TEACHERS' PERCEPTIONS ON EFFECTIVENESS OF THE KCSE BIOLOGY PRACTICAL ASSESSMENT APPROACH IN TESTING SCIENCE PROCESS SKILLS IN SECONDARY SCHOOLS IN SIAYA COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

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

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Recommendation

This thesis has been submitted for examination with our approval as university supervisors.

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DEDICATION

This thesis is dedicated to my late parents Mzee Aloice Ouko and Mama Margaret Ouko for their great love and nurture, my loving wife Mrs. Pamela Akeyo Otieno for her patience, support and empathy during my study and my children Ronald Ouko, Norbert Okoth and Harold Odhiambo in whom I find true friendship and kindness.

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ABSTRACT

Assessment is an important aspect of teaching - learning process in secondary schools. The Kenya Certificate of Secondary Education (KCSE) biology practical assessment approach introduced in the year 2005 is one in which out of the three questions tested, only one question, mostly food tests involve handling apparatus and specimens by the candidates. In the other two questions, the candidates observe photographs and photomicrographs presented and then answer questions. The approach was adopted with an aim of reducing the problems of cheating in biology practical examinations. However, its effectiveness in the assessment of Science Process Skills had not been ascertained. The purpose of this study was to establish the perceptions of teachers' on the effectiveness of the assessment approach in testing science process skills. Descriptive survey research design was used in this study. The target population comprised all trained secondary school biology teachers in Siaya. Accessible population were a total of 108 secondary school biology teachers in Siaya County. Proportionate stratified sampling and simple random sampling were used to select the subjects of the study. Proportional stratified sampling was used to ensure the study sample were derived from all the six sub-counties that constitute Siaya County, while simple random sampling was used to obtain study sample from each sub-county. A total of 90 teachers formed the study sample. Biology Practical Teachers' Questionnaire (BPTQ) was used to generate data from the respondents. Five research experts from the Faculty of Education and Community Studies, Egerton University, validated the instrument. The reliability of the instrument was estimated using Cronbach's Alpha coefficient. Pilot-testing was conducted in the neighbouring Kisumu sub-county, Kisumu County. Reliability coefficient for the questionnaire was 0.85. Data analysis was carried out using descriptive statistics which were frequencies, means and percentages. The findings of this study indicated that, from teachers' perceptions, the assessment of science process skills is ineffective in the KCSE Biology Practical Assessment Approach. It was concluded that in the perceptions of teachers, the KCSE Biology Practical Assessment Approach has not contributed much to the testing of science process skills in Biology practical Examinations. It was therefore recommended that a lot of hands-on activities, manipulation of specimens and handling of apparatus be reinforced in the testing of biology practical skills. The findings of this study are important in improving the testing of Biology practical paper by KNEC and teaching laboratory lessons by Biology teachers.

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LIST OF ABBREVIATIONS AND ACRONYMS

AAAS: American Association for the Advancement of Science

BPTQ: Biology Practical Teachers' Questionnaire

CDE 1: California Department of Education

CDE 2: County Director of Education

IBO: International Biology Olympiad

KCSE: Kenya Certificate of Secondary Education

KESSP: Kenya Schools Support Programme

KIE: Kenya Institute of Education

KNEC: Kenya National Examinations Council

MoE: Ministry of Education

NACOSTI: National Commission for Science, Technology and Innovation

NECT: National Examinations Council of Tanzania

SAPA: Science - A Process Approach'

SMASSE: Strengthening of Mathematics and Science in Secondary Education

SPSTFT: Science Process Skills Test For Teachers

UNEB: Uganda National Education Board

USA: United States of America

WAEC: West African Examinations Council

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Biology is one of the science subjects offered in Kenya's secondary schools (Kenya Institute of Education [KIE], 2002). Good quality, appropriate biology experiments and investigations are the key to enhanced learning and clarification and consolidation of theory. Biology aims at equipping the learners with the knowledge, attitude and skills necessary for preserving the environment (Bennett & Kennedy, 2001). The subject enables the learner to appreciate humans as part of the broader community of living organisms. According to Kenya Institute of Education [KIE], 2002 the subject is important in fields such as Health, Agriculture, Environment and Education. In view of the attainment of Kenya Vision 2030 goals, appropriate testing approaches to establish the acquisition of relevant practical skills is Paramount. The overreaching aim of Biology in secondary schools is to provide biology-related learning experiences that enable students to develop scientific literacy, so that they can participate actively in the rapidly changing knowledge-based society, prepare for further studies or careers in the fields related to life science, and become lifelong learners in science and technology (Republic of Kenya, 2008).

The broad aims of the Biology Syllabus (KIE, 2002) are to enable students to: Communicate biological information in a precise, clear and logical manner; develop an understanding of interrelationships between plants and animals and between humans and their environment; apply the knowledge gained to improve and maintain the health of the individual, family and the community; relate and apply relevant biological knowledge and understanding to social and economic situations in rural and urban setting; observe and identify features of familiar and unfamiliar organisms, record the observations and make deductions about the functions of parts of organisms; develop positive attitude and interest towards biology and the relevant practical skills; demonstrate resourcefulness, relevant technical skills and specific thinking necessary for economic development; design and carry out experiments and projects that will enable them understand biological concept; create awareness of relevant knowledge, skills and attitude for further education and for training in related scientific fields, and acquire a firm foundation of relevant knowledge, skills and attitudes for further education and for training in related scientific field (KIE, 2002).

In contemporary society, it is obvious that as a result of the rapid explosion of knowledge in biology due to the achievements of molecular biology and biotechnology, many new content areas and technologies are involved in the teaching of biology (Boardman, 2001). For graduates to be successful, they must have the ability to access and generate new knowledge in a purposeful fashion, and to move beyond simple content knowledge to critical analysis and an understanding of emerging trends and issues. According Bridges (1997), they should be able to solve real life problems, communicate with one another and consider relationships within what they have learned, perceive their field of study in the broad perspective and develop flexibility and adaptability to continue learning in their disciplines throughout life, including practical skills and personal skills.

The application of the contemporary education theories and strategies in the teaching process will facilitate students developing the relevant tasks. In fact teaching and learning are inseparable, in that learning is a criterion and product of effective teaching. Bridges (1997) argues that learning is in essence the goal of teaching. If students are to become independent, lifelong and active learners, programs of teaching and assessment strategies needs to include methods and tasks which are interesting, motivating and require students to be involved in both team and individual learning tasks (Boardman, 2001). Assessment is an important aspect of teaching and learning process in secondary schools (Boardman, 2001). It is the main approach in the evaluation of curriculum delivery and implementation. The type of assessment to be used should therefore be given critical consideration in the teaching and learning process in secondary schools in any country. According to Urevbu (1991), assessment deals with how well a student or group of students have learned a particular set of skills or kind of knowledge. Lorrie (2000) noted that in addition to using assessment to monitor and promote individual students' learning, classroom assessment should also be used to examine and improve teaching practices. Several scholars all over the world such as Lorrie (2000) Kalomba and Mpaju (2003), Boit, Njoki, and Koskey (2012) among others have carried out studies and reported on the close link between teaching/ learning and assessment.

Science process skills refer to any ability that helps a person do science such as observing, inferring, classifying, questioning, predicting, experimenting, data analysing and communicating (Rillero, 1998). According to researchers Badri and Shri (2013), science process skills are the sequence of events that are engaged by researcher while taking part in scientific investigations. They are series of connected actions, experiences or changes which go on internally within a learner and can usually be demonstrated externally. The skills are important to formal presentation of science. Thus, scientific process skills lay the basis of scientific inquiry and scientific thinking. A learning environment where science process skills are used requires active participation of students (Bagcı, 2006). Without developing these skills, it is difficult for people to construct new information. Jerry (1997) defines science process skills as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behaviour of scientists.

An overview of biology practical syllabus and tests internationally and regionally has revealed that emphasis is given to hands-on/practical activities. The approach used in testing biology practical skills both internationally and regionally (USA, Britain, Nigeria and Uganda) emphasises testing of experimenting skills (California Department of Education [CDE], 2011; Nuffield Foundation, 2010 and West African Examinations Council [WAEC], 2011) have questions demanding that the students physically handle specimens as they make observations, drawings and conclusions.

Biology practical examinations in Uganda aim at; testing students' ability to follow carefully a sequence of instructions within a set time allowance, using unfamiliar techniques in practical, recording observations and making deductions from it; examining and recognising features of familiar and unfamiliar biological specimens; recording observations and making deductions about functions of whole specimens or their parts, making clear line drawing of specimens provided, indicating magnification and labelling familiar structures; interpreting unfamiliar data and drawing conclusions from their interpretations; employing manual skills in assembling apparatus, in using chemical reagents and in using instruments such as mounting needles, scalpels and razor blades, forceps and scissors among others, and observing reactions, reading simple measuring instruments and performing simple arithmetic calculations.(Uganda National Examination Board [UNEB], 2011).

Over the years in Kenya, the testing of biology as a science subject in KCSE has been done in such a way that students do both theory paper(s) and a practical paper. The theory papers were and are designed to test mainly cognitive knowledge of the students whereas the practical papers emphasised laboratory skills. The previous testing of biology practical examination was such that in all the three questions tested, the candidates were allowed to manipulate apparatus or handle the actual specimens while answering questions (KNEC, 2005). However from the year 2005 the KCSE changed their format of setting the practical paper by replacing the actual specimens that were provided to students during the examinations with their images in the form of photographs (for multi-cellular organisms or their parts) and photomicrographs(for unicellular structures), citing cheating problems (KNEC, 2005). KNEC argued that when practical confidential instructions were sent to teachers earlier so that they could start assembling the specimens to be used in the examinations, the teachers were using this information to thoroughly drill their students in all aspects of the specimen that could be tested.

The concern however is that biology is a science subject in which students should be tested on practical skills by allowing them to observe, cut, measure, and cross examine actual specimens among other things as they respond to questions in the examinations. This is not possible with photomicrographs and photographs. It is also possible that the approach of replacing specimens with photomicrographs and photographs may make the teachers not to see the need of taking students through biology practical lessons in the laboratories which are viewed as laborious and time consuming but instead resort to the use of photomicrographs and photographs similar to those used by KNEC in testing.

