest.

### 2.4.1 Gender Difference in Biology Achievement

According to Forum for African Women Educationists [FAWE] (1995), most countries in the Sub Saharan region report lower performance for female students in Biology than their male counterparts. FAWE (2009) points out that this situation becomes more pronounced as the level of education increases. FAWE further points out that the myth that boys are more intelligent than boys makes girls feel inferior. In many countries girls have been narrowing the gaps in Biology, but recent evidence from the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) suggest that these differences are persisting (FAWE, 2012). Gender differences in science achievement still exists (Ceci, Ginther, Kahn, & Williams, 2014). Biology is a science subject. Boys generally perform better than girls in sciences (OECD, 2015; Kibet & Kajilwa, 2016)). OECD attributed this to negative self-beliefs or because they are less encouraged by their teachers and parents. A study by Otieno-Alego (1991) on competence of junior secondary pupils on some science process skills, namely, observation, prediction, generalization and control variables showed that boys performed significantly better than girls. A study by Mondoh and Changeiywo (2003) investigated the gender gap in KCSE examination performance and found out that girls perform worse in all subjects to boys. KNEC (2012) contends that girls have continued to perform dismally as compared to boys in Biology. FAWE (1999) contends that Biology achievement for girls in Kenya is lower than that of boys due to their poor attitude towards the subject. Twoli (1986) argues that in most societies girls perform poorly compared to boys in sciences.

UNESCO (2017) argue that while gender differences in Biology achievement appear to have decreased in recent years, they have not been eliminated. This gender differences could be attributed to cultural and gender norms, which influence the way girls and boys are brought up and interact with friends, teachers and societies which shape their beliefs and choices (UNICEF, 2017). Explicit and implicit messages carried out by textbooks and learning materials about the roles of males and females reinforce gender stereotypes and discourage girls from pursuing STEM carriers (UNESCO, 2017). These textbooks fail to show female STEM professionals and if they do, they use images that portrays women in subordinate roles, for example male doctors but female nurses ( Huyer & Westholm, 2007). RoK (2014) argues that in Kenya, girls' performance in Biology is lower than that of boys.

RoK further argue MOEST and JICA focused on developing girls interest in Biology through secondary school competitions and mentorship talks from female scientists that in order to address the overall poor performance of girls in Biology. Male students like science subjects more than their female counterparts (National Center for Education Statistics [NCES], 2015). Male high school graduates had a higher average in 2009 National Assessment of Educational Progress (NAEP) science scale scores than female students in the United States of America (NCES, 2015). NCES further points out that male students post better scores than their female counterparts in the advanced Biology course.

### 2.5 Students' Attitude towards Science Education

Secondary school students in Africa generally have a negative attitude towards science. The negative attitude is attributed to the fact that Africans perceive science as a foreign culture (Aikenhead, 1997). Hendley, Parkinson, Stables and Tanner's (1995) contend that science is the most disliked subject. According to a report by the science and technical committee to House of Commons (2002), United Kingdom (UK) students' interest in school science is declining with an accompanied decline in the number of students taking science. Osborne, Simon and Collins (2003) argue that students' attitude towards science declines from the point of entry to secondary school in UK.

There is decline in attitude towards science education from the age of 11 onwards (Breakwell & Beardsell, 1992). Osborne et al. (2003) argue that there is decline in attitude towards learning science and enrollment in science based careers. According to Hofstein and Mamlok-Naaman (2011), students will not make an effort to learn and understand scientific concepts if they are not interested in science. A study by Akpinar, Yildiz, Tatar and Ergin (2009) demonstrated that students' attitude declined with an increase in grade level. There is a sharp decline in learners' interest towards science education in secondary schools (Southerland, Kittleson, Settlage & Lanier, 2005). According to George (2006) students attitude towards learning science declines as they progress to higher grades. Science is perceived to be a difficult, boring and inaccessible subject (Osborne, Driver & Simons, 1998). It is because of its difficulty that many students do not want to continue studying science (Kind, Jones and Bamby, 2007). According to TIMSS (2011) by the eighth grade very few students like science. Relationship exist between learning environment and students' attitude towards science (Den Brok, Fisher & Richards, 2004). Olatunji and Olusola (2016) argue that negative attitude towards Biology makes further learning difficult. UNESCO (2017) opines that parents' socio-economic status and education levels have direct

effects students' attitude towards science. UNESCO further points out that parents with higher socio-economic status and educational qualifications tend to have more positive attitudes towards science education for their students than parents with lower socio-economic status and education qualifications. OECD (2015) points out that female students' self-confidence towards learning science is lower compared to their male counterparts.

### 2.5.1 Gender Difference in Attitude towards Biology

Kenyan girls are less interested in Biology and other STEM courses (Malit, 2017). Malit further argues that poor attitude among girls can be attributed to the teaching methods teachers employ. Female students do not want to engage in courses with less facilities. Many girls in in Kenyan secondary schools have poor attitude towards Biology (FAWE, 2018). This poor attitude increases as the level of education increases. FAWE points out that poor attitude is attributed to cultural practices. UNESCO (2018) points out that Kenya has shortage of females in Biology and other STEM fields. This due to continued decline and lack of interest among female students towards learning Biology. Students attitude towards learning Biology can be improved by engaging a more learner centered methods of teaching. UNESCO further opines that there is need to build capacity of teachers so as to address various gender barriers that may stand in the way of female students' choices.

## 2.6 Advance Organizers

After his research to promote meaningful learning over rote learning, Ausubel (1960) formulated the subsumption theory. This theory stresses meaningful learning by linking the prior knowledge of students with new information that is presented in the school setting. According to Ausubel, the best way of facilitating retention is to introduce the appropriate subsumers and make them part of a learner's cognitive structure prior to the actual presentation of the learning tasks. The introduced subsumer thus becomes the advance organizers or *anchoring foci* for the reception of new material (Ausubel, 1978). A primary process in learning is subsumption in which new material is related to relevant ideas in the existing cognitive structures (Kearsley, 2000).

Ausubel points out that the most important single factor influencing learning is what the learner already knows. Novak (1977) argues that advance organizers provide a conceptual framework for factual information and that meaningful learning is the formulation of concepts, not the memorization of isolated facts. According to Ausubel (1963), advance organizers are a material that is introduced before unfamiliar content so as to facilitate assimilation. Ausubel further argues that advance organizers, therefore, act as an anchor for

the reception of new content. He points out that potentially meaningful material is learned when it fits into an existing cognitive structure, interacts with established elements of that structure, and is appropriately placed under a relevant and more inclusive concept in that cognitive structure.

Maryam, Moenikia and Zahed-Babelan (2010) argue that advance organizers are effective ways to facilitate the task because they can provide an overview of a new topic and visually represent links between the concepts to be learned. Advance organizers are cognitive bridges, which teachers use to help learners make a link between what they know and what is to be learnt (Novak, 1980; Cliburn 1990). It is, therefore, a tool that can be used to connect what the learners know and what is to be learnt.

Novak further argues that advance organizers may include analogy, metaphor, model, graphics, concept maps, diagrams, pictures as well as hierarchical structures.

Advance organizers act as subsumers of information whereby input can be collected into a more meaningfully and inclusive schema (Ausubel, 1960). He points out that learning and retention of unfamiliar material could be generally facilitated by providing the learner with advance organizers that were more general and inclusive. There are two broad categories of advance organizers namely expository and comparative advance organizers. Kirkman and Shaw (1997) argue that expository advance organizers provide a conceptual frame work for unfamiliar material while comparative organizers are used for recall and when the knowledge to be acquired is familiar. According to Woolfolk, Winnie, Perry and Shapka (2010) expository organizers provide new knowledge that students will need to understand the incoming information.

Melrose (2013) contends that advance organizers such as charts, diagrams or other visual tools created by teachers can be used for organizing and representing consensually validated knowledge into their teaching practice. Ausubel (1968) argues that those organizers which are used in the activation of existing schemas are called comparative organizers. He argues that comparative organizers integrate new ideas with basically similar concepts in cognitive structure. They also act as reminders to bring into the working memory of what you may not realize are relevant. Comparative organizers are those that points out whether already established anchoring ideas are not specifically or specifically relevant to the learning material (Ausubel & Robinson, 1969). Comparative organizers can also help learners

integrate new information and discriminate between ideas. According to Chun and Plass (1996) the use of advance organizers aids in overall comprehension.

Advance organizers can be used as expository organizers which simply describe new content, narrative organizers which presents new information in a story format, skimming material before reading by providing main points and important concepts of a lesson by telling a story that includes these concepts and graphical organizers which present information in the visual realm such as in pictographs, concept patterns and descriptive patterns.

There are a number of ways in which advance organizers can be presented in a classroom. Keraro and Shihusa (2009) argue that they may be productively utilized before instructional activities such as reading or viewing a film, to activate prior knowledge to provide a conceptual framework for integrating new information and encourage students' prediction. Students can be allowed to look through the book to gather information for questions and discussions (Eisenwine, 2000).

Advance organizers help learners who have difficulty identifying important contents to conceptualize most of the content while developing their higher level thinking abilities. This improves students' achievement in test that requires recall of information they have learned (Story, 1998). Fisher, Schumaker and Deschler (1995) argue that even when prior knowledge is present, visually graphic advance organizers can be a benefit to all students in an inclusive classroom, especially those with organizational difficulties. Advance organizers should be straight forward to provide the most effectiveness and clarity (Boyle & Yeager, 1997). If the organizers are not easily understood, their effectiveness will be lost. Concept mapping can still be used as advance organizers. They can be generated and used as advance organizers by the teacher. In this case the teacher constructs a concept map which contains content which is to be covered in the next lesson. When used as advance organizers the visual organization increases the students' ability to link new concepts with prior knowledge; therefore increasing retention and recall (Dye, 2000).

### 2.6.1 Advance Organizers and Students' Learning

Advance organizers increase students' understanding by providing a skeletal map that increases the students' ability to link new concepts with prior knowledge; therefore increasing retention and recall (Dye, 2000; Hassard, 2005; Mosco, 2005). According to Anderson (2004), a student uses prior knowledge of objects and events to make sense of concepts presented in new material and then recall that information. Anderson further argues

that these processes are so natural that normal functional readers are not aware that it is occurring. Baxendell (2003) argues that since the organizer's main purpose is to provide clarity and understanding of new concepts, it is best if they are free of distracting information or visuals. This, however, does not mean that creativity should be sacrificed. Students can illustrate their own organizers with relevant pictures to aid in remembering the information. Labeling of key concepts and listing hierarchical information helps students to organize their thoughts and internalize their new concepts, while activating prior knowledge (Baxendell, 2003). Loyd (1996) argues that when learners refer to previous lessons, asking students to share personal experiences and knowledge with the class, teachers sharing their personal experiences and knowledge with the students, and teachers giving students the information necessary to understand the new concepts by way of direct instruction are some of the ways that stimulate discussions to activate prior knowledge. Advance organizers help students who have a difficulty identifying important contents to concentrate on important concepts and provide a way of thinking that allows them to conceptualize most of the content while developing their higher level thinking abilities.

According to Eggen et al., (1979) advance organizers act as a road map that guides students over the new content to be learned. Advance organizers can also be used in a situation where a teacher provides gapped handouts which leave blanks for students to fill in as the teacher provides instruction, the teacher can choose to leave large spaces for note taking or small gaps where words can be placed (Atherton, 2005). Critics of advance organizers, however, argue that if used in a haphazard way it will leave students more confused than they were before the lesson. Students background, experience and type of advance organizers may hinder the attainment of certain science concepts ( McAdaragh, 1981).

According to Chiu and Lee (2009), a pre-class video viewing of the lecture content and hands on laboratory activities in class enhanced the learning of high-school students' basic image processing. In this study, a well designed computer simulation, a flip chart and pamphlets on gaseous exchange will be used to help relate what they already know and what they do not know. A study by Kang Sook-Hi (1997) found that advance organizers made significant difference in facilitating learning in a computer simulation environment. Computer simulation will provide visual representation of facts. A comparative study by Teichert (1996) on using illustrations, brainstorming and questions as advance organizers in intermediate college German conversation classes found out that the use of advance organizers (with video and audio tapes) developed superior listening skills in German classes.

Pamphlets will act as comparative organizer while computer simulation will act as expository advance organizer.

Computer simulation will show gaseous exchange surfaces, respiratory passages and gaseous exchange across a respiratory surface. Wittich and Schuller (1973) argue that computers are useful in simulations which provide real life experiences that would otherwise be impossible to achieve within the high school classroom.

One great advantage of computers over the other kinds of educational technology is that they can provide a very flexible presentation of materials to learners and keep track of the progress of a number learners at the same time (Bower & Hilgard, 1981). Maryam et al. (2010) contends that visual learning promotes dual coding effect which allows the students to comprehend more information, associate it with other ideas, and incorporate new insights into their prior knowledge. Chuang and Liu (2014) contend that in order to achieve learning objectives, digital age learners are required to process information encoded n different delivery technologies which includes computer screens and screen projections. In simulation lessons, learners must actively engage with material and or practice the desired behaviors in order to reach a goal (Garris, Ahlers & Driskell, 2002).

Studies have been conducted on the effects of advance organizers on students' learning. Studies have shown that advance organizers improve students' achievement (Montanero & Lucero, 2012; Agnihotri & Sharma, 2013; Babu & Reddy, 2013). The findings of the researches have suggested that advance organizers are of considerable value where the learner may not be able to recognize his or her prior knowledge as relevant and where the teacher wishes to focus students' attention on relationships among linked parts of an idea and on connections between parts and the whole (Curzon, 1990). A study by Keraro and Shihusa (2005) demonstrate that advance organizers have positive effects students' motivation in learning Biology.

A study by Ciullo, Falcomata and Sharon (2015) demonstrate that graphic organizers are effective in enhancing learning of social studies in secondary schools for students with learning difficulties in grades 4 and 5. The findings of the study by Willerman and Mac Harg (1992) on the effects of advance organizers on students' conceptualization of pollution in Biology revealed that students' were not passive subjects in the learning process if concept mapping were used as advance organizers. Studies have demonstrated that advance organizers are associated with improved learning (Dexter & Hughes, 2011; Dexter, Park &

Hughes, 2011; Tamir, 1992). A study by Racheal Mshenga (2013) shows that advance organizers have positive effects on students' achievement, perception and attitude towards the learning of narratives in literature in English in secondary schools in Kilifi district.

### 2.6.2 Advance Organizers and Students' Attitude

A study by Walia and Walia (2014) indicate that students taught using integrated syntax of advance organizer model had a higher positive attitude towards mathematics in comparison to those taught by conventional method. A study by Chen (2007) demonstrates that advance organizers have positive effects on students' attitudes. The findings further indicated that the effect was even stronger on weaker students. These findings makes contribution to the literature on teaching strategies that would be used improve students' achievement and attitude. In this study, teachers of the experimental groups 1will be inducted on how to effectively use advance organizers teaching strategy. A study by Safdar, Shah, Rifat, Afzal, Labal, Malik and Wing (2014) on the use of pre-labs as advance organizers show that their use improve students' attitude towards learning of physics which result in high achievement. A study by Siahpoosh, Saeid and Ahangari (2015) demonstrate that advance organizers leads to positive attitude towards listening comprehension. The use of advance organizers makes learners to directly participate in their learning, thus developing interest in the process. Advance organizers enable students to construct their own knowledge and by doing so their interest towards learning Biology is aroused. Engaging instruction improves students' attitude which in turn leads to higher achievement (TIMSS, 2011). TIMSS 2011 further argue that there is a strong positive relationship between students' attitude towards science and their science achievement.

## 2.7 Theoretical Framework

Advance organizer is an instructional tool based on the subsumption theory of meaningful learning and retention advanced by Ausubel (1960). This theory holds that learning is based upon superordinate representation and combinational processes that occur during the reception of information (Ausubel, 1963). Ausubel further argues that advance organizers acts as a subsuming bridge between new learning material and existing related ideas. Ausubel (2000) further argues that meaningful learning refers to learning where the new knowledge to be acquired is related to previous knowledge. He is of the view that no meaningful learning can take place unless a stable cognitive structure exists. This existing structure provides a framework into which new learning is related, hierarchically, to previous information in the individual's cognitive structure. A teacher should provide subsumers to learners who are

unable to relate previous information to the new knowledge. Subsumption theory of meaningful learning and retention has resulted in paradigm shift in teaching methods and tools used by Biology teachers. This theory is relevant to the current study as advance organizers acts as subsumers. This enabled students to relate prior knowledge to new knowledge thus, enhancing meaningful learning. In this study, Advance Organizers were used as a bridge between prior knowledge and new knowledge. This bridge enabled better reception and retention of new knowledge. Thus enhancing meaningful learning, which led to an improvement in achievement and attitude towards learning Biology. Skemp (1962) argues that organizations of past impressions give meaning in all future learning.

### 2.8 Conceptual Framework

The conceptual framework that guided this study was based on subsumption theory of meaningful learning. Subsumption theory of meaningful learning is of the view that learners require subsumers to link existing knowledge with previous knowledge. This conceptual framework is based on presumption that learners benefit and enjoy the lesson more when they are allowed to connect prior knowledge with new knowledge. This study had two independent variables namely Advance Organizers and conventional teaching methods.

These variables were perceived as factors which are likely to influence the dependent variables of the study comprising of students' achievement and attitude. Intervening variables such as gender, teacher characteristics and student characteristics could also influence the independent variables. Students' gender was controlled by using co-educational secondary schools and hence a subject of study.

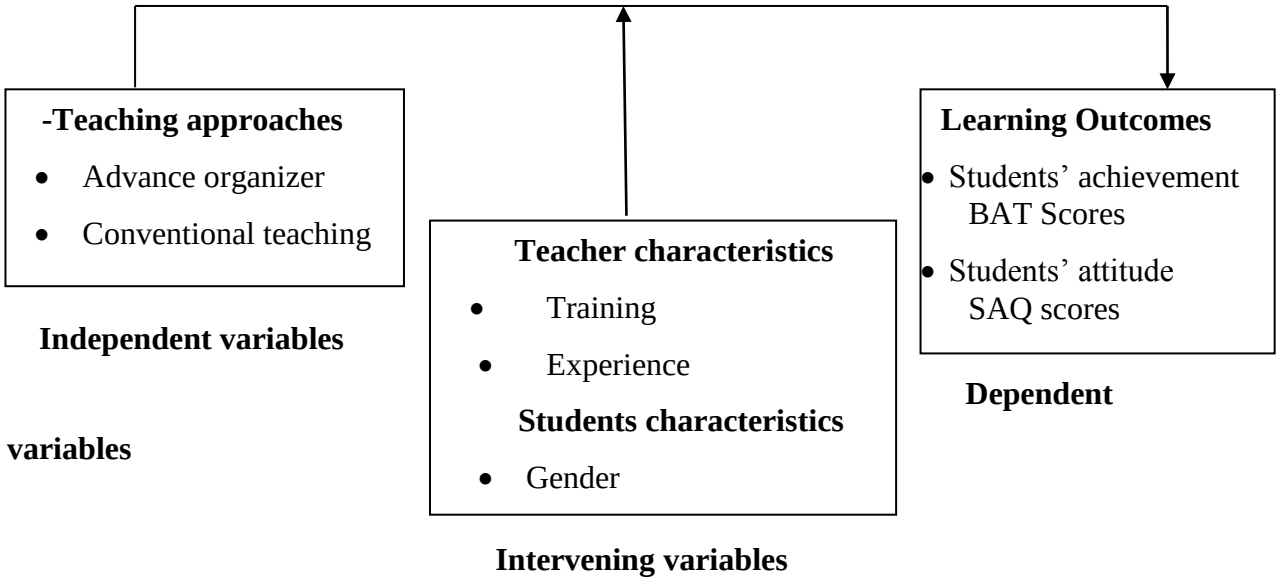


**Figure** 1: **Conceptualization of Relationship between teaching and learning outcomes**

Effectiveness of independent variables on dependent variables were based on SAQ and BAT scores. Students' attitude was measured using SAQ while students' achievement was determined using BAT.

This framework shows Advance Organizers as an intervention in the teaching and learning of Biology. Learning outcomes are also influenced by intervening variables such as teacher training and experiences which enables the choice of effective methods of teaching. The teacher characteristics were controlled by involving trained teachers with teaching experience of two years and above. The effects of teaching methods on students' achievement and attitude was studied. Students' gender may also affect their achievement and this was addressed by the choice of co-educational centers.

# CHAPTER THREE
# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter focuses on research methodology used in the study. It describes the research design, target and accessible population, sampling procedures used and sample size. Research instruments which were used in this study for data collection are discussed. This chapter also describes procedures used in data collection and methods used in data analysis.

## 3.2 Research Design

In this study, Solomon Four, Non-Equivalent Control-Group Design was used. Non-Equivalent Control-Group Design is used when research participants are not randomly assigned to the experimental and control groups (Gall, Gall & Borg, 2007). The design provides control for threats to internal validity (Fraenkel & Wallen, 2009). This design also provides some idea of how similar control and treatment groups were before intervention (Breakwell, Hammond, Fife-Schaw & Smith, 2007). Non-equivalent control-group design is preferred because secondary school classes once constituted exist as intact groups and school authorities do not allow such classes to be broken up and re-constituted for purposes of research (Gall et al., 2007). Solomon four, non-equivalent control-group design was used as shown in Table 3.

**Table 4:**
Solomon IV, Non Equivalent Control-Group Design.

| GROUP | PRE-TEST | TREATMENT | POST TEST |
|---|---|---|---|
| E1 | O1 | X | O2 |
| E2 | __ | X | O3 |
| CI | O4 | __ | O5 |
| C2 | __ | __ | O6 |

**KEY**

X = Experimental treatment where students were taught using advance organizers.
O1 & O4 = Pre-test.
O2, O3, O5 & O6 =Post-test.
Group E1 is the experimental group which received the pre-test, the treatment X and

the post-test

Group E2 received treatment X and a post test, but did not receive pre-test

Group C1 is the control group which received pre-test followed by control condition and Post-test

Group C2 is the control group which received received post-test only.