Performance in biology in Siaya County has continued to be poor over the years despite the government’s effort to equip biology teachers with new skills through in-service trainings such as Strengthening Mathematics and Sciences in Secondary Education (SMASSE). Tables 1 and 2 show the performance in biology in Siaya County (formerly greater Siaya District) before the year 2005 and from the year 2005 - 2012 respectively.

Table 1

Siaya County Biology KCSE Performance Before 2005

Year	2000	2001	2002	2003	2004
Mean	6.032	5.943	5.904	5.863	6.454

Source: Siaya County Director of Education's office.

Table 2

Siaya County Biology KCSE Performance From 2005-2012

Year	2005	2006	2007	2008	2009	2010	2011	2012
Mean	4.737	4.770	5.431	5.233	6.180	5.337	6.101	5.210

Source: Siaya County Director of Education's Office.

Comparing Tables 1 and 2 reveals that there was a general better performance in biology prior to 2005 when the current practical assessment approach came to effect. For instance, in the year 2004, the county biology mean score was the highest at 6.454 but this went down to 4.737 at the onset of the current assessment approach. This could be attributable to the effect of the new assessment approach, although other intervening and extraneous variables may also play significant roles. It is recommended that the Kenya National Examination Council should include more integrated science process skills into the KCSE biology practical examinations to enable the students to develop problem solving abilities and creativity which are important tools for biotechnology (Ongowo & Indoshi, 2013).

The overall performance in Biology Practical paper nationally in the year 2005 when the new testing approach was introduced attest to the fact that there could be a possibility of the new testing approach affecting performance in the paper. The mean score in biology practical paper was 10.71 marks out of a maximum score of 40 marks which is equivalent to 26.775% pass compared to performance in 2006 when the mean score was 11.63 (KNEC, 2006), a difference which was considered significant by the researcher. This dismal performance could be attributed to the new KCSE biology practical testing approach. The study sought to establish whether, in teachers' perceptions, the KCSE biology practical assessment approach effectively tests science process skills, especially those that are hands-on and whether this approach has succeeded in enhancing achievement of students' in biology. It also sought to unveil whether this assessment approach improves students' interest in the subject.

1.2 Statement of the Problem

The KCSE biology practical paper testing involves a study of photographs and photomicrographs in two out of the three questions done in biology practical paper. It is only in one question where candidates handle apparatus and reagents as they answer the question. It is a departure from the previous biology practical examination which emphasised 'hands-on' approach in all the three questions. The possibility, therefore, is that the testing approach in biology promotes the acquisition of theoretical skills rather than the entire science process skills, especially the observation, controlling variables and experimenting skills which are considered fundamental at this level. The science process skills are practical skills important in the construction of scientific knowledge especially biological knowledge at secondary school level in Kenya. There is therefore need to investigate the level of testing of the science process skills in KCSE biology practical examinations. This study, therefore, sought to investigate the teachers' perceptions on the effectiveness of the KCSE biology practical assessment approach in testing science process skills.

1.3 Purpose of the Study

The purpose of this study was to determine teachers' perceptions on the effectiveness of the KCSE biology practical assessment approach in testing science process skills in secondary schools in Siaya County.

1.4 Objectives of the Study

This study was guided by the following objectives:

i. To determine whether, in the perceptions of teachers, KCSE biology practical assessment approach effectively tests the acquisition of observation skills in secondary schools in Siaya County.

ii. To determine whether, in the perceptions of teachers, KCSE biology practical assessment approach effectively tests the acquisition of controlling variables skills in secondary schools in Siaya County.

iii. To determine whether, in the perceptions of teachers, KCSE biology practical assessment approach effectively tests the acquisition of experimenting skills in secondary schools in Siaya County.

iv. To determine teachers' perceptions on how KCSE biology practical assessment approach influences learners' achievement in biology in secondary schools in Siaya County.

1.5 Research Questions

The study sought to provide answers to the following questions:

i. Does KCSE biology practical assessment approach effectively test the acquisition of observation skills?

ii. Does KCSE biology practical assessment approach effectively test the acquisition of controlling variables skills?

iii. Does KCSE biology practical assessment approach effectively test the acquisition of experimenting skills?

iv. How does KCSE biology practical assessment approach influence learners' achievement in biology?

1.6 Significance of the Study

The findings of this study have brought to the fore the biology teachers' perceptions on the effectiveness of the KCSE biology practical assessment approach in testing science process skills. The stakeholders such as biology teachers, school principals, Kenya Ministry of Education and KNEC have benefited in knowing the effectiveness of this approach in testing the science process skills. It has shown whether the KCSE biology practical assessment approach has achieved its core objectives in Siaya County, Kenya. The Biology teachers and school principals in the region have benefited by knowing whether the assessment approach is relevant in effectively evaluating curriculum. The findings of this study are useful in guiding the Ministry of Education and KNEC on necessary adjustments to the KCSE biology practical assessment approach for future testing.

1.7 Scope of the Study

The study was carried out in Siaya County, Kenya and its scope was restricted to the following:

i. Only qualified Biology teachers who prepare candidates for KCSE biology practical examination were studied. The qualified Biology teachers were those with diploma, degree or masters' level pre-service teacher education.

ii. The study mainly delved on the testing of three science process skills; observation, controlling variables and experimenting skills, which are considered to be involving a lot of hands-on activities.

1.8 Limitations of the Study

i. The study largely relied on the honesty of the respondent teachers from whom data was collected.

ii. The study only focused on the extra-county schools.

1.9 Assumptions of the Study

The study made the following assumptions;

i. Teachers' teaching experience in terms of handling the candidate classes did not vary significantly.

ii. Teachers who participated in the study came from schools with resources which are more or less similar.

iii. The class sizes are within the Ministry of Education recommendation of 40-50 students.

1.10 Definition of Terms

Achievement: This is something accomplished successfully, especially by means of exertion, skill, practice, or perseverance. In this study, achievement will be used to mean the learners performance in KCSE biology practical paper.

Biological photograph: A photograph is an image, especially a positive print recorded by a camera and produced on a photosensitive surface. In this study biological photographs are images of biological specimens taken by photographs used for study in biology.

Biological photomicrograph: A photomicrograph is a photograph made through a microscope. It is also known as microphotograph. In this study biological photomicrographs are images of unicellular biological specimen which are first magnified then photographed used for study in biology.

Biology practical: A method of studying some biological concepts where students are made to handle specimens, apparatus, chemicals and many other biological apparatus in the course of study in secondary schools, and as well make observations, drawings, deductions among other things.

Confidential Instructions Paper: This is a paper containing a set of rules or a promise that limits access or places restrictions on certain types of information. In this study, biology confidential means a paper containing some information conveyed to the biology teachers by KNEC but must not be accessed by the candidates. They contain instructions on specimens, reagents and chemicals to be used by candidates during biology practical examination.

Effectiveness: This is the capability of producing desired result. In this study the effectiveness of biology practical paper is the ability of the paper to test most of the Science Process skills such as experimenting and observation skills learnt in biology.

Experimenting skill: This is a systematic approach to solving a problem. Usually experimenting is synonymous with the algorithm called scientific method which follows these five basic steps: **Problem Identification-->Hypothesis-->Predictions-->Test of Predictions--> Evaluation of Hypothesis** (Badri & Shri, 2013). In this study experimenting skill were used to mean skills demonstrated when students are involved in hands - on activities as they perform biological practical activities in the laboratory.

Extra- county schools: These are the well established boarding secondary schools which were initially referred to as Provincial Boarding Schools in Kenya. They are currently allocated at least one student from every county in the republic.

Food test: This is a complete range of food testing and laboratory analysis to ensure the safety, quality and legality of manufacturing operations. In this study food test is a biology practical testing approach used to determine the type of food substance present in a sample of food using reagent(s).

Performance improvement: This is the concept of measuring the output of a particular process or procedure, then modifying the process or procedure to increase the output, efficiency, or effectiveness of the process or procedure. In this study, performance improvement means better scores in biology by the candidates.

Perceptions: This is the organisation, identification, and interpretation of sensory information in order to represent and understand the environment. In this study, perceptions refer to the opinion of biology teachers on the effectiveness of the new KCSE biology practical assessment approach on testing science process skills.

Science process skills: This is a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behaviour of scientists. These abilities include observation, measurement, classification, quantification, inferring, predicting relationships, communication, interpreting data, controlling variables, operational definitions, hypothesizing and experimenting (Jerry, 1997). This study selected three science process skills, which are, observation, controlling variables and experimenting and evaluated their testing in KCSE biology practical testing approach. Observation skills are basic science process skills while controlling variables and experimenting skills are integrated science process skills.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter covers what writers or other researchers said or did, especially with regards to teaching and testing in biology and the importance of testing in biology practical paper in particular. It flows from science process skills to rationale for the process approach; categories of science process skills, role of assessment in instruction, assessment of science practical skills, biology practical assessment, and the KCSE approach in assessing biology practical skills (the use of photographs and photomicrographs). The chapter ends with both the theoretical and conceptual frameworks which explain and figure out the relationship between the independent variable (The new KCSE biology practical assessment approach) and the dependent variable (assessment of science process skills) respectively.

2.2 Science Process Skills

The term science process skills refer to a set of broadly transferable abilities appropriate to many science disciplines and reflective of the behaviour of scientists (Padilla, 1990). According to Nwosu and Okeke (1995), science process skills are mental and physical abilities and competencies which serve as tools needed for the effective study of science and technology as well as problem solving and individual societal development. Akinbobola and Afolabi (2010) view science process skills as cognitive and psychomotor skills employed in problem solving, problem identification, data gathering, transformation, inter- pretation and communication.

According to Ozgelen (2012), science process skills are thinking skills that scientists use to construct knowledge in order to solve problems and formulate results. Implicit in these definitions of science process skills is that these skills are integral and natural to a scientist; they are instruments for the study and generation of scientific knowledge; science learning and development of science process skills are integrated activities.