Groups C1 and C2 were taught using the conventional methods.

### 3.3 Target and Accessible Population

The target population comprised all secondary school students in Kilifi County who are about 53149 in 249 secondary schools. The study focused on county co-educational secondary school students. The accessible population consisted of all Form Two students in Kilifi County. These students had an average age of 15 years. The number of male students were more than their female counterparts. The sample size comprised 156 Form Two students from four co-educational secondary schools in Kilifi County. These schools admit students with almost the same entry behavior. Most of the schools in this county admit students from within the County. Students in this county have been performing dismally in KCSE Biology examination. Form two class was chosen because gaseous exchange is taught at that level.

### 3.4 Location of Study

The study was carried out in Kilifi County. Kilifi County was chosen because it is among those counties with persistent poor performance in Biology at Kenya Certificate of Secondary Examination. Kilifi County is located in Coastal region of Kenya. The county has a total area of 12483 square kilometers (RoK, 1998). Kilifi County is bordered by a 265 kilometer coastline which offers a high potential for marine and beach attraction. Marine water provides a wide range of aquatic organisms which can provide specimens for making the subject more interesting. The county has under developed human resource and most people lack proper education skill (RoK, 1998, 2009). Certain parts of the county are classified as semi-arid. According to County Education Officer (2019), Kilifi County has 249 secondary schools with a population of 53149. Kilifi County has 2 national schools, 19 county schools, 175 sub county schools and 53 private schools. Schools in this region are far apart and have inadequate resources like teachers, science and computer laboratories and libraries (RoK, 2005, 2006, 2007).

### 3.5 Sampling Procedure and Sample Size.

Four co-educational secondary schools were used in this study. Students from four county secondary schools were selected for the study from the ten co-educational county secondary

schools. Students from County schools were chosen because they have comparable academic abilities. Each school was treated as a group. Purposive sampling was used to select the four groups out of the ten co-educational secondary schools. Purposive sampling was used because the study required individuals with particular characteristics (Mugenda & Mugenda, 1999; Haslam & Mc Garty, 2014). Not all schools had all the required characteristics for the study. The characteristics required of the schools included science laboratory, approximately same number of boys and girls. Other characteristics are computer laboratory for viewing computer simulations and trained Biology teacher with a minimum of two years of teaching experience. Four schools were obtained because the study adopted Solomon four group designs which required four groups. Each school formed a group in the Solomon (IV) group design which was randomly assigned to either experimental or control group. The number of students in each of the four groups ranged between 35- 47. According to Mugenda and Mugenda (1999) a sample size of at least 30 cases per group is required. In schools that had more than one form two stream, one stream was randomly selected for the study. This study involved head of science department, head of Biology subject and Biology teachers of these schools in teaching, developing and critiquing of advance organizer module. Biology teachers in the two experimental schools were inducted on the creation and use of advance organizers. The number of students in each group were as follows

Group 1 ( E1), N= 39 composed of 19 male and 20 male students
Group 2 ( E2), N= 47 consisting 22 males and 25 female students
Group 3 ( C1), N=35 made up of 16 male students and 19 female students
Group 4 ( C2), N=35 comprising 18 male students and 17 female students.
The sample size for the study consisted of 156 Form Two students.

### 3.6 Instrumentation

The instruments used in data collection were the Biology Achievement Test (BAT) and the Students Attitude Questionnaire (SAQ). BAT and SAQ were used to collect data on students' achievement and attitude respectively. According to Orodho (2009), Achievement test are used to measure the amount of learning acquired.

#### 3.6.1 Biology Achievement Test (BAT)

Biology Achievement Test (BAT) (see Appendix B) was developed by the researcher and consisted of 51 multiple choice test items and 14 open ended items. This instrument was administered as pre-test. The instrument was based on the content covered in Biology

lessons. BAT consisted of section A and B. Section A items were multiple choice items while those of section B were open ended. The items tested knowledge, comprehension and application of learned materials. BAT was used to determine students' achievement. BAT comprised of 65 test items obtained from past KCSE Biology examinations. The multiple choice questions had four alternatives of which one was the correct answer. The same, but modified test items was used to collect data for post-test. Items in the multiple choice questions had one mark each while those of the structured questions was allocated between one to five marks. It had a maximum score of hundred marks.

### 3.6.2 Student Attitude Questionnaire (SAQ)

Student Attitude Questionnaire (SAQ) (see Appendix C) was used to determine students' attitude towards learning Biology. This instrument was adopted from Kiboss (1997) and modified to suit this study. The questionnaire items were re-written to find out the effects of Advance Organizers on students' attitude. This questionnaire comprised 24 five-point Likert-scale type items and was used to assess students' attitude towards learning Biology when they were taught using advance organizers. Students were required to indicate whether they strongly agree (SA), agree (A), disagree (D), strongly disagree (SD) or undecided (A) with the statements. The items SA, A, U, D, and SD were scored as 5, 4, 3, 2, and 1 respectively for positive items. SAQ items SA, A, U, D and SD were scored as 1, 2, 3, 4 and 5 respectively for negative items.

### 3.6.3 Validity of BAT and SAQ

BAT was validated by comparing the test items with the content covered in the topic gaseous exchange. Achievement tests are usually content validated (Lewis, 1976). Content validity of this instrument was established by matching the learning objectives for the topic gaseous exchange with the instrument. Table of specifications was used to construct the test to ensure that all objectives of the topic gaseous exchange are covered. This test was also content and face validated by five subject specialists from Egerton University and four secondary school Biology teachers to establish the relevance of items to the objectives of the topic and their opinions were incorporated in the final test. According to Mugenda and Mugenda (1999), the usual procedure in assessing the content validity of a measure is to use subject specialists. BAT was also face validated by same specialists. Face valid Items in the BAT was obtained from specific objectives found in the KICD Biology syllabus and students' textbooks.

SAQ was content validated by five lecturers from the Department of Curriculum, Instruction and Educational Management (CIEM), Egerton University. According to Gomm (2008), face

validity entails investigators subjective assessment of the presentation and relevance of the questionnaire: do the questions appear to be relevant, reasonable, unambiguous and clear?

### 3.6.4 Reliability of BAT and SAQ

BAT was pilot tested on form two students in two randomly selected schools in Kwale. Kwale County was identified for piloting because students in that county have similar characteristics to those found in Kilifi County. Kwale was also the appropriate place for pilot testing of the instruments because of the long distance and the target population would not collude with the sample group.

Reliability of section A of BAT comprising multiple choice items was estimated using K-R 20. K-R 20 estimates inter item consistency of items scored dichotomously (Gall, Gall & Borg, 2007). K-R 20 was preferred because the BAT items had a wide range of difficulty (Gall et al., 2007). Reliability of section B of BAT composed of open ended items was estimated using Cronbach's Alpha. Cronbach's Alpha was used establish reliability of items in section B since those items were not dichotomously scored (Gall et al, 2007). These formulae are impacted by the mean score, test variance and number of test items. The result of reliability estimate of the BAT was 0.82 and 0.79 for section A and B respectively. According to Mugenda and Mugenda (1999) a reliability coefficient with alpha value of 0.70 and above are considered acceptable.

SAQ was also pilot tested on the same form two students in Kwale County and the data obtained analyzed using Cronbach's coefficient Alpha. The reliability of SAQ was estimated using Cronbach's coefficient Alpha yielding a coefficient of 0.74. Cronbach's coefficient Alpha was used because it is suitable for multiple items with a range of scores (Zaiontz, 2017). Reliability coefficient ranges from 0 to 1. The reliability coefficient with alpha value equal to 0.70 or more was considered acceptable (Cronbach, 1970).

## 3.7 Advance Organizers Instructional Module

Advance organizer teaching module (see Appendix A) was used to teach gaseous exchange to form two students. This module was based on KICD approved Biology syllabus (KIE, 2003). The Advance Organizers that were used included computer simulations, handouts and charts. The computer simulation were shown for ten minutes. Before the start of each lesson learners were exposed to an Advance Organizers. Teachers were inducted on how to employ advance organizers in the teaching of Biology lessons. Students were expected to observe gaseous exchange structures, features of gaseous exchange surfaces and mechanism of gaseous

exchange. Students were then be asked to present what they observed. Advance organizers were presented to the learners one day prior to the classroom instruction.

### 3.8 Data Collection

An introduction letter was obtained from Graduate School of Egerton University. Permission was then sought from the National Commission for Science, Technology and Innovation (NACOSTI) to allow this research to be carried out. Authority to carry out this study also sought from County Director in the Ministry of Education in Kilifi County before carrying out this research. Authority to collect data was also sought from Sub County Director of Education in Kilifi. Permission was also sought from the principals of the selected schools. BAT and SAQ was used in collecting data. BAT was administered as pre-test to two groups; one experimental and one control group before the treatment. After the pre-tests, the experimental groups were subjected to the treatment. Students in the experimental groups were taught using advance organizers. The students in the control group were taught using conventional teaching methods. Their regular teachers taught all groups. All simulation lessons were carried out in the schools' computer laboratories and all the requirements were provided by the schools. The intervention took a period of four weeks. Post-tests were administered to all students after the intervention.

### 3.9 Data Analysis

The study generated statistical data. Data obtained from Pre-test and post-test for different groups and gender were compared using t-test. Post test scores for the four groups were analyzed using one way Analysis of Variance (ANOVA) to test for any significant difference in achievement between the experimental and control groups at 0.05 level of significance. One way ANOVA was used because the groups were more than two (Miles & Banyard, 2007). Sheffe's post hoc multiple comparisons was used to establish where the difference existed among the groups. Sheffe's post hoc multiple comparison is used to compare all possible pairs of means (Zaiontz, 2017). Hypothesis one was analyzed using One way ANOVA. Hypothesis two was also tested using one way ANOVA since there were four groups. One Way ANOVA is used when comparing the means of more than two samples (Gall, Gall & Borg, 2007). Scheffe's post hoc multiple comparison was also used alongside one way ANOVA to test hypothesis two. Hypotheses three and four were tested using t-test since only two groups were compared. The total scores of the experimental and control

**Table 5: Summary of data analysis procedure**

| Hypotheses | | Independent variables | Dependent variable | Analytical tool |
|---|---|---|---|---|
| **$H_0$1:** | There is no statistically significant difference in achievement between students taught using advance organizers and those taught using conventional teaching methods | Instructional approach<br>i) Advance organizers<br>ii) Conventional teaching methods | Students' achievement | One way ANOVA |
| **$H_0$2:** | There is no statistically significant difference in attitude towards learning Biology between students' using advance organizers and those taught using conventional teaching methods | Instructional approach<br>i) Advance organizers<br>ii) Conventional teaching | Students' attitude | One way ANOVA |
| **$H_0$3:** | There is no statistically significant gender difference in achievement in Biology when students' are taught using advance organizers. | i) Gender | Students' achievement | i) t-test |
| **$H_0$4:** | There is no statistically significant gender difference in attitude towards learning Biology when students' are taught using advance organizers. | ii) Gender | Students' attitude | i) t-test |

# CHAPTER FOUR
# RESULTS AND DISCUSSION

## 4.1 Introduction

This chapter focuses on presentation of results obtained using both descriptive and inferential statistics. Quantitative results are presented inform of tables. The chapter has the following sections:-

a. Pre-test analysis.
b. Effects of advance organizers on students' achievement in learning Biology.
c. Effects of advance organizers on students' attitude towards learning Biology.
d. Achievement by gender for students exposed to advance organizers.
e. Attitude by gender for students' exposed to advance organizers.
f. Discussion of Results.