According to Badri and Shri (2013), science process skills are the sequence of events that are engaged by researcher while taking part in scientific investigations. They are series of connected actions, experiences or changes which go on internally within a learner and can usually be demonstrated externally. The skills are important to formal presentation of science. Thus, science process skills lay the basis of scientific inquiry and scientific thinking. A learning environment where science process skills are used requires active participation of students (Bagci, 2006). Without developing these skills, it is difficult for people to construct new information. Jerry (1997) defines Science Process Skills as a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behaviour of scientists.

The American Association for the Advancement of Science (AAAS) developed a programme known as ‘Science A Process Approach’ (SAPA) whose main concern is to promote acquisition of science process skills (Ibe, 2004). He asserts that this programme sees science processes as true essence of science. The programme was designed to improve children’s skills in the process of science. Americans believe that the acquisition of science process skills is the bases for scientific inquiry and the development of intellectual skills and attitudes that are needed to learn scientific concepts. According to Bagci (2006), without developing the appropriate science process skills in the learners, it would be difficult for people to construct new information. Ideas are constructed by ‘doing’ and not by ‘hearing’. Science process skills are about doing.

Leonard and Penick (2000) point out that standard-based activities should engage the students in observing; asking and identifying questions and problems; identifying dependent and independent variables; formulating hypotheses; designing and conducting experiments; manipulating independent variables; collecting data; organising data; displaying data; inferring from data; generalising; applying generalisations; communicating results; and formulating new hypotheses. They argue that inquiry makes learning more interesting and engaging and can have lasting effects on one's mind. Nwagbo (2008) asserts that the use of science process approach to the teaching of biological concepts should be a rule rather than an option to biology teachers, if we hope to produce students that would be able to acquire the necessary knowledge, skills and competence needed to meet the scientific and technological demands of the nation.

2.3. The Rationale for the Process Approach

According to Harlen (1999) and Sevilay (2011), the mastery of science process skills enables students to conceptualise at a much deeper level, the content they do know and equips them for acquiring content knowledge in the future. Content knowledge is acquired more efficiently and understood at a deeper level when obtained through inquiry using science process skills. The science curriculum that emphasizes science process skills will be able to help students to improve the skills in critical thinking, creative thinking and decision making. These skills can be transferred to other disciplines (Meador, 2003; Halim and Meerah, 2012).

According to Brotherton and Preece (1996) and Sevilay (2011), the basic science process skills helps in providing the intellectual groundwork in scientific inquiry such as ability to order and describe natural objects and events. The ability to apply basic science process skills is attributed to the ability to perform empirical inductive reasoning or Piagetian concrete operational reasoning. Sevilay (2011) holds that the integrated science process skills are the terminal skills for solving problems or doing science experiments. The ability to carry out integrated science process skills are attributed to hypothetico-deductive reasoning. Sevilay (2011) continues to hold that science process skills help the students to develop a sense of responsibility in their own learning, increase permanency of learning as well as teach them research methods. According to Opateye (2012) and Okere (1997), science process skills are helpful on the development of favourable scientific attitudes and a disposition in the learners. These include being curious and imaginative, including enthusiasm about inquisitiveness.

2.4. Categories of Science Process Skills

The commission on science education of the American Association for the Advancement of Science (AAAS) launched a program named Science A Process Approach (SAPA), which emphasised the laboratory method of instruction and learning of scientific processes by children. SAPA grouped process skills into two types, that is, basic and integrated (AAAS, 1993).

According to Rambuda and Fraser (2004), the basic science process skills apply specifically to foundational cognitive functioning in especially elementary grades. They represent the foundation of scientific reasoning learners are required to master before acquiring and mastering the advanced integrated science process skills (Brotherton & Preece, 1995). Funk et al. (Cited in Rambuda & Fraser, 2004), maintain that basic science process skills are interdependent, implying that investigators may display and apply more than one of the skills in any single activity. For instance to *measure* the area of a habitat, the biology student may start by *observing* the habitat, then *measure* the dimensions and communicate the same using a symbol. Thereafter the student may *calculate* the area. In this scenario, the student was involved in the skill of *observing*, *measuring* and *calculating*. The basic science process skills include observing, inferring, measuring, communicating, classifying and predicting (Padilla, 1990). From this, it appears the basic science process skills provide an intellectual groundwork in problem solving.

According to Rambuda and Fraser (2004) integrated science process skills are the immediate skills used in problem solving or doing science experiments. As the term integrated implies, learners are called upon to combine basic science process skills for greater expertise and flexibility to design the tools they apply when they study or investigate phenomena. The integrated skills include controlling variables, defining operationally, formulating hypotheses, interpreting data, experimenting, and formulating models.

Science process skills refer to any ability that helps a person do science such as observing, inferring, classifying, questioning, predicting, experimenting, data analysing and communicating (Rillero, 1998). This study sought to establish whether science process skills, mainly observation, controlling variables, and experimenting are effectively tested by KCSE biology practical assessment approach. The specific science process skills have been discussed in sections 2.4.1, 2.4.2, 2.4.3 and 2.4.4 with special emphasis on the three (observation, controlling variables and experimenting) that are fundamental to this study.

2.4.1. Observation Skills

Defined as the gathering of information through the use of any one, or combination of the five basic senses; sight, hearing, touch, taste, and smell. It involves the use of the five senses to derive characteristics of living organisms (Ongowo & Indoshi, 2013). The skill of observation is seen by Webb and Glover (2004) as an activity in which all the people young and old, engage in throughout their lives. It is said to be theory dependent in that what we see is dependent to some extent on the theories that we hold. They further aver that children's ability to observe involves the learning of a conceptual framework that identifies the elements of a complex situation that is scientifically worth observing. The skill is important to researchers in that they are able to identify similarities and differences hence make an informed decision about a phenomenon.

Ostlund (1998) posits that science begins with observations of objects and events; these observations lead to the asking of questions. Crucial to the method of science is the ability to ask the right question and to make selected observations relevant to that question. Observations are influenced by past experience, often involve instruments (microscopes, telescopes, oscilloscopes, hand lenses etc.), and require careful recording and description. Surprising or unexpected observations occasionally contribute new and important knowledge.

Almost every activity of science begins with observation. From nature to the test tube and to experiments in the laboratory, observation must be used. A useful characterisation of scientific observation is given by Harlen (1987) taking information about all things around, using the senses as appropriate and safe; identifying similarities and differences; noticing details and sequence; ordering observations. According to Gacheri and Ndege (2014), observation skills are applied in the testing of KCSE biology as a subject.

Observation alone is not necessarily an accurate and reliable activity for gathering data. Observers often "miss seemingly obvious things" and "invent quite false observations." Nevertheless, the skill is valuable for and crucial to both the process of conducting scientific inquiry and to the process of teaching and studying the ways of science (Ango, 2002).Observational skills expected in science are to read the instrument correctly, notice colour change, notice relevant details in given specimen, locate desired parts in specimen accurately, and take observations carefully in a systematic manner. Without studies to explain if the schools are taking the observation accordingly, there remains inadequate knowledge.

2.4.2. Controlling variables Skills

According to the AAAS' classification (AAAS, 1993), controlling variables skills have been classified as integrated skills. However, Rehorek (2004) classifies controlling variables as a basic science process skill. Controlling variables is the ability to recognise dependent and independent variables. In practical investigations, practical group is usually exposed to some treatment (the independent variable) while the control group is not exposed to the treatment .This process is also a kind of group process because one may engage in several different behaviours in an attempt to control variables. According to Ongowo and Indoshi (2013), controlling variables entails identifying variables, keeping variables constant and manipulating.

2.4.3. Experimenting Skills

Badri and Shri (2013) describe experimenting as an integrated process skill that includes other process skills like observation, interpretation, planning and reporting. Integrated process skills are involved when learners conduct experiments. This is in tune with the AAAS' classification of the science process skills (AAAS, 1993). They formulate hypothesis, design experiments and make a generalisations after collecting data. A central feature of experimentation is said to be the idea of control in order that possible alternate, interpretations of a situation may be eliminated. It is a systematic approach to solving a problem. Usually experimenting is synonymous with the algorithm called scientific method which follows these five basic steps: Problem Identification-->Hypothesis-->Predictions-->Test of Predictions--> Evaluation of Hypothesis. It is an important skill to the learners in that during experimenting the learners acquire the other integrated skills.

An experiment is a series of observations carried out under special conditions (Ostlund, 1998). According to him, the distinction between observation and experimentation is slight. An experiment always consists of observations, but it is more than that because the observers usually interfere to some extent with nature. Experimentation is the hallmark of good science whether it comes at the beginning - as a gathering of facts - or at the end in the final test of a hypothesis. The hands-on manipulative experiences science provides are the key to the relationship between process skills in both science and reading (Lucas & Burlando, 1975).

Ongowo and Indoshi (2013) describe experimenting as testing by following procedures to produce verifiable results. The complete process of science cannot be learned by merely reading, listening, memorising or problem solving but effective teaching requires active mental involvement (Visser, 2000). All sciences are built with information from direct experiments and the nature of the subject rests heavily on the interaction between the theory and the experiment. For conceptualisation to occur, learners must be both mentally and actively involved. A student therefore needs to possess handy experimental skills to be able to effectively learn science. Any science testing approach needs to test the experimenting skills of the candidates effectively. This study sought to evaluate whether, in teachers' opinions, the KCSE biology practical assessment approach effectively tests experimenting skills as science process skills.

2.4.4. Other Science Process Skills

Hypothesis is a statement put forward or an attempt to explain some happening or features Badri and Shri (2013). The learners may provide some plausible explanation for observation. Each student may provide a different explanation, these plausible explanations become hypothesis. Hypothesis suggests, thus, provides an explanation which should be consistent with evidences. It helps the researchers to use previous knowledge in attempting an explanation. Hypothesis is only provisional and should also be testable. Hypothesizing is, again, an intrinsic and creative mental process rather than a more straight forward and obvious behaviour.

Inferring is an inventive process in which an assumption of cause is generated to explain an observed event. According to Wenham (2005), Inferring is also a kind of guess based on subjective explanation for observations. It is important to researchers in that it uses scientific principles to explain the observations. Predicting is a process which deals with projecting events based upon a body of information. Prediction proceeds investigation. It is an intelligent guess to what would happen given the type of questions. It is important in that it helps in planning the experiments and suggests what type of investigation is required to test hypothesis. It is different from guess in that it makes use of scientific knowledge (Bagci, 2006).

Communication as a science process skill actually refers to a group of skills, all of which represent some form of systematic reporting of data. According to Ward, Roden, Hewlett and Foreman (2008), Communication involves reporting the results of investigation and sharing with peers and others is important communication in science involves graph, chart, table, symbols. It involves the following stages; discussing ideas among students orally and in written form, recording observations while conducting experiments and using graph, charts diagram, table to make communication meaningful. It is an important skill in that it allows the researchers to present their findings to the audience.

Ostlund (1998) posits that a scientist is obligated to make the information from observation and experimentation available to the scientific community for independent confirmation and testing. Discussion and critical analysis of findings are the key means by which science advances. Scientists disseminate their results in journals, at professional meetings, seminars, and through informal networks. This dissemination contributes to the common core of knowledge of the past and provides the vehicle for continuous review of this body of knowledge. Communication is the means by which purpose and usefulness are given to scientific investigation.

Classification is the process of grouping objects on the basis of observable traits. Objects that share a given characteristic can be said to belong to the same set. Quantification refers to the process of using numbers to express observations rather than relying only on qualitative descriptions. Data interpretation process refers to the intrinsic ability to recognize patterns and associations within bodies of data. The process skill of relationships deals with the interaction of variables. This interaction can be thought of as a kind of influence-counter influence occurring among a system's variables. An operational definition is one that is made in measurable or observable terms. An operational definition should not require interpretation of meaning nor is it relative. The meaning of the defined term must be explicit and limited to the parameters established for the definition.

Measurement involves assigning numbers to objects or events that may be arranged in a continuum according to a set of values (Ostlund, 1998). Expression of observations in quantitative terms adds precision and permits more accurate descriptions. Learning by students is facilitated by the process in which they are informed with feedback about their solutions to problems. With feedback, they can rework problems, formulate new problems and solve them. One of the main ways in which students receive feedback from their scientific inquiry is through measurement. It is a science process skill which gives students an opportunity to appraise themselves realistically. Adetula (1981) states clearly the important role of measuring; nearly every aspect of contemporary civilization depends on the concept of measurement and its application, ranging from the relatively simple measurements needed for the manufacture of clothing to the highly complex measurements required sending a space craft into orbit.

2.5. Role of Assessment in Instruction

The ultimate measure of the quality of any education system is not how many are in school but what- and- how well they learn. Urevbu, (1991) says that "Assessment deals with how well a student or group of students have learnt a particular set of skills or kind of knowledge". Looking at assessment from this view thrusts a lot burden on the teachers who are very critical in any learning institution and this is why Rice (2003) says that "the single most important factor affecting student achievement is teachers and the effect of teachers on students are both additive and summative".

Several research findings presented in the form of Journals or Academic Reports all over the world underscore the close link between assessment and instruction (Lorrie,2000; Carr, McGee, Jones, McKinley, Bell, Barr and Simpson ,2004). Lorrie (2000) noted that in addition to using assessment to monitor and promote individual students' learning, classroom assessment should also be used to examine and improve teaching practices. She noted this during her research on the Role of Classroom Assessment in Teaching and Learning in the University of Colorado, USA.

In South Africa, Carr, *et al.* (2004) emphasise the purposes of assessment or feedback as an integral part of the learning process which has both formative and summative functions. They argue that these two sets of functions are mainly a matter of when they occur in relation to their purpose, and not a differentiation of rigour or quality. They assert that Formative assessment is an on-going informed interaction between the teacher and student designed to enhance student learning. Assessment provides feedback to the teacher and to the student about present understanding and skill development in order to determine a way forward (Carr *et al.*, 2004). They said this on their research findings on the Effects of Curricula and Assessment on Pedagogical Approaches and on Educational Outcomes for the New Zealand Ministry of Education.

Kalomba and Mpaju (2003) found out that Tanzanian Schools have a system that emphasizes regular and integrated assessment and feedback. The Assessment emphasizes assisting teachers and students to know areas in which they are strong or weak. They also provide a means through which good teaching and learning can be identified, celebrated and rewarded. They discovered this in their research paper on The Impact of Assessment and Certification on Teaching and Learning in Tanzania.

In Kenya Ngware, Oketch, Mutisya, and Kodzi, (2010) in their research findings titled: 'Does Teaching Style Explain Differences in Learner Achievement in Low and High- Performing Schools in Kenya', noted that the dominant teaching activity in a lesson, the availability of relevant teaching aids, and the interaction between teaching aids and teaching experience significantly explains learners' test scores and is a source of the difference in performance between high and low performing schools. They discovered that use of recitation (highly interactive teaching methods) during lessons, use of visual teaching aids that stimulate learning and provide memorable experiences, and the presence of experienced teachers all characterized high-performing schools.

Boit, Njoki, and Koskey (2012) in their work on: 'The Influence of Examinations on the Stated Curriculum Goals' concluded that examinations have had a negative effect on curriculum implementation. The researchers posit that examinations have played a central role in the entire school programme, influencing each activity that took place in the school hence as a result of pressure due to examinations; the teachers cannot engage all the methods of instruction to attract the learners' interest in class. Teacher centred methods like the lecture methods are used at the expense of the learners' understanding. Examinations also made teachers to be selective in the content to be taught. For instance predicted topics were taught while the rest were either done partially or completely left out. They assert that the integration of life skills in the various subjects were also ignored or rushed over when all the other "important" topics have been dealt with. The unexamined subjects like Physical Education were also not taught. This is supposed to be a compulsory subject in the school curriculum in every class but its slot is used by the teachers to cover the syllabus or for revision.

They conclude by cautioning that all these happenings are contrary to the education goals which are expected to be achieved in the school system.

The findings from various researchers (Lorrie, 2000; Carr, *et al.*, 2004) underscore the importance of assessment as feedback to teaching-learning process among other things. According to Giddings & Fraser (1988), achieving the objectives of science practical work depend a lot on the mode of assessment of laboratory work adopted by the teachers and examination bodies. According to them, the mode of assessment directly influences teachers' teaching methods, students' learning styles and attitudes towards practical activities. It is therefore for this reason that this study sought to find out whether, in the opinion of the biology teachers, the science process skills they teach in class are effectively tested by the KCSE biology practical assessment approach.

2.6. Assessment of Science Process Skills

There have been several issues around the nature of the practice of assessment strategies in science. Champagne and Newell (1992) argued that assessment is a highly political process and a critical issue in today's education world. Assessment in schools is a concern for everybody else in the society as it determines future placement of the candidates to tertiary institutions, universities and jobs. Race (1997) argued that many areas of study involve practical work, but it is often much more difficult to assess such work in its own right. Assessing reports of practical work may involve measuring the quality of the end-product of the practical work but not the work itself. According to him, therefore, testing tools should be formulated that are able to assess the process as well as the product of the practical work.

Race (1997) laid out some suggestions for assessing practical work:-

• Reserve some marks for the process.
• Get students to self-assess how well they undertook tasks.
• Ask students to include in their reports "ways I could do the experiment better next time".
• Include some 'supplementary questions'.
• Design the right end-products.

Race (1997) pointed to the danger of measuring the final product of certain skills and ignoring measurement of the skills themselves. He laid out ten questions and suggested that addressing these questions may help to get the balance right. Wilkinson and Ward (1997) suggested that laboratory work should be assessed and should form part of a student's overall assessment. It is usually tempting for teachers and examiners to test theoretical knowledge at the expense of practical skills.

Clackson and Wright (1992) argued that practical science could be treated as a subject in its own right. They also suggested that the aim of the practical work should be clear to consider if the current practice was the best approach. Wilkinson and Ward (1997) compared the opinions of students of different achievement levels, and the opinions of students with their teachers, regarding the aims of practical work. Both students and teachers ranked "to make science more interesting and enjoyable through actual experience" as the most important aim. "To give practice in following a set of instructions" and "to prepare students for examinations" were considered to be of the least importance.

Wilkinson and Ward (1997) found that the responses of the male and female students were statistically different, and that their achievement levels also influenced what the students expected from the laboratory work. The reason for the low ranking of "to prepare students for practical examinations" may be the lack of practical examinations. When formal practical assessments involved, it may be necessary to involve such practice in school science teaching.

Jenkins (1994) argued that the slogan "scientific literacy" must be changed to "science for action". He stated that science education for action demands a rationale which is fundamentally different from that which underpins science curricula traditionally offered by schools and colleges. Scientific knowledge in the context of action is essentially about empowerment. It follows, therefore, that institutional provision, curricula, pedagogy and, where required, assessment must all be directed towards this end. The assessment action strategy used should be a tool of empowering the students' learning in science classes as it can provide feedback on the process of teaching and learning. There is evidence in the literature to suggest that practical work should be part of classroom activities and should be assessed.

Lawson (2000) stated that American Association for Advancement of Science recommended "science should be taught as it is practiced". In the South African context, just as in Kenyan context, this is a very challenging issue because the educators themselves also do not seem to be qualified enough to practice this and the resources are also not satisfactory. However, this could be achieved through designing and conducting simpler activities which do not require too many complicated and technical tools and apparatus and also by improvisation of teaching and learning resources. Bennett and Kennedy (2001) stated that a written examination of practical work can assess only a limited number of areas of the cognitive domain, namely knowledge, comprehension and application. They argued that some key areas of practical work such as analysis and synthesis could not be assessed by written examinations at all.

There is a wide range of agreement regarding the value of the practical work in science (Bennett and Kennedy, 2001). However the assessment of practical work and the knowledge and skills of practical work has not been researched conclusively. This might be due to the difficult nature of designing the right practical assessment tools. Bennett and Kennedy (2001) noted very positive responses from the students to a new assessment model for practical work which assessed manipulative skills, observational and measurement skills, recognition of apparatus and understanding of experimental work. They argued that there is a need for changes to be made in the assessment procedures in practical work.