## 4.2 Pre-test analysis

Pre-test was administered to experimental group (E1) and control group (C2) to assess homogeneity of the groups before they were subjected to the treatment.

### 4.2.1 Pre-Test Performance Between Experimental and Control Groups

Pre-test scores were entered into the computer and SPSS version 19 used to generate the mean scores. The mean scores for the two groups were compared using independent t-test statistic to establish if any statistical difference existed in their performance. The results of the t-test are shown in Table 6.

**Table 6 :**
Pre-test mean scores on BAT and independent t-test results

| Learning method | N | Mean | SD | df | t-test | P- value |
|---|---|---|---|---|---|---|
| E1 | 39 | 29.54 | 5.26 | 72 | 0.862 | 0.392 |
| C1 | 35 | 29.29 | 5.24 | | | |

Critical values at df=72, t=0.862, P<0.05

Results in Table 6 show that the differences between the mean scores of groups E1 and C 1 were not statistically significant at the $\alpha$=0.05 level. The p-value of 0.392 is greater than 0.05. The results in Table 6 show that the groups exhibited comparable characteristics and were, therefore, suitable for the study. This indicates that the two groups were homogeneous.

The pre-test measures of SAQ for E1 and C1were subjected to the t-test to find out if the groups were homogeneous before the intervention. The results were presented in Table 7.

**Table 7:**
Pre-test mean scores on SAQ and independent t-test results

| Learning method | N | Mean | SD | df | t-test | P- value |
|---|---|---|---|---|---|---|
| E1 | 39 | 67.12 | 6.69 | 72 | -0.22 | 0.40 |
| C1 | 35 | 67.20 | 5.98 | | | |

Table 7 shows SAQ Biology pre-test mean scores for groups E1 and C1 as 67.12 and 67.20 respectively. The p value of 0.40 is greater than 0.05. This indicates that the two groups had comparable characteristics and therefore suitable for the study. This implies that the two groups had same levels of attitude.

### 4.2.2 Comparison of Students Pre-test BAT and SAQ Scores by Gender

Pre-test BAT scores for male and female students were compared to find out if the groups are comparable. The pre-test scores were sorted out by gender, fed to the computer and SPSS used for analysis. The results are tabulated in table 8.

**Table 8:**

Pre-test mean scores by gender on BAT and independent t-test results

| Gender | N | Mean | SD | df | t-test | P- value |
|---|---|---|---|---|---|---|
| Male | 35 | 29.91 | 5.29 | 72 | 1.82 | 0.0730 |
| Female | 39 | 29.38 | 5.08 | | | |

Critical values at df= 72, t=1.82, P>0.05

Table 8 shows that male students had a slightly higher mean scores in the pre-test scores (29.91) than girls (29.38). Independent t-test was computed to find out whether statistically significant gender differences existed. The results in Table 8 indicate that there are no statistically significant differences between male and female students in pre-test scores; t(72)=1.82p> 0.05. This indicates that male and female students had the same level of achievement in Biology before treatment. The findings exhibited comparable achievement for male and female students. The results in Table 8 show that the groups were homogeneous and could be studied.

**Table 9**:

**Pre-test mean scores by gender on SAQ and independent t-test results**

| Gender | N | Mean | SD | df | t-test | P- value |
|---|---|---|---|---|---|---|
| Male | 35 | 66.75 | 4.66 | 72 | -0.55 | 0.29 |
| Female | 39 | 67.56 | 7.66 | | | |

The results in Table 9 show that the p-value obtained was 0.29, which is greater than 0.05. The results; t= (71) = p>0.05 indicate that there was no statistically significant difference between male and female students attitude towards learning Biology. This implies that male and female students had the same level of attitude prior to the treatment.

### 4.3 Effects of Advance Organizers on Students Achievement

Objective one of the study was to determine the effects of advance organizers on students' achievement towards learning Biology. This was achieved by comparing post test results for students taught using advance organizers and those taught using conventional teaching methods. Mean scores and Standard deviation for the post test scores were calculated with the aid of SPSS. Post-test performance of the four groups was used to compare effects of the two teaching approaches on students' achievement. The post-test mean scores for all the groups are presented in Table 10.

**Table 10:**

BAT post-test mean score obtained by the students in the four groups

Maximum scores = 100 marks

| **Group** | **N** | **Mean score** | **Std. dev.** |
|---|---|---|---|
| E1 | 39 | 52.42 | 8.3298 |
| E2 | 47 | 50.21 | 7.9288 |
| C1 | 35 | 38.03 | 7.7781 |
| C2 | 35 | 39.29 | 4.0408 |
| **TOTAL** | 156 | | |

The results in Table 10 show that post-test mean scores for experimental groups (E1=52.42 and E2=50.21) were higher than those of control groups (C1 =38.03 and C2=39.29). The standard deviation for the experimental groups were higher than the control groups. Further

analysis was done using One-Way Analysis of Variance (ANOVA), to determine whether the difference in mean score is statistically significant at 0.05 level of significance. This was done to test $H_{01}$ of the study, which sought to establish if there was any statistically significant difference in achievement between students exposed to advance organizers and those taught using conventional methods.

One Way ANOVA results for the four groups are presented in Table 11.

**Table 11:**

Analysis of Variance (ANOVA) of the post-test Scores

| | Sum of squares | df. | Mean of square | F | p-value |
|---|---|---|---|---|---|
| Between groups | 6469.1349 | 3 | 2071.9958 | 38.69 | 0.000* |
| Within groups | 8328.174 | 152 | 53.5548 | | |
| Total | 14797.3089 | 155 | | | |

Critical values at df=(3,152), F=38.69, P<0.05

Table 11 show the calculated value of $F(3,152)=38.69$, $p< 0.05$. The results presented in Table 11 reveal that there is a statistically significant difference between the mean scores of the experimental groups and control groups since the $p< 0.05$. This implies that the experimental groups attained higher scores in post-test BAT than the control groups. This, however, does not show which groups attained a significant difference. Further analysis was done using the scheffe's Post hoc tests of multiple comparison to obtain differences between groups. Sheffe's Post hoc was preferred because the group sizes were unequal (Kleinbaum, Kupper, Muller & Nizam, 1998). This was done to establish areas where the differences in post-test BAT scores were different (Miles & Banyard, 2007). The results obtained were presented in Table 12.

**Table 12:**

**Sheffe's Post Hoc Comparisons of the BAT Post-Test Scores for the Four Groups**

| Learning method | Learning method | Mean difference | p-value |
|---|---|---|---|
| E1 | E2 | 2.21 | 0.915 |
| | C1 | 14.39 | 0.0001* |
| | C2 | 13.13 | 0.0001* |
| E2 | E1 | -2.21 | 0.915 |
| | C1 | 11.91 | 0.0001* |
| | C2 | 10.92 | 0.0001* |
| C1 | E1 | -14.39 | 0.0001* |
| | E2 | -11.91 | 0.0001* |
| | C2 | -1.26 | 0.74 |
| C2 | E1 | -13.13 | 0.0001* |
| | E2 | -10.92 | 0.0001* |
| | C1 | 1.26 | 0.74 |

* Mean statistically significant at Alpha (α) = 0.05 level. P<0.05

Results in Table 12 reveal that there was statistically significant mean score difference between experimental and control groups since the p-value is less than 0.05. The results show that statistically significant differences existed between groups: E1 and C1, E1 and C2, E2 and C1 and E2 and C2. The results also indicate that there is no statistically significant mean score difference between two experimental groups. The same case applies to control groups. This implies that the difference in mean for E1 and E2 is statistically insignificant since their p-values of 0.217 are more than 0.05. The results show that there is no significant difference when one treatment group is compared with another treatment group. The same scenario is witnessed for C1 and C2. Significant differences exists when a treatment group is compared to a control group.

Further analysis was done using Cohen's d to determine the standardized difference between the mean scores of the control and treatment groups. Cohen's d was used to accompany the reporting of one way ANOVA and t-test. Cohen's d statistic is a type of effect size. As an effect size it is used to represent the magnitude of differences between two or more groups on a given variable (Salkind, 2010). Salikind argues that cohen's d is suitable for establishing the extent to which a null hypothesis is false. According to Cohen (1988) Cohen's d is used to

establish the size of difference between the means. This is done to determine how large the effect size of treatment was. The rule of thumb for effect sizes includes; d=0.2 small, d=0.5 medium and d=0.8 large ( Cohen, 1988 ). Post-test results for the groups E1 and C1 were analyzed using Cohen's d. The results from this analysis was Cohen's d = (38.03-52.42/8.0587= 1.786. The value of d obtained is 1.786 which is greater than 0.8. This implies that the effect size of advance organizers is larger. Post-test scores for groups E2 and C2 were also analyzed using Cohen's d to establish the effect size of treatment of groups that were only exposed to post-test only. Cohen's d results was d=939.29-50.21/6.293=1.735. The value of d is greater than 0.8. This implies that the effect size of treatment is large.

The results obtained from the study indicate that students taught using advance organizers achieved higher scores than those taught using conventional methods. Advance organizers enhances students' retention of Biology concepts, therefore, making them to score highly. According to the results of this study, hypothesis one ($H_{01}$) was rejected. $H_{01}$ sought to establish if there was statistically significant difference in Biology achievement between students who are taught Biology using advance organizers and those taught using conventional methods was rejected. The schemata initially built when a learner encounters knowledge for the first time is crucial for all future learning (Skemp, 1962). Learning through development of schemata is more effective than rote learning (Lovell, 1973). Lovell further contends that a more efficient recall of information is enhanced when schemata is built at the beginning of a new learning situation. The results of this study corroborated the findings of other earlier studies which concluded that advance organizers improved students achievement compared to the conventional methods. This concurs with the findings of the study by Wachanga, Arimba and Mbugua (2013) on the effects of Advance Organizers teaching approach on secondary school students' achievement in chemistry in Maara district in Kenya.

A study by Muiruri (2016) on effects of Advance Organizers teaching strategy on primary school pupils' achievement in poetry in secondary Nakuru North Sub County found out that advance organizers have positive effects on students' achievement. A study by Korur, Toker and Eryilmaz (2016) reveal that the use of online advance organizer concept teaching material increases students' achievement scores. Study by Githua and Nyabwa (2008) on the effects of Advance Organizers strategy during instruction on secondary school students' mathematics achievement established that the use of Advance Organizers improved students' scores significantly than when conventional method is used.