According to Inal (2002), there exists disconnect between instructors' value of scientific literacy, their teaching of these skills, and their assessment of students' skill proficiency. He came up with this interesting finding from a study in which he developed an assessment tool for testing science processing skills and using it to test the learners. More than 65.8% of faculty surveyed agreed that all nine skills were "important" to "very important" to scientific literacy. Similarly, most faculty instructors reported that they teach and assess these skills. However, when asked in an earlier open-ended question to state the three most important skills students need to develop for scientific literacy, many responses were related to biology content knowledge, rather than skills. This dissonance between what many faculty instructors say they do and classroom reality has been documented by others and may be indicative of such concerns as the need to cover content and lack of time or expertise to develop and incorporate opportunities for skill development.

Testing helps to evaluate or assess student learning to discover misconception among students to determine effectiveness of program (Duran and Hajaily 1992). Unless evaluation adequately tests practical skills, the tendency in class room is to emphasize rote learning of facts similar to those of included in test. The greatest challenge in assessment is being able to comprehensively assess student in achievement in science process skills.

Radford (1992) suggests that if teachers expect students to learn the processes of science, then at least three conditions must be present: the teacher must have a command of the process skills; the students must be taught and given opportunities to practice the skills; and student progress in acquiring the skills must be evaluated. The level of testing of these skills by the KCSE biology practical paper therefore needs to be ascertained in compliance with the three conditions provided by Radford. Ronald et al., (1981) highlights the assessment of practical and skills test as a powerful tool in assessing the manual competence because it allows students to demonstrate what they know or what they can do.

2.7. Biology Practical Assessment

The practical examination traditionally assesses how much the students have learned in the practical classes in terms of practical skills (Bennett & Kennedy, 2001). An end of course practical examination may not provide students with the best opportunity to demonstrate the skills they have developed during the course since the examination should also reflect the assessment of laboratory skills such as dissection and drawing. The best dissections are often done when a student works carefully and precisely. Kirschner and Meester (1988) argue that if a goal of the course is acquisition of skills, then penalisation for mistakes does not advance the learning of those skills.

Sutherland and Peckham (1998) reported that many students consider assessment to be a discriminatory process which identifies who fails and who passes. However, the recent research and policy documents emphasise that assessment should be used as an aid in effective teaching. However, KSCE being a form of summative evaluation, assesses what students have gained over the four years in secondary school. Science assessment studies reveal very little attention on testing Science Process Skills emphasizing practical examination which is understudied in secondary schools (Gacheri & Ndege, 2014).

Assessment which is perceived as threatening and which provokes anxiety may encourage students to take an in-depth learning approach (Gibbs, 1992). The practical examination would fall under this category of "threatening and anxiety provoking" and we know that a large proportion of students think memorisation is the appropriate method of study for this subject. Bennet and Kennedy (2001) argues that if we reduce the emphasis on formal examinations and increase the value of ongoing practical assessment (dissections, drawings and scientific reports), we may achieve better outcomes for the students in terms of what they learn and how they study Biology.

Biology practical assessment approach should be that which poses the demand of doing science on the learners, as opposed to simply hearing, writing or reading about it. It should engage students and allow them to test their own ideas and build their own understanding (Ewers, 2001). Therefore, it is difficult to imagine a science-testing program without doing science experiences.

Several studies in the literature show that hands-on activities help students to outperform students who follow traditional, text-based programs (Turpin, 2000), to enhance their understanding and replace their misconceptions with the scientific ones (Coştu, Ünal and Ayas 2007; Ünal, 2008), to develop attitudes toward science positively (Bilgin, 2006; Bristow, 2000). According to t. Bilgin, (2006), hands-on activities will also help learners' to encourage their creativity in problem solving, promote student independence, improves skills such as specifically reading, arithmetic computation, and emphasizes that children learn better when they can touch, feel, measure, manipulate, draw, make charts, record data and when they find answers for themselves rather than being given the answer in a textbook or lecture. For students to truly learn science concepts, they both need practical opportunities to apply knowledge and also need help in integrating or exchanging the knowledge they gain.

This study sought to establish whether science process skills, especially observation, communication, controlling of variables and experimenting skills which are core skills acquired through practical work or hands on activities are, in the opinion of the teachers, adequately tested in the new KCSE biology practical assessment approach. It further sought to reveal whether the KCSE biology practical assessment approach enhances students' performance in biology and there interest in the subject.

An overview of the approaches used in testing biology practical skills both internationally and regionally (Nuffield Foundation, 2010; WAEC, 2011, and CDE, 2011), alongside the general objectives of biology practical in Uganda (UNEB, 2011) attests to the fact that biology practical exams should test for and as well emphasise acquisition of practical skills. National Assessment of Educational Progress (2009) advocates for hands-on performance task where students manipulate selected physical objects and try to solve scientific problem involving objects as fundamental assessment method.

2.8. KCSE Biology Practical Assessment Approach

Currently, KNEC uses mainly photographs, diagrams and photomicrographs in testing practical skills in biology in the KCSE assessment approach as opposed to other sciences (Chemistry and Physics). Out of the 3 questions in biology practical paper, only in one question are candidates required to manipulate apparatus. The other two questions are answered from diagrams, photographs and photomicrographs (KNEC, 2006). In Chemistry and Physics practical examinations, all the 3 and 2 questions respectively engage students in practical or hands- on activities. The biology practical paper takes $1^3/_4$ hours as opposed to $2^1/_4$ hours taken by both physics and Chemistry practical papers. Bennet, (2001) provides strong evidence that supports the claim that the use of written examination questions to assess practical abilities is likely to permit only very limited range of skills assessed.

The use photographs and photomicrographs to replace the real specimen deny the students the opportunity to manipulate the specimen and learn more about it. This preposition is supported by Winter, Lemons, Bookman & Hoose, (2001) who argue that practical work is a central theme of lessons and assessment in the natural sciences. They insist that a student cannot be considered to have acquired science practical skills without handling and manipulating specimens and apparatus. The KCSE biology practical paper can be improved by allowing questions with more practical activities to dominate.

Adey and Shayer (1994) pointed out that the mere recall of knowledge without the ability to transfer it in a working situation later on cannot be viewed as acquisition of a good standard of quality, which the goals of education intend to achieve in a society. They aver that meaningful knowledge should be transferable to real working situations in life. Michael (2006) posits that in science education, one route to achieve better performance is the active student-centred methods of school work such as class discussions, excursions, field work, problem solving, with laboratory work as a flagship. This study sought to establish teachers' perceptions on the effectiveness of the KCSE biology practical assessment approach in testing science process skills.

During the previous biology practical testing approach used by KNEC up to the year 2004, the candidates were subjected to three questions all of which required students to handle specimens, apparatus and chemicals as they perform tasks that lead them into answering the questions (KNEC, 2004). All the three questions had the actual specimens provided to the students to observe, dissect, draw and label required parts as they answer the questions. There was no use of photographs and/or photomicrographs to represent specimens or their parts as is the current practice (KNEC, 2004).

2.8.1. Use of Photographs and Photomicrographs

A Photograph is an image produced as a result of the art, science and practice of creating durable images by recording light or other electromagnetic radiation, either electronically by means of an image sensor or chemically by means of a light-sensitive material such as photographic film (Krebs, 2004). Typically, a lens is used to focus the light reflected or emitted from objects into a real image on the light-sensitive surface inside a camera during a timed exposure. The result in an electronic image sensor is an electrical charge at each pixel, which is electronically processed and stored in digital for subsequent display or processing. According to Krebs(2004), the result is a photographic emulsion, an invisible latent image, which later chemically developes into a visible image, either negative or positive depending on the purpose of the photographic material and the method of processing (Campbell,2005). A negative image on film is traditionally used to photographically create a positive image on a paper base, known as a print, either by using an enlarger or by contact printing.

In a study by Gacheri and Ndege (2014), a majority of teachers agreed that in KCSE biology practical examination, photographs are mostly used and real specimens are never used in a test. They confirm that photographs are commonly used in this practical paper. They performed a study to investigate science process skills application assessment in Maara district secondary schools in Kenya.

A photomicrograph or micrograph is a photograph or similar image taken through a microscope or similar device to show a magnified image of an item (Krebs, 2004). Biological materials may be killed, dyed so that their structure can be seen, and mounted on glass slides for photographing by transmitted light using ordinary light microscopes; or, by using ultraviolet, infrared, electron, or X-ray microscopes, sharp photographs can be made of living, unstained specimens (Campbell, 2005). The new KCSE biology practical assessment approach uses this technology to present images of specimens to students writing the examination. The students are expected to study photographs of various specimens and use what they see to respond to practical questions.

According to Sadiq (2013) photographs and photomicrographs are worth a thousand words through which a complex idea can be conveyed with just a single still image. Pictures make it possible to absorb large amounts of data quickly. Using photographs for explaining complex phenomena is one of the teaching aids of modern education system all over the world. As the world is changing day by day so are the methods of instructions as the modern curriculum requires conceptual elaborations (Sieber & Hatcher, 2012). Visual aids have the tendency to materialize the thoughts of students in the form of graphics to give thoughts a concrete frame of reference. They argue that use of photographs is important for students because they are more likely to believe findings when the findings are paired with coloured images describing complex situations during learning as opposed to other representational data such as complex text books.

Sadiq (2013) outlines the following as some of the advantages of using photographs and photomicrographs in teaching/ learning: To illustrate concepts and to show examples of what you are talking about during a lecture when you can't visit the real; inspire discussion of a topic, looking at multiple aspects and contexts; categorise within a subject discipline and potentially build reference collections for student project work and research; encourage team work and foster collaboration and the sharing of a learning experience; encourage students to become independent; encourage critical thinking skills (e.g. describing a photograph from many different viewpoints); enhance visual communication skills (e.g. decoding the message from a photograph); assess students' knowledge, understanding and observational skills; introduce unpopular topics in more exciting way than a straightforward lecture/tutorial.