A study by Mshenga (2013) on the effects of Advance Organizer on students' achievement, perception and attitude towards the learning of narratives in literature in English in secondary schools in Kilifi district found that Advance Organizer improved students' achievement. A study by Shihusa and Keraro (2009) on using Advance Organizers to enhance students' motivation in learning Biology found that advance organizers improve achievement and facilitates meaningful learning. The finding of this study is also in agreement with those of Onwioduokit and Akinbobola (2005) and Akinbobola (2015) that advance organizers improves students' achievement in physics. It is also in harmony with that of Omotade (2016) which established that Advance Organizers improve student academic achievement in physics in secondary schools. It also concurs with the findings of Kapri (2017) that students taught using Advance Organizer model scored highly in science achievement test than those taught using conventional teaching method. These results are in agreement with those of Kapri (2017) and Muiruri, Wambugu and Wamukuru (2016) who established that Advance Organizers improved students' achievement. This implies that Advance Organizers improves students' achievement towards learning. Advance organizes provides long term retention of information and allows for easy retrieval. Students' centered and participatory strategies improve students' achievement towards Biology.

The results of this study are also in agreement with that of Nazimuddin (2015) who sought to find out the effects of Advance Organizer Modal (AOM) on academic achievement of 9th class students in four west Bengal Government aided Schools. In this study, Advance organizer Model was found to be more effective than the conventional teaching method. The student of 9th class taught using Advance Organizer Model Showed Superior achievement in geography.

### 4.4 Effects of Advance Organizers on Students' Attitude.

Objective two of the study sought to find out the effects of advance organizers on students' attitude towards learning Biology. After the students were exposed to Advance Organizers they were given questionnaires to express their feelings towards Biology lessons. Their responses were scored and analyzed to determine the effects of Advance Organizers on their attitude. This analysis was done using one way ANOVA to compare the SAQ post-test scores for the four groups. Further analysis of post-test SAQ scores was done using independent t-test to compare attitude of students taught using advance organizers and those taught using conventional teaching method. SAQ post-test mean scores were obtained and presented in table 13

**Table 13:**
SAQ post-test mean score obtained by the students in the four groups

| Group | N | Mean score | Std. dev. |
|---|---|---|---|
| E1 | 39 | 85.70 | 7.926 |
| E2 | 47 | 82.47 | 8.897 |
| C1 | 35 | 77.71 | 7.318 |
| C2 | 35 | 78.57 | 8.406 |
| **TOTAL** | 156 | | |

The results in Table 13 show that SAQ post-test mean scores for experimental groups (E1=85.70 and E2=82.47) were higher than those of control groups (C1 =77.71 and C2=78.57). The results obtained imply that students taught using advance organizers developed a positive attitude towards learning Biology. Further analysis was done using One-Way Analysis (ANOVA), to determine whether the difference in mean score is statistically significant at 0.05 level of significance. This was done to test $H_{02}$ of the study, which sought to establish if there was any statistically significant difference in attitude between students exposed to advance organizers and those taught using conventional methods.
One Way ANOVA for the four groups are presented in Table 14.

**Table 14:**
Analysis of Variance (ANOVA) of the SAQ post-test Scores

| | Sum of squares | df. | Mean of square | F | p-value |
|---|---|---|---|---|---|
| Between groups | 1943.38 | 3 | 647.74 | 9.536 | .000* |
| Within groups | 10325.46 | 152 | 67.93 | | |
| Total | 12268.84 | 155 | | | |

*mean statistically significant

Table 14 shows P-value corresponding to the F-statistic of one way ANOVA obtained from the results is lower than 0.05. This suggest that one or more groups have statistically significant different mean scores. The results $F(3,152)=9.536$, $p< 0.05$ presented in Table 14 show that there is statistically significant difference between the mean scores of the experimental groups and control groups. This implies that the experimental groups attained higher scores in post-test SAQ than the control groups. The experimental groups exhibited positive attitude towards Biology than the control groups. Further analysis of SAQ was done

using the Scheffe's Post hoc tests of multiple comparison to determine groups with significant mean differences. Table 15 shows the Scheffe's post hoc comparisons.

**Table 15**:
Sheffe's Post Hoc Comparison of the SAQ Mean Scores for the Four Groups.

| Learning method | Learning method | Mean difference | p-value |
|---|---|---|---|
| E1 | E2 | -0.642 | .999 |
| | C1 | -5.290 | .001* |
| | C2 | -3.380 | .0004* |
| E2 | E1 | 0.682 | .999 |
| | C1 | -4.65 | .004* |
| | C2 | -2.740 | .012* |
| C1 | E1 | 5.29 | .001* |
| | E2 | 4.65 | .0004* |
| | C2 | 1.91 | .84 |
| C2 | E1 | 4.38 | .024* |
| | E2 | 3.740 | .012* |
| | C1 | 0.91 | .84 |

* Mean statistically significant at Alpha (α) = 0.05 level. P<0.05

Scheffe's post hoc comparisons show that E2 with the highest SAQ mean score of 85.70 had significant difference with C1 and C2 since the values of P in both cases are less than 0.05. E1 with the second highest SAQ mean score of 85.48 had statistically significant differences with control groups C1 and C2. SAQ mean scores for C1 and C2 were 77.71 and 79.51 respectively. However, the difference between C2 and C1 is statistically insignificant since the value of P is greater than 0.05. The difference between E1 and E2 is statistically insignificant because the value of p is greater than 0.05. E1 and E2 had higher SAQ scores than C1 and C2. This results indicate that students taught using Advance Organizers developed a more positive attitude towards learning of Biology than those taught with conventional teaching method.

Further analysis was done using independent t-test. This was done by categorizing the four groups into two groups of experimental groups (E1 and E2 ) and control groups (C1 and C2). The two groups were then analyzed using independent t-test. Hypothesis two sought to establish if there was statistically significant difference in students' attitude towards learning Biology between students' taught using advance organizers and those taught using

conventional teaching methods. The results of the comparison of SAQ scores for the experimental groups and control groups are presented in Table 16.

**Table 16:**
Independent t-test results on attitude towards learning Biology

| Teaching method | N | Mean | Std. dev | t-value | df | p-value |
|---|---|---|---|---|---|---|
| Advance organizer | 86 | 85.14 | 8.65 | -4.786 | 154 | .000* |
| Conventional teaching | 70 | 78.61 | 8.24 | | | |

Results in Table 16 show that p-value obtained was .000, which is lesser than the acceptable alpha value of 0.05. The results obtained; t (154)= -4.786, P< 0.05 indicate that SAQ scores for the two groups had statistically significant differences. This implies that there is statistically significant difference in attitude between students taught using advance organizers and those taught using conventional teaching methods. Hypothesis two which stated that there is no statistically significant difference in attitude towards learning Biology between students taught using advance organizers and those taught using conventional teaching methods is therefore rejected.

Further analysis was done using Cohen's d to determine the effect size of treatment on students' attitude between experimental and control groups. Post SAQ results of E1 and C1 were analyzed using Cohen's d. The results obtained from this analysis Cohen's d = (77.71-85.70/7.628= 1.05. The value of d obtained implies that the effect size of treatment on students' attitude between the experimental groups and control group was large. Effect size of treatment between groups E2 and C2 was also determined using Cohen's d. The results obtained from this analysis Cohen's d= 78.57-82.47/8.654=0.5. The value of d obtained implies that the effect size of the treatment was medium. Group C2 had slightly higher post SAQ scores than C1 which could be attributed to other factors other than the teaching method used in the study.

The results of this study reveal that students exposed to advance organizers had a positive attitude compared to those taught using conventional teaching methods. Advance Organizers enable students develop an interest towards learning Biology. Lovell (1973) opines that when schemata is built at the start of new learning situations, learners will prepare for future learning. Advance organizers are tools which can be used to build schemata. These findings

are in agreement with (Gall 2013) who argues that conventional teaching make learners to lose interest in learning since they are passive while those taught using advance organizers are actively involved. Students who are actively involved in the learning process tend to develop interest in the same. A study by Onwioduokit and Akinbobola (2005) on effects of Pictorial and Written Advance Organizers on students' achievement in senior secondary school physics found out that Advance Organizers awakens the students' interests and therefore, helps them develop positive attitude towards learning. These findings concurs with Mshenga (2013) who established that use of advance organizers enhanced active participation which improves students' attitude.

A study by Mede (2010) on the effects of instruction of Graphic Organizers in terms of students' attitude towards reading in English found out that Graphic organizers leads to an improvement in students' attitude towards learning. Similarly, a study by Korur, Toker and Eryilmaz (2016) on the effects of Intergrated Online Advance Organizer teaching materials in students' science achievement and attitude established that the use of advance organizer improved students' attitude.

The results of this study are in agreement with that of Akinbobola (2015) who established that use of Advance Organizers leads to positive attitude towards physics learning. Advance Organizers improves students' motivation towards learning Biology (Keraro & Shihusa 2009) which in turn lead to a positive attitude towards learning. According to Akinbobola (2008) Advance Organizers improved students' attitude towards learning physics. UNESCO (2017) argues that effective teaching methods improves students' self-confidence and interest in Biology. This implies that a positive attitude towards learning Biology is developed when learners are helped to connect prior knowledge with new knowledge. Students' attitude and interests towards science play a very big role in their learning of scientific concepts.

### 4.5 Gender Differences in Achievement towards Learning Biology

Objective three sought to determine whether there was gender difference in achievement in Biology when students are taught using Advance Organizers. To achieve this, the post test BAT mean scores were analyzed using independent t-test on the basis of gender. The results obtained were compared to establish whether there is significant difference in achievement. This was done to test Hypothesis three of the study which sought to establish if there were statistically significant gender difference in achievement in Biology when students are taught

using advance organizers. The total number of students exposed to advance organizers were 41 boys and 45 girls. The post-test BAT means by gender are presented in Figure 2.

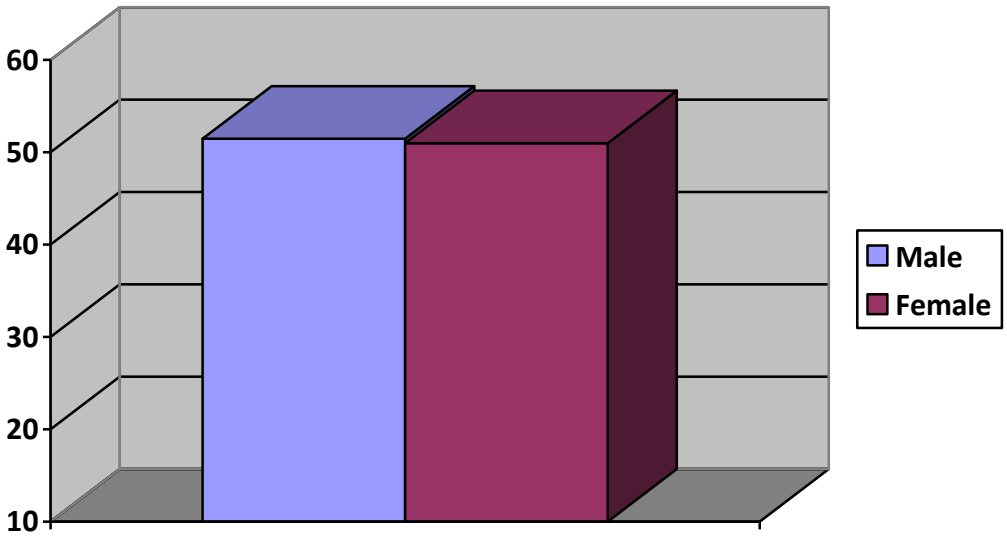


**Figure 2**: Post-test BAT Mean Scores by gender.

To test this hypothesis, independent t-test was used to compare post-test BAT means obtained by male and female students exposed to advance organizers. The results are presented in Table 17.

**Table 17:**
Independent t-test Results of the Post- Test BAT by Gender for Students Subjected to Advance Organizers

| Gender | N | Mean | Std. dev | t-value | df | p-value |
|---|---|---|---|---|---|---|
| Male | 41 | 51.46 | 7.99 | 0.29 | 84 | .387 |
| Female | 45 | 50.97 | 7.85 | | | |

Critical values at df =84, t =0.29, P>0.05

Table 17 shows post-test BAT mean scores for boys and girls exposed to Advance Organizers. The table shows that boys had a slightly higher mean score of 51.46 while girls had 50.97. The standard deviation for boys was slightly higher (7.99) than girls (7.85). The results as shown in Table 17 indicate that there is no statistically significant differences in Biology achievements between boys and girls t (84) = 0.29; p> 0.05. Results obtained show that male students performed slightly better than their female counterparts. However, the

difference was statistically insignificant. This is because the p- value is greater than 0.05. This implies that both male and female students had equal achievement. Hypothesis three which stated that there is no statistically significant gender difference in achievement in Biology when students are taught using Advance Organizers is accepted.

These results reveal that the use of Advance Organizers minimizes the gender differences in achievement in Biology. The results of this study indicate that there is no statistically significant gender difference in achievement for students taught using advance organizers. This implies that the performance for both boys and girls were similar. The results of this study was consistent with the findings of Wachanga et al (2013) that gender has no significant difference on achievement when students are taught using advance organizers. These results are in agreement with the findings of Akinbobola (2008) who observed that both the male and the female students do well in science if exposed to similar conditions. The results of this study is in agreement with that of Omotade (2016) that Male and female students taught using Advance Organizers did not differ significantly in achievement. This implies that male and female students subjected to the same learning conditions will perform equally in achievement test. The findings of this study is in harmony with the findings of the study by Ekenobi and Mumuni (2015) on efficacy of Advance Organizers strategies on chemistry students' cognitive achievements in redox reaction concept. This study by Enkobi and Mumuni etablished that female and male students exposed to graphic advance organizers strategies performed equally. The implications of this study is that gender does not affect students' academic performance in Biology. A study by Githua and Nyabwa (2008) on the effects of Advance Organizers strategy during instruction on secondary school students' mathematics achievement, established that the use of Advance Organizers improved male and female students equally. This implies that Advance Organizers can be used to enhance gender parity in the learning of Biology. A positive correlation exists between attitude and achievements towards of learning science.

### 4.6 Effects of Advance Organizers On Students Attitude by Gender

Objective four sought to establish whether there was a gender difference in attitude towards learning Biology when students are taught using Advance Organizers. The post-test SAQ mean scores were analyzed on gender basis using independent t-test. The scores obtained by girls and boys from SAQ are shown in Figure 3.

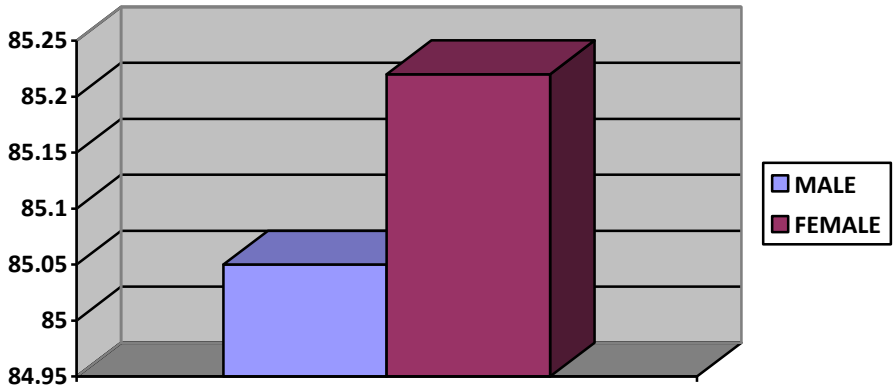


**Figure 3:** SAQ Mean Scores by Gender.

Results in Figure 3 show that boys scored lower than girls on the SAQ with a mean score of 85.05 and 85.22 respectively.

Hypothesis four, which sought to establish if there was statistically significant gender difference in attitude among students taught using advance organizers was tested using independent t-test. The results are presented in Table 18.

**Table 18:**
Independent t-test on Students Attitude by Gender.

| Gender | N | Mean | t-value | df | p-value |
|---|---|---|---|---|---|
| Male | 41 | 85.05 | 0.091 | 84 | 0.93 |
| Female | 45 | 85.22 | | | |

Critical values at df =84, t =0.091, P>0.05

According to Table 18, p-value obtained was 0.93 which is greater than the acceptable value of 0.05. The results obtained; t (84) = 0.091, P >0.05 indicate that the difference in attitude is not statistically significant. This therefore implies that, there is no statistically significant gender difference in the attitude scores. This indicates that both boys and girls taught using Advance Organizers had same levels of attitude. Hypotheses four which state that there is no statistically significant gender difference in attitude towards learning Biology when students are taught using Advance Organizers is accepted.

The results of this study indicate that there is no statistically significant gender difference in attitude when students are taught using advance organizers. This implies that male and female students taught using advance organizers have the same levels of attitude. The results of this

study concurs with the findings of the study by Akinbobola (2015) on enhancing Nigerian physics students' attitude through the use of pictorial, written and verbal Advance Organizers that the use of advance organizers improves both the male and the female students' attitudes in the same way. The results of this study are in agreement with that of Aworanti and Abimbola (1997) on the level of achievement on ecology concepts among Nigeria final year secondary school students which revealed that gender is not a factor in their attitude in science.

A study by Mshenga (2013) show that female students exposed to Advance Organizers exhibit positive attitude towards learning of Narratives than their male counterparts exposed to similar conditions. The findings of this study concurs with that of Olatungi and Olusola (2016) which found out that there is no significant relationship between gender and achievement towards Biology for students taught using Advance Organizers. The findings of this study also concurs with that of Omotade (2016) which sought to establish effects of Advance Organizer teaching approach on students' academic performance in physics in senior secondary school. This study found out that the use of Advance Organizers has no significant effect on male and female students' academic achievement.

UNESCO (2017) contends that supportive learning increase girls' self-confidence and self-efficacy in STEM exposure to real world learning opportunities can help inspire and retain girls' interest in science education. This implies that a more engaging teaching method will help improve female students' attitude towards science. Effective teaching practices can help promote girls motivation and engagement in STEM subjects (Spearman & Watt, 2013). This implies that effective intervention such as the use of Advance Organizers can improve female students' attitude towards learning Biology.

# CHAPTER FIVE
# SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

This chapter presents a summary of the findings of this study, implications and conclusions made. Recommendations made from the findings and suggestions for further research are also discussed in this chapter.

## 5.2 Summary of the Findings

The following is a summary of the findings of the study.

(i) Pretest analysis indicate that the groups used for the study comprised students with comparable abilities and attitude.

(ii) Pre-test analysis showed that both male and female students had similar characteristics before the intervention.

(iii) Use of advance organizers enhances achievement

(iv) Use of advance organizers improves students' attitude towards learning Biology compared to conventional teaching methods.

(v) The use of Advance Organizers enhances gender parity in achievement and attitude to learn.

## 5.3 Conclusions

Findings of this study indicate that

(i) The use of advance organizers in teaching Biology leads to higher student achievement in Biology compared to the conventional teaching methods. Advance organizers can be used to address the challenge of poor performance.

(ii) The use of advance organizers also improves students' attitude towards learning Biology compared to conventional teaching methods. Active involvement of the students made them develop a lot of interest towards the subject.

(iii) This study also revealed that the use of advance organizers enhances gender parity in Biology achievement. Advance organizers could therefore be used to address the challenges of gender disparity towards learning Biology.

(iv) Advance Organizers can be used to reduce attitudinal differences that exist between male and female students towards learning Biology. Advance Organizers enables male and female students develop almost equal levels of attitudes towards learning

Biology. This reveals that gender does not influence students' attitude towards learning Biology.

### 5.4 Recommendations

Based on the findings of this study, the following recommendations were made:

(i) The use of advance organizers should be adopted by curriculum implementers so as to improve female students' achievement towards learning Biology.

(ii) Kenya Institute of Curriculum Development (KICD) should encourage teachers to adopt the use of advance organizers in teaching Biology. This may help in improving the achievement of students in Biology.

(iii) Workshops and seminars should be organized by CEMASTEA to incorporate the use of advance organizers in teaching Biology.

(iv) Advance organizers should be used in teaching since it led to an improved achievement for both boys and girls.

(v) Adoption of advance organizers by teachers and tutors in teachers training colleges is necessary since it enables students to develop positive attitude towards learning.

(vi) Curriculum developers should consider incorporating advance organizers as part of teachers training so that teachers get used to applying it from the time they enter the profession.

### 5.5 Suggestions for Further Research

The following areas are recommended for further study

(i) Studies should be conducted on the effects of the use of advance organizers on students' acquisition of science process skills.

(ii) Studies should be carried out to investigate the effects of the use of advance organizers alongside cooperative learning on students' attitude towards learning.

(iii) Studies should be conducted to compare the use of advance organizers and cooperative learning and to determine their effects on students' achievement.

(iv) Studies should be carried out on the effects of using advance organizers in single sex secondary schools.

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## APPENDIX A :

## ADVANCE ORGANIZER TEACHING MODULE FOR THE EXPERIMENTAL GROUP.

**WEEK 1**

**Topic Gaseous exchange in Animals.**

**Lesson 1 -2**

**Objectives**

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

a) Define gaseous exchange.

b) Explain the need for gaseous exchange.

**Teaching and Learning Activities**

Viewing of visual presentation showing importance of gaseous exchange in Animals.

Discussion of the need for gaseous exchange.

**Lesson 3-4**

**Objectives**

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

a) Describe the types of gaseous exchange structures.

b) Describe characteristics of gaseous exchange structures.

**Teaching and Learning Activities**

Visual presentation in form computer simulation of types and characteristics of gaseous exchange structures. Charts are also provided showing the various gaseous exchange structures.