Studies of biology syllabi and examination papers in countries such as Uganda, (UNEB, 2013); Tanzania (National Examination Council of Tanzania [NECT], 2013), China, (International Biology Olympiad [IBO]- China, 2013) and U.S.A (IBO- USA, 2013) show deliberate avoidance of photographs and photomicrographs in biology practical examinations. Though a few countries like Uganda tend to incorporate photographs and photomicrographs in their biology practical papers, a number of them are still reluctant and opt to use them in the theory papers.

2.8.2 Food Tests

Food test is an approach in biology practical examination where the presence or absence of various food substances in a food sample is tested for using various chemicals called reagents (Kenya Literature Bureau [KLB], 2010). This is important in that appropriate dietary advice can be given to the recipients of the results. The food substances tested for, reagents used and expected results are summarised in Table 3.

Table 3

Food substances tested for, Reagents used and Expected Results

Food substance	Reagents	Expected results
Reducing sugars	Benedict's solution	Solution turns yellow/ orange
Non reducing sugars	Dil. Hydrochloric acid, Sodium hydrogen carbonate And Benedict's Solution.	Solution turns yellow/ orange
Starch	Iodine Solution	Solution turns blue-black
Protein	Sodium hydroxide and Copper Sulphate	Solution turns purple
Lipids	Ethanol	White emulsions formed
Ascorbic acid	Dichlorophenol Indophenol	Dichlorophenol Indophenol (blue in colour) is decolourised.

When answering food test questions the candidates handle the apparatus, perform measurements and heating and makes observations. They also record their observations and make appropriate deductions from what they have observed (Okuto and Ndwiga, 2010). The question therefore offers the candidates enough opportunity to indulge in hands-on activities and employ adequate science process skills in answering the question.

2.9. Theoretical Framework

This study was based on the constructivism learning theory as proposed by various constructivist theorists, notably Jean Piaget (Pollard, 2006). According to Piaget (1970), people learn through an interaction between thinking and experience, and through the sequential development of more complex structures. Piaget (1970) asserts;

> "Knowing is not a copy of reality. To know an object, to know an event, is not simply to look at it and make a mental copy or image of it. To know is to modify, to transform the object to understand the way the object is constructed."

When children encounter a new experience they both accommodate their existing thinking to it and assimilate aspects of the experience. In Constructivism, the learners are learning by doing and experiencing rather than depending on the teachers' wisdom and expertise to transmit knowledge (Brown, 2008). Constructivist philosophy of teaching reflects and has enrooted the learner-centred approach (Brown, 2008 and Weimer, 2002).

Findings of Walsh and Vandiver (2007) study indicated that students performed better academically because they had a say in what they learned, and the teachers only acted as facilitators in order to allow the students to learn actively. Learner-centred teaching style focuses on how students learn instead of how teachers teach. In a learner-centred classroom, teachers abandon lecture notes and power point presentations for a more active, engaging, collaborative style of teaching (Wohlfarth, *et al*., 2008). Learner-centred instruction is most suitable for the more autonomous, and more self-directed learners who not only participate in what, how, and when to learn, but also construct their own learning experiences.

The study attempted to find out whether the KCSE Biology Practical assessment approach has achieved its core objective of testing the acquisition of science process skills by the KCSE candidates. The core role of the teacher is to create a learning environment that allows learners to activate existing cognitive structures or construct new ones to subsume the new input. Teaching/learning should progress from known to unknown to enable learners to link new ideas to the existing knowledge. It also assesses the abilities of the biology teachers to organise laboratory lessons that will enable student acquire science process skills which is the core of a practical lesson.

Better laboratory lessons are more likely to result into better learning, hence more intellectual growth of the learners. With hands-on laboratory activities, learning can be made more interesting and learners get more motivated. This can be achieved by using actual specimens and not their images as one organises experiments to link theory to practice. The testing of these skills need to be made as interactive and motivating to the learners as their teaching by engaging learners on hands-on activities in answering practical questions as opposed to the minds-on tasks that should be seen in the theory papers.

2.10. Conceptual Framework

The KCSE Biology practical assessment approach, as it is currently, was conceived by KNEC as an intervention measure to reduce cases of examination cheat in KCSE Biology Practical paper and also to assess the science process skills of the candidates (KNEC, 2005). Two questions in the paper out of the three questions set are in the form of photographs or photomicrographs. The conceptual framework of this study is presented schematically in Figure 1.

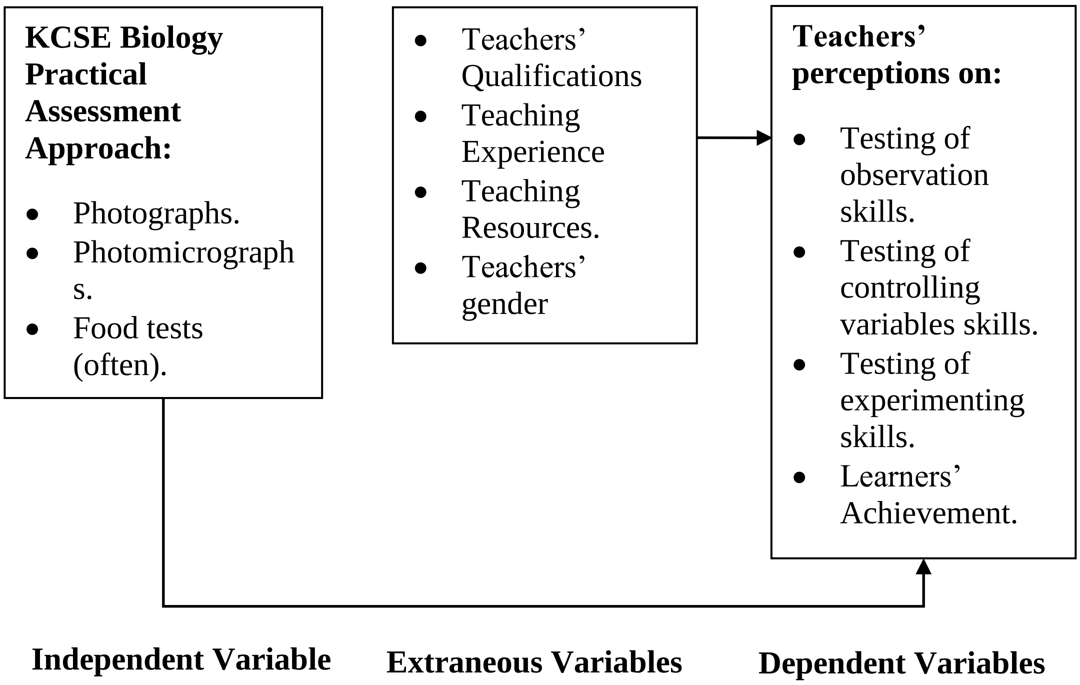

Figure 1: Relationship between the independent variable and dependent variables

In conceptualising the study, the researcher points out how the independent variable (The KCSE Biology Practical Assessment Approach) interacted with the dependent variable (testing of science process skills and learner's achievement). The study hypothesised that a good practical assessment approach must succeed in, not only testing the product, but also the process of the practical work (Race, 1997). As the teachers strive to adopt the constructivists approach to teaching and learning in order to actively involve the learners, the testing approach should also be that which actively engages the learners in hands-on activities. The influence of the extraneous variables such as teachers' qualifications, teaching experience and teaching resources were reduced by randomisation (Mugenda & Mugenda, 2003). It was also reduced by sampling teachers with the requisite qualifications, that is, diploma or university level of pre-service teacher education level. The study therefore, assumed the influence of the extraneous variables.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research methodology used in this study. It covers the description of the research design used. This is followed by a description of target and accessible population of the study. The chapter in addition highlights the sampling procedures used, the sample size and instrumentation. The final part of the chapter dwells on data collection and analysis techniques.

3.2 Research Design

The study used descriptive survey research design. The main purpose of this design is to find out how the members of a population distributed themselves on one or more variables (Mbwesa, 2006), which in this study was how effective the KCSE biology practical assessment approach tests the science process skills. This design involves observing and describing behaviour of a subject without influencing it in any way (Shuttleworth, 2008). Survey research design is a very valuable tool for assessing opinions and trends (Peil, 1995). Orodho (2003) points out that descriptive survey is a method of collecting information by interviewing or administering a questionnaire to a sample of individuals. It can be used when collecting information about peoples' attitudes, opinions, habits or any other educational or social issues (Orodho & Kombo, 2002). Fraenkel and Wallen (1996) explain that the aim of survey research is to collect data from one group to describe some characteristics of the group.

The design was appropriate for this study since the KCSE biology practical assessment approach under study had already been used for several years and the researcher did not have the opportunity to manipulate the approach. The major purpose of this design is description of state of affairs as it exists (Kombo & Tromp, 2006). In this study, perceptions of the biology teachers ware sought on whether the KCSE biology practical assessment approach (independent variable) effectively tests science process skills (dependent variables). The study therefore sought to identify what large numbers of people think or feel about certain issues (Kathuri & Pals, 1993).

3.3 Location of Study

The study was carried out in Siaya County, Kenya. The study area comprised six Sub-counties; Bondo, Rarieda, Siaya, Gem, Ugenya and Ugunja. Siaya County is located to the Western side of Kenya within Nyanza region.

3.4 Population of Study

The target population of this study was all trained teachers of Biology in Kenya. The main subjects of the study were trained biology teachers who were conversant with the current KCSE Biology practical paper assessment approach. The accessible population was all trained biology teachers in Siaya County who had handled the examination class. However, the study was limited to teachers of extra-county boarding secondary schools in Siaya County. The researcher chose the extra-county schools since these are schools with homogenous level of teaching and learning resources and their learners possess almost equivalent entry behaviours from primary schools. The County has 138 schools out of which 37 are extra-county boarding secondary schools. According to the data available in the office of the County Director of Education, the total number of trained biology teachers teaching in extra-county boarding schools under the study who had handled candidate class in Siaya County was 108. Table 4 shows the distribution of the said teachers per sub-county.