The teacher should guide the students in identifying gaseous exchange surfaces
Discussion of the types and characteristics of gaseous exchange.

**WEEK 2**

**Sub topic: Mechanisms of gaseous exchange**

**Lesson 1-2**

**Objectives**

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

**a)** Describe the mechanism of gaseous exchange in amoeba

**b)** Describe mechanism of gaseous of gaseous exchange in Insects

**Teaching and Learning Activities**

Visual presentation of mechanism of gaseous exchange in Amoeba and in insects

Practical activity where the teacher guides the students to identify the spiracles from the insects provided. The teacher provides insects which the learner observes the pulsating movement of the abdominal region.

Discussion of mechanism of gaseous exchange in insects and in amoeba.

**Lesson 3-4**

**Sub topic: Mechanisms of gaseous exchange in Fishes and Amphibians**

**Objectives**

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

**a)** Describe mechanism for gaseous exchange in Amphibians

**b)** Describe mechanism for gaseous exchange in fishes

**Teaching and Learning Activities**

Visual presentation of mechanism of gaseous exchange in Amphibians

Visual presentation of mechanism of gaseous exchange in fishes

Practical activity to examine the moist skin of a live frog provided.

The teacher should guide the students to observe the pulsating movement of the lower mouth floor of a frog.

The teacher should guide the students in to identify the gill filaments and their dark colour from the fish provided.

The teacher should guide the students to identify the gill rakers and state their functions.

The teacher should use liebeg's condenser to demonstrate counter current flow system

Discussion of mechanism of gaseous exchange in amphibians

Discussion of mechanism of gaseous exchange in fishes.

**WEEK 3**

**Lesson 1-2**

**Sub topic: Mechanisms of gaseous exchange in Mammals**

**Objectives**

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

**a)** Describe breathing systems in Mammals

**b)** Describe inhalation in Mammals

**c)** Describe exhalation in mammals

**Teaching and Learning Activities**

Visual presentation of breathing system in Mammals.

The teacher should guide the students to identify breathing system from the models provided.

Practical activity to demonstrate mechanism of inhalation and exhalation using locally available materials such as balloons, funnel or bell jar and rubber bungs.

Visual presentation of exhalation and inhalation in Mammals

Discussion on inhalation and exhalation in mammals

Discussion on breathing system in mammals

**Lesson 3-4**

**Sub-topic:Factors affecting the rate of breathing**

**Objectives**

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

**a)** Describe factors affecting the rate of breathing

**b)** Describe various respiratory diseases

**Teaching and Learning Activities**

The teacher guides students in an exercise after which they will be required to discuss the change of breathing rates.

Discussion of factors affecting the rates of breathing

Discussion on pamphlets showing respiratory diseases

**WEEK 4**

**Lesson 1 - 2**

Post-test

**APPENDIX B :**

**BIOLOGY ACHIEVEMENT TEST (BAT)**

**Admission number……** **School…….**

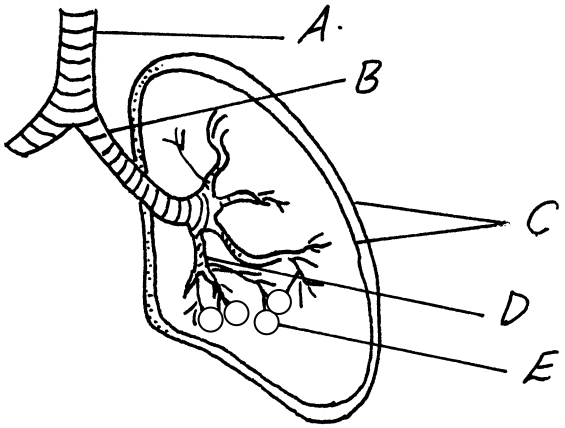
**Class……..** **Time: 2 hours**

**Instructions**

1. Write your name and admission number and class in the spaces provided
2. Attempt all question in Section A and B
3. Read the questions carefully before writing your answers
4. Write your answers in the spaces provided
5. Each question in section A carries 1mk

**Section A**

1. Study the diagram below and answer questions 1-8 that follow.
Which one of the following parts is responsible for gaseous exchange in human beings?
A. C B. E C. A D. B




2. Name the parts labeled A
A. Bronchus B. Gullet C. Trachea D. Small Intestines
3. Name the part B
A. Bronchioles B. Alveoli C. Lungs D. Aorta
4. Name part C
A. Thoracic cavity B. Lungs C. Pleural Membrane D. Alveoli
5. Name part E
A. Pleural Membrane B. Alveolus C. Ribosomes D. Bronchioles
6. What is the function of the fluid found between the parts marked C.

A. Reduce friction making the lungs to move freely in the chest cavity
B. Carries blood to the lungs

C. Allows diffusion of gases

D. Dissolving respiratory gases before diffusing

7. One of the following is adaptation of part labeled E to its function.Which one is it?

A.They are thin for faster diffusion of respiratory gases
B. They have ribosomes for synthesis of proteins

C. they have mucus for trapping dust

D. They are highly vascularized to reduce surface area for for gaseous exchange.

8. What is the significance of rings of cartilage found around the part marked A and B.

A. To prevent the parts from collapsing
B. To prevent food from reaching those parts
C. To prevent entry of disease causing micro organisms
D. Protect the lungs

9. Name the physiological process by which gaseous exchange takes place at the respiratory
surface in animals and plants

A. Osmosis B. Diffusion C. Transpiration D. Active transport

10. Three of the following events accompany inhalation in humans breathing in mammals. Which one is not?

A. External intercostals muscles contract
B. Internal intercostals muscles contract
C. Diaphragm flattens
D. Ribcage moves outwards and upwards

11. A patient had the following symptoms:
- Dry and prolonged coughs
- Production of bloody sputum
- Weight loss
- Night sweats

Which disease was the patient suffering from

A. Bronchitis B. Malaria C. Pneumonia D. Tuberculosis

12. Why is it necessary to breathe using the nose rather than the mouth

A. It is lined with hairs to trap dust
B. it secretes pleural fluid which is used for gaseous exchange
C. the skin in the nose region is very thin to increase the surface area for gaseous exchange

D. Oxygen in the nose diffuses directly into the blood stream

13. Which region of the brain controls the rate of breathing

A.Cerebellum B. Cerebrum C. Medulla oblongata D Hypothalamus

14. What is the name of the membrane that surrounds the lungs

A. Pericardial membrane B. Outer membrane C. Tonoplast D. Pleural membrane

15. What is the function of hairs which surrounds the spiracles.

A. Trap dust particles
B. To prevent air from diffusing into the tracheole
C. To regulate the amount of air from entering the tracheole
D. To detect changes in the environment

16. Which of the following parts uses vibrations of airflow to create sound
A. Larynx B. Bronchi C. Trachea D. Pharynx

17. Why are respiratory surfaces moist

A. To dissolve the gases C. To prevent them from drying
B. To make them turgid D. To carry the gases

18. What is the causal agent for whooping cough
A. *Bordetella pertusis* B. *Bacillus anthracis* C. *Plasmodium vivax* D.*Vibrio cholera*

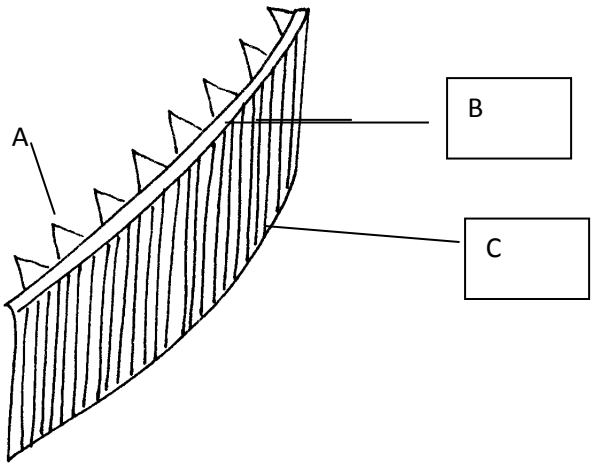
19. What is the causal agent for tuberculosis
A. *Mycobacterium tuberculosis* B. *Bacillus anthracis* C. *Vibrio cholerae* D.bacteria

20. Which of the following organism is not correctly matched with its respiratory surface?
A. Amphibians- Buccal cavity
B. Insects - Tracheole system
C.Bony fish - Gills
D.Earthworms - Skin

21. Why should trachea and bronchi have rings of cartilage
A. To make it open B. To allow gases to move out C. To moisten it
D. To allow diffusion gases

The diagram below shows a gill obtained from fish.

Study it and answer questions 22-28



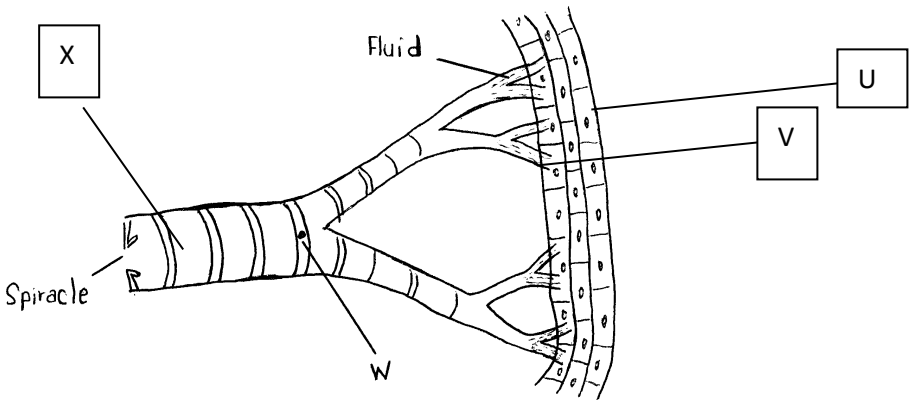

22. Name the part Labelled A
A. Gill filaments B. Gill Bar C . Operculum D. Gill rakers

23. Name the part labeled B
A. Gill filaments B. Gill Bar C. Gill rakers D. Buccal cavity

24. Name the part labeled C
A. Gill bar B. Gill filaments C.Gill rakers D. Gill cleft

25. What is the function of gills to fish?
A. Gaseous exchange B. Digestion C. Locomotion D. Sensitivity

The diagram below shows the tracheal system in an insect.Study it and answer question 26-31




26. **Name** the structure labeled W.
A.Ring of cartilage B. Trachea C. Valve D. Nostril

27. Name the part labeled X
A. Ring of Cartilage B Bronchus C. Muscle tissues D.Tracheole

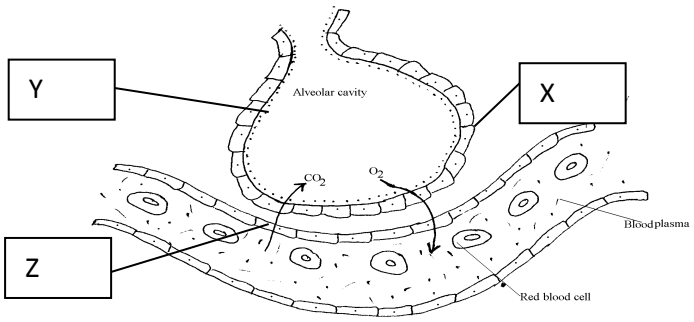
28. Name the parts labeled V
A. Tracheole B. Trachea C. Muscle tissue D. Bronchiole

29. Name the parts labeled U

A. Muscle tissue B. Trachea C. Tracheole D. Gills

30. What is the function of the fluid found in the above structure
A. Dissolve gases C. Contain haemoglobin
B. Contain haemocoel D. To reduce friction

The wall of the alveolus is the gaseous exchange surface in a mammal. Below is a cross-section through an alveolus. Study it and answer question 31-36.




31. Name the part labeled X
A. Layer of moisture B. Alveolus C. Alveolar wall D. Blood capillary

32. Name the part labeled Y

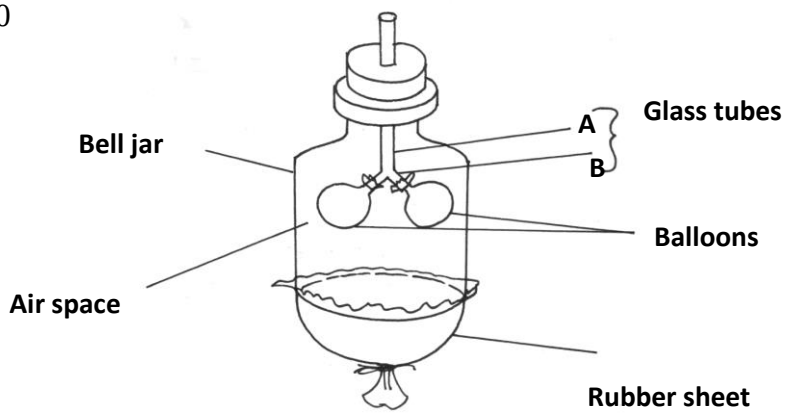
A.Cell membrane B. Alveolar wall C. Alveolus D. Film of moisture

33. Name the part labeled Z
A. Blood capillary B. wind pipe C. Alveolus D. Blood

34. Name the substance formed when red blood cell combines with oxygen
A. Oxyhaemoglobin B. Haemoglobin C. Bicarbonate ions D. Carboxy haemoglobin

35. What is the physiological process involved in the movement of CO2 and O2?
A. Diffusion B. Active transport C. Osmosis D. Movement

The diagram below represents a model of lungs and thorax. Study it and answer question 36-40




36. To what parts of the mammalian body parts are represented by glass tube A and B

A. Trachea and Bronchus B. Trachea and Lungs

C. Bronchus and Bronchioles D. Trachea and bronchioles

37. To what parts of the mammalian body parts are represented by bell jar
A. Rib cage B. Ribs C. Intercostal Muscles D. Diaphragm

38. To what parts of the mammalian body parts are represented rubber sheet
A. Sternum B. Diaphragm C. Ribs D. Rubber sheet

39. To what parts of the mammalian body parts are represented balloons
A. Heart B. Alveoli C. Lungs D. Trachea

40. What will be observed on the balloons when the rubber sheet is pulled outwards.
A. Deflated B. No change C. The balloon will burst D. inflated

41. Which one of the following is a disease of the respiratory system
A. Pneumonia B. Typhoid C. Malaria D. Cholera

42. The following are factors affecting the rate of breathing.Which one is not?
A. Age B. health C . Altitude D. Longitude

43. Which one of the following is not true about spiracles
A. They are found on the head B. They are found on the abdomen
C. They have valves D. They have hairs

44. Gaseous exchange in the tadpoles take place through?
A Mouth cavity B. Gills C. Lungs D. skin

45. What keeps the skin of a frog moist when on land?
A. Saliva B. Water C. Mucus D. Urine

46. Mosquito larva uses which of the following structures to breathe.
A. Plastron B. Siphon C. Tracheal gills D. Spiracles

47. The trachea are usually strengthened by a certain tissue.What is the name of the tissue?
A. Lignin B. Chitin C. Cellulose D. Sclerenchyma

48. What is the name of the flap that prevents food from entering the trachea
A Epiglotis B. Glotis C. Valve D . Sphincter muscle

49. A patient was suffering from the following symptoms
- Production of greenish yellow phlegm
- Coughing
- Fever
- Difficulty in breathing

Which disease is he suffering from?
A. Bronchitis C. Asthma C. Tuberculosis D. Pneumonia

50. What is the function of gill rakers?

A. To prevent solid materials from reaching the gill filaments
B. To allow water into the mouth
C. To hold the gill bar firmly
D. For gaseous exchange

51. What is the role of cilia which is found in the trachea of humans?
A. They beat to push the mucus up the throat
B . They secrete mucus
C. The moisten the trachea
D. They prevent solid particles from reaching the trachea

**SECTION B**

52. Briefly describe the importance of counter current flow in bony fish. (2mks)

53. Explain briefly four adaptations of alveoli to its functions (4mks)

54. Describe inhalation in mammals (5mks)

55. Which substance in cigarette smoke causes lung cancer? (1mk)

56. Briefly explain why fish will never survive for long outside water
(2mks)

57. Distinguish between inhalation and exhalation (2mks)

58. Distinguish between inspiratory capacity and vital capacity (2mks)

59. Differentiate between inspiratory reserve volume and expiratory reserve volume.
(2mks)

60. Briefly describe how the following factors affects the rate of breathing
(4mks)

a) Exercise
b) Temperature

61. Explain the adaptations of the tracheoles to its functions (4mks)

Explain the significance of branching of the tracheal system into fine tubes in an insect.
(2mks)

62. a) In the year 2003 a new disease called severe acute respiratory syndrome (SARS).Which organs are likely to be affected? (2mks)

a) Which would be the easiest way of preventing the spread of the disease from one country to another? (1mk)

63. A student divided a small airtight box into two chambers with a wire mesh. In one chamber he kept a number of rats and in the other a number of potted plants. What was likely to happen if the box was placed in the dark for 24 hours? Explain your answer. (2mks)

64. In insects, a rare disease has been found to attack the breathing system. Name the parts of an insect which are most likely to be damaged by the disease. Give a reason for your answer. (2mks)

65. In an experiment to analyse a sample of air, a J-tube was used to find out the amount of carbon (IV) oxide and oxygen in the sample. The length of the sample air in the J-tube was 8cm and alter mixing it with some sodium hydroxide solution for some minutes. The length was reduced to 7.6 cm. When pyrogallic acid was also made to mix with the sample of air for some minutes, the length reduced further to 6.6 cm. Calculate the percentage composition of oxygen gas. (2mks)

**APPENDIX C :**

**STUDENTS ATTITUDE QUESTIONNAIRE**

Name of the Institution_____

Admission number----------

Gender ( ) Male ( ) Female

We are interested to know how you feel about this lessons on gaseous exchange.

**INSTRUCTIONS**

Fill the spaces provided or tick inside the brackets( ) or in the spaces provided.

This is not a test and there are no **RIGHT** or wrong **ANSWERS.**

Feel free to give us your **HONEST** feeling.

This questionnaire has Part A and B

Read the items carefully before choosing your honest opinion

The letter choices are SA=Strongly Agree, A=Agree, D=Disagree, SD=Strongly Disagree, U=Undecided.

| | | **SA** | **A** | **U** | **D** | **SD** |
|---|---|---|---|---|---|---|
| 1 | The Biology lessons were satisfying. | | | | | |
| 2 | The Biology lessons were enjoyable | | | | | |
| 3 | The Biology lessons were meaningless. | | | | | |
| 4 | The Biology lessons were easy. | | | | | |
| 5 | The Biology lessons were difficult | | | | | |
| 6 | Biology makes me restless | | | | | |
| 7 | Biology lessons play a role in developing my thinking. | | | | | |
| 8 | The Biology lessons taught by the teacher were friendly. | | | | | |
| 9 | The Biology is not my favourite subject. | | | | | |
| 10 | I have a good feeling towards Biology | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11 | The Biology lessons taught were clear. | | | | | |
| 12 | The Biology lessons taught by the teacher were not interesting. | | | | | |
| 13 | The Biology lessons were dull | | | | | |
| 14 | The Biology lessons were unimportant. | | | | | |
| 15 | The Biology lessons taught by the teacher were interesting | | | | | |
| 16 | The Biology lessons taught by the teacher were difficult to understand. | | | | | |
| 17 | Biology is a waste of time. | | | | | |
| 18 | If I had an option of choosing another subject instead of Biology, I would opt for it. | | | | | |
| 19 | The Biology lessons taught by the teacher were simple | | | | | |
| 20 | Biology lessons were boring | | | | | |
| 21 | Biology concepts are unfamiliar | | | | | |
| 22 | I feel nervous when I think of Biology lessons | | | | | |
| 23 | I feel stressed during Biology lessons | | | | | |
| 24 | Biology concepts are not related to real life | | | | | |
| | **Totals** | | | | | |

## APPENDIX D :

## RESEARCH AUTHORIZATION BY NACOSTI


**NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION**

Telephone: +254-20-2213471,
2241349, 3310571, 2219420
Fax: +254-20-318245, 318249
Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying Please quote

9th Floor, Utalii House
Uhuru Highway
P. O. Box 30623-00100
NAIROBI-KENYA

Ref: No. NACOSTI/P/16/97688/13737

Date: 27th September, 2016

Kevin Kodeny Oscah Omondi
Egerton University
P.O. Box 536-20115
**EGERTON.**

**RE: RESEARCH AUTHORIZATION**

Following your application for authority to carry out research on ***"Effects of advance organizers on students' achievement and attitude towards learning biology in secondary schools in Kilifi County Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Kilifi County** for the period ending **21st September, 2017.**

You are advised to report to **the County Commissioner and the County Director of Education, Kilifi County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

**BONIFACE WANYAMA**
**FOR: DIRECTOR-GENERAL/CEO**

Copy to:

The County Commissioner
Kilifi County.

The County Director of Education
Kilifi County.

*National Commission for Science, Technology And Innovation Is ISO 9001:2008 Certified*

## APPENDIX E:

## RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
*MR. KEVIN KODENY OSCAH OMONDI*
of EGERTON UNIVERSITY, 1143-80108
KILIFI,has been permitted to conduct
research in *Kilifi County*

on the topic: *EFFECTS OF ADVANCE ORGANIZERS ON STUDENTS ACHIEVEMENT AND ATTITUDE TOWARDS LEARNING BIOLOGY IN SECONDARY SCHOOLS IN KILIFI COUNTY KENYA*

for the period ending:
*21st September,2017*

.....
*Applicant's Signature*

Permit No : NACOSTI/P/16/97688/13737
Date Of Issue : 27th September,2016
Fee Recieved :ksh 1000

.....
*Director General*
*National Commission for Science, Technology & Innovation*

### CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.
2. Government Officer will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one (1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEACH CLEARANCE PERMIT

Serial No.A 11080

CONDITIONS: see back page