Table 4

Biology Teachers in Extra- County Schools per Sub-county in Siaya County

Sub-counties	Number of Teachers
Bondo	19
Rarieda	20
Gem	22
Ugenya	16
Ugunja	13
Siaya	18
Total	**108**

Source: Siaya County Director of Education’s Office, 2012

3.5 Sample Procedure and Sampling Size

3.5.1. Sample Procedure

Both Stratified random sampling and Simple random sampling were used to select a study sample from the list of trained Biology teachers in the County. The list of trained Biology teachers who had handled candidate classes used as a sampling frame was obtained from the County Director of Education's Office, Siaya. Stratified sampling was used since different Sub-counties were involved hence the population was considered to be heterogeneous (Mbwesa, 2006). The strata were the six sub-counties in Siaya county; Bondo, Rarieda, Gem, Ugenya, Ugunja and Siaya. The following formula was used to determine the sample quota each Sub-county was expected to contribute to the total sample size:

$$\text{Sample size per Sub} - \text{county} = \frac{\text{Total Sample Size (90)} \times \text{Sub} - \text{county Population}}{\text{Total Population of study (108)}}$$

Using the above formula, Table 5 was developed to guide on the number of respondents each sub-county was to contribute.

Table 5

Number of Respondents per Sub-county in Siaya County

Sub-county	**Number of Respondents**
Bondo	15
Rarieda	17
Gem	19
Ugenya	13
Ugunja	11
Siaya	15
Total	**90**

Source: Constructed by the researcher.

Simple random sampling is important in reducing the influence of extraneous variables in a study (Mugenda & Mugenda, 2003). Table 5 was used by the researcher to randomly pick the Sub-county sample summing up to a total sample of 90 teachers from the total population of 108 by balloting. This procedure is justified for selection of small samples as opposed to the use of tables of random numbers (Peil, 1995). According to Peil, this method is satisfactory where there are no systematic differences.

3.5.2. Sampling Size

The general rule in the determination of sample sizes is to use the largest sample possible (Kathuri & Pals, 1993; Mugenda & Mugenda, 2003). Kerlinger (1964) explains that a smaller sample results in larger error than a larger sample. Balian (1988) asserts that sample sizes usually range from 60 to 300 respondents with most averaging about 200, although the nature of the study dictates the specific size of the sample. The proposed minimal sample size for survey research is 15 in each group (Kathuri & Pals, 1993; Gall, Borg & Gall, 1996). According to Gay (1987), the minimum sample size for a descriptive survey research, which was the method for this study, is 10% of the accessible population. Krejcie and Morgan (1970) used a formula for calculation of appropriate sample size from a given finite population and out of their calculations came up with a table relating any population of study to the sample population required (Appendix I).

According to Krejcie and Morgan's table of sample determination from a finite popuation (Appendix I), 80 Biology teachers should be sampled from a population of 108 in the study area. However, Balian (1988) proposes a percentage adjustment of 10% to 30% to initial sample sizes to compensate for attrition, respondent refusal to participate, or other circumstances. This is for in-person data collection instrument which gives an upward adjustment of 8 to 24. In this case, the researcher therefore settled for a sample size of 90 which falls within the proposed range after upward adjustment.

3.6 Instrumentation

The instrument used to collect the data required to achieve the objectives of this study was constructed by the researcher. The instrument was Biology Practical Teachers' Questionnaire (BPTQ- Appendix II), which was used to solicit information from Biology teachers teaching in extra-county secondary schools in Siaya County who have handled examination classes. It gathered information on the perceptions of teachers' on effectiveness of testing science process skills by the KCSE Biology

Practical Paper. It also collected information on the perceptions of teachers on how the new approach affects the students' performance in biology and their interest in biology.

The BPTQ contained 21 items of which 20 were structured matrix items and one was open-ended item. Thirteen of the matrix items on the Likert scale assessed the effectiveness of testing science process skills by the KCSE Biology Practical assessment approach. The levels of effectiveness of testing of each of the science process skills were indicated based on the parameters given. The scale ranged from 'Very Ineffective' to 'Very Effective'. The minimum score was 1 representing 'Very Ineffective', 2 'Ineffective', 3 'Slightly Effective' 4 'Effective' to 5 'Very effective'. Four matrix items assessed the extent to which experimenting skills were tested in the new KCSE Biology practical paper. The scale ranged from 'Strongly disagree' to 'strongly agree.' The minimum score was 1 for 'Strongly disagree', 2 'Disagree', 3 'Undecided' 4 'Agree' and the maximum score was 5 for 'Strongly agree'.

Two matrix items were used to assess the influence of the assessment approach on students' achievement and interest in biology. The minimum score was 1 for 'Strongly disagree' 2 'Disagree', 3 'Undecided', 4 'Agree' and the maximum score was 5 for 'Strongly agree'. The open ended question was used to solicit the views of respondents on improvements that could be made on the assessment approach to better it. The closed-ended matrix questions was used to ensure objectivity and clarity of the subjects' responses for ease of statistical analysis while the open-ended items allowed the respondents some room for independent opinion (Mugenda & Mugenda, 2003). The responses for the open-ended item were not scored for statistical analysis but were used by the researcher to make some qualitative judgements on the variables.

3.7. Validity and Reliability of the Research Instruments

3.7.1 Validity of the Research Instruments

Validity is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study (Mugenda & Mugenda, 2003). It has to do with the accuracy of the data collected in representing the variables of the study so as to make accurate and meaningful inferences based on the data. According to Kathuri and Pals (1993), validity refers to how well the measured indicators really measure what they are supposed to measure. This is especially true in educational research where constructs like achievement, perceptions and effectiveness cannot be directly measured, but must be inferred from representative measurement.

Five research specialists from the Faculty of Education and Community Studies of Egerton University helped to validate the instruments, whose focus was face and construct validities (Kerlinger, 1964; Gall, Borg & Gall, 1996). Two secondary school teachers helped in content validation of the instruments. The teachers were those who had conducted academic research in the past and had the knowledge of objectives and principles of the KCSE Biology Practical testing. The validation procedures concentrated on face, content and construct validities of the instruments.

Face validity refers to the appeal and appearance of the instrument, that is, the instrument should appear as if it measures what it should measure, in this case, assessment of science process skills by the KCSE Biology Practical Paper. Content validity refers to the representativeness of the instrument items as they relate to the entire domain or universe of content being measured while construct validity refers to accuracy of the instrument in measuring what it should measure (Kathuri & Pals, 1993). In constructing the instruments, the researcher made the questionnaire items as relevant, objective and clear as possible to improve face validity. The researcher proof-read the questionnaire items and effectively eliminated systematic/non-random error which would have been due to poor validity of the instruments (Tindal & Marston, 1990).

3.7.2 Reliability of the Research Instruments

The reliability of an instrument refers to its suitability over time or the level of internal consistency (Fraenkel & Wallen, 2000). To estimate their reliability, the instrument was pilot–tested by the researcher himself on teachers from the neighbouring Kisumu sub- county, Kisumu County. This was done after sampling but before the actual study began. The acceptable pilot sample size is 1% to 10% of the sample size (Mugenda & Mugenda, 2003). Eight teachers were used in the pilot study.

After piloting, Cronbach's Alpha coefficient was used to estimate the reliability of the instrument. The use of Cronbach's alpha coefficient was appropriate since the items were not scored dichotomously and scores took a range of values (Thorndike & Thorndike, 1994). This is a general, all purpose formula applicable to all types of scales and requiring only one administration of the instrument (Suter, Allyn & Bacon, 1998). Cronbach's Alpha coefficient was computed using the Statistical Package for Social Sciences (SPSS) version 17.0. The reliability coefficient of 0.85 was acceptable to the researcher. It was found to be within the range of a reliability coefficient of 0.7 and above acceptable in educational science research as suggested by Mugenda and Mugenda (2003). According to Fraenkel and Wallen (1990), an alpha value of 0.7 is considered suitable to make possible group inferences that are accurate enough. Since the reliability coefficient was within the range, the questionnaire items were not reviewed and corrected and instructions not redrafted for more clarity as proposed by Kurpius and Stafford (2006).

3.8 Data Collection Procedures

The researcher sought research authorisation from the National Commission for Science, Technology and Innovation (NACOSTI) of the Ministry of Education, Science and Technology through the Board of Postgraduate Studies, Egerton University to collect data. The researcher then sought permission from Siaya County Director of Education to be allowed to visit schools. The researcher then visited each school whose teachers' were sampled for the study where the head teachers' permission to conduct the study had been sought. The researcher himself met the sampled teachers and explained to them the nature and importance of the study. The researcher thereafter administered the questionnaires by himself to the sampled teachers and involved them in setting the date for collecting back completed questionnaires to improve the return rate where he could not get back with the questionnaire.

The researcher sampled 80 teachers for the study from a population of 108. However a percentage adjustment of 10% was added to the initial sample to compensate for any attrition or respondents who may not have been able to participate. This led to a total number of 90 teachers being sampled. Out of the 90 questionnaires issued, 86 were returned, yielding a return rate of 95.6%. This return rate was satisfactory for the study.

3.9 . Data Analysis

The data collected were summarised, organised and described using descriptive statistics. Descriptive statistics such as means, frequencies, standard deviations and percentages were used to summarise and organise data so as to answer the research questions. SPSS version 11.7 for windows was used to run the data, which was presented in form of tables and bar graphs.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of findings. The chapter starts by outlining the demographic characteristics of the population under study. The results are presented and interpreted based on the objectives that guided the study. At the end of the chapter, findings have been exhaustively discussed.

4.2 Demographic Characteristics of the Respondents

The respondent teachers were required to give general information concerning their demographic characteristics. They were required to indicate their teaching sub-counties, Age, Gender, Level of Qualification and Teaching Experience. The results are as presented and discussed in sections 4.2.1, 4.2.2, 4.2.3, 4.2.4, and 4.2.5.

4.2.1 Distribution of Respondents by Sub-county of Teaching.

Teachers were required to indicate the sub-counties where they teach within Siaya County. The results are presented in Table 6.

Table 6

Sub-county of Teaching of Respondents

Sub-county	Frequency	Percentage
Rarieda	17	19.9
Bondo	15	17.4
Siaya	15	17.4
Gem	18	20.9
Ugenya	11	12.8
Ugunja	10	11.6
Total	**86**	**100.0**

Results in Table 8 show that majority of the respondents were derived from Rarieda (17) and Bondo (15) Sub-counties, totalling to 37.2% of the respondents. This was due to the fact that the two Sub-counties had many extra-county boarding secondary schools the research was targeting hence many respondents. It was also due to the fact that Rarieda Sub-county is the home sub-county of the researcher and Bondo is the immediate neighbouring Sub-county. This enhanced the proximity of the researcher to the respondents. Ugunja, Ugenya and Siaya sub-counties contributed 10, 11 and 15 respondents respectively which were equivalent to 41.8% of the respondents. They have fewer extra-county boarding secondary schools hence fewer respondents and are far away from the home sub-county of the researcher. Gem Sub-county which also has a number of well established Extra-county schools similarly gave a large number of respondents (18) or 20.9%.

4.2.2 Distribution of Respondents by Age.

The respondents were required to indicate their age categories from the scale provided. The results are presented in Figure 2.

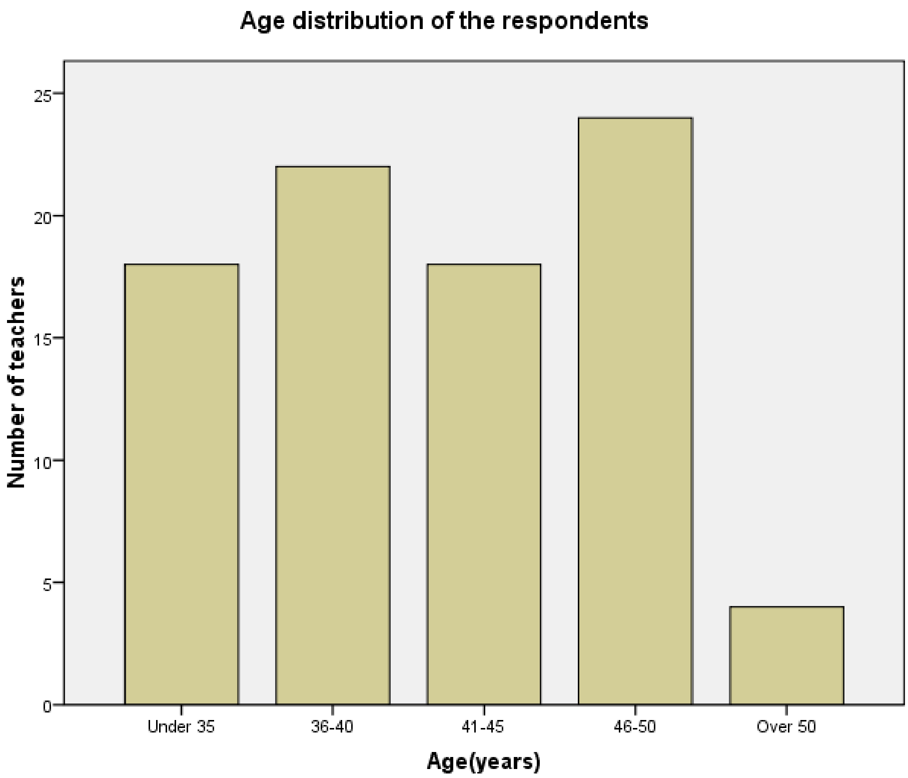

Figure 2: Bar Graph Showing the Distribution of Respondents by Age.

Results in Figure 2 show that majority of the respondent teachers were in the age bracket of between 36 years and 50 years old. They formed 74.45% of the teachers who participated in the study. Teachers who were above 50 years old were found to be very few in most of the schools studied. Only 4 (4.7%) could be found to participate in the study. Teachers who were up to 35 years old were only 18(20.9%).

4.2.3 Distribution of the Respondents by Gender.

Teacher respondents were required to indicate their gender. Their responses, frequencies and percentages are presented in Table 7.

Table 7

Gender of Respondents

Gender	Frequency	Percentage
Male	51	59.3
Female	35	40.7
Total	**86**	**100.0**

Results in Table 7 indicate that out of the 86 teachers who took part in the study, 51 (59.3%) were males while 35 (40.7%) were females. This conforms to the legal requirement that 33.3% representation in any public activity be of either gender.

4.2.4 Distribution of the Respondents by Level of Qualification.

The respondents were categorised based on their highest levels of academic qualifications. Their indications on their levels of academic qualifications were as presented in Table 8.

Table 8

Level of Qualification of Respondents

Level of Education	Frequency	Percentage
Diploma	13	15.1
Degree	54	62.8
Masters	19	22.1
Total	**86**	**100.0**

Results in Table 8 show that majority of teachers who took part in the study (62.8%) were degree holders. The teachers who had diploma certificate as at the time of study were only15.1% whereas those with masters' degree were 22.1%.

4.2.5 Distribution of the Respondents by Years of Experience

Respondent teachers were required to indicate their teaching experience in terms of the number of years they had taught since obtaining their teaching qualifications. Their responses, frequencies and percentages are presented in Table 11.

Table 9

Teaching Experience

Teaching experience (Years)	**Frequency**	**Percent**
Up to 10	20	23.3
11-15	35	40.7
16-20	20	23.3
21 and above	11	12.8
Total	**86**	**100.0**

Results in Table 9 indicate that majority of the respondents were teachers who had taught for at least 10 years (76.8%). The respondents who had taught for up to 10 years were 23.3%. Most of the respondents, however, were teachers who had taught the candidate class for between 11 and 15 years, with a frequency of 35 out of 86 and a percentage of 40.7.

4.3. Teachers' Perceptions on Testing of the Observation Skills by The KCSE Biology Practical Assessment Approach.

The first objective of the study was to determine whether The KCSE Biology Practical Assessment Approach adequately tests the Observation Skills of the candidates as perceived by their teachers. The teachers were to indicate the extent to which they thought the KCSE Practical Assessment Approach was effective in testing observation skills. Their responses were categorised and scored in the range of one to five. 1 represented 'Very Ineffective', 2 'Ineffective', 3 'Slightly effective', 4

‘Effective’ and 5 ‘Very Effective’. Their responses, frequencies and percentages are presented in Table 10.

Table 10

Teachers’ Perceptions on the Testing of Observation Skills by the KCSE Biology Practical Assessment Approach (N = 86).

Response	Score	Frequency	Percentage
Very Ineffective	1	4	4.65
Ineffective	2	26	30.23
Slightly Effective	3	42	48.84
Effective	4	9	10.47
Very Effective	5	5	5.81
	Mean = 2.83		

Results in Table 10 show that majority (83.72%) of teachers who participated in the study indicated that testing of observation skills was very ineffective, ineffective or only slightly effective in the KCSE practical assessment approach. According to them, the paper does not effectively test observation skills as science process skills. Only 16.28% of the teachers view the testing of observation skills in the KCSE biology practical assessment approach as either effective or very effective. A very small percentage of 5.81% of teachers rated the testing of observation skills as ‘Very Effective’.

A mean response score of 2.83 implies that the teachers perceive the testing of the skill as either ineffective or only slightly effective in the KCSE practical assessment approach. The teachers therefore affirm that testing of this skill is not adequate and so the paper fails to assess the students’ competence in observation skills.

4.4. Teachers’ Perceptions on Testing of the Controlling Variables Skills by KCSE Biology Practical Assessment Approach.

The second objective was to determine whether the KCSE Biology Practical Assessment Approach effectively tests the controlling variables skills as science process skills of the candidates as perceived by their teachers. The teachers were to indicate the extent to which they thought the KCSE Practical Assessment Approach was effective in testing the controlling variables skills as science process skills. Their responses were categorised and scored in the range of one to five. 1 represented ‘Very Ineffective’, 2 ‘Ineffective’, 3 ‘Slightly effective’, 4 ‘Effective’ and 5 ‘Very Effective’. Their responses, frequencies and percentages are presented in Table 11.

Table 11

Teachers’ Perceptions on the Testing of Controlling Variables Skills by the KCSE Biology Practical Assessment Approach (N = 86).

Response	Score	Frequency	Percentage
Very Ineffective	1	19	22.09
Ineffective	2	26	30.23
Slightly Effective	3	31	36.05
Effective	4	7	8.14
Very Effective	5	3	3.49
	Mean = 2.41		

Results in Table 11 show that majority of the teachers (88.37%) are convinced that testing of controlling variables skills in the KCSE practical assessment approach is either very ineffective, ineffective or slightly effective. They argue that the approach used does not allow the candidates to be in a position to effectively control variables in experimental set-ups.

Eleven point six three percent (11.63%) of the respondent teachers, however, vouches for the effectiveness of this approach in testing controlling variables skills. They indicated either ‘Effective’ or ‘Very Effective’. In their opinion, the three questions in the biology practical paper provide enough opportunities for the learners to control variables.

The mean response score in 2.41 implying that teachers, on average, view the testing of this skill as ineffective in the KCSE biology practical assessment approach. They are convinced that this skill is not adequately tested as is prescribed in the biology syllabus. Most practical activities undertaken during the learning process emphasise this skill but its testing is ineffective.

4.5. Teachers' Perceptions on Testing of the Experimenting Skills by The KCSE Biology Practical Assessment Approach.

The third objective of the study was to determine whether the KCSE Biology Practical Assessment Approach adequately tests the Experimenting Skills of the candidates as perceived by their teachers. The results are presented in sections 4.5.1 and 4.5.2.

4.5.1. Testing of Experimenting Skills

The teachers were to indicate the extent to which they thought the KCSE Practical Assessment Approach was effective in testing the experimenting skills in general as science process skills. Their responses were categorised and scored in the range of one to five. 1 represented 'Very Ineffective', 2 'Ineffective', 3 'Slightly effective', 4 'Effective' and 5 'Very Effective'. Their responses, frequencies and percentages are presented in Table 13.

Table 12

Teachers' Perceptions on the Testing of Experimenting Skills by the KCSE Biology Practical Assessment Approach (N = 86).

Response	Score	Frequency	Percentage
Very Ineffective	1	14	16.28
Ineffective	2	33	38.37
Slightly Effective	3	20	23.26
Effective	4	14	16.28
Very Effective	5	5	5.82
	Mean ═ 2.57		

Results in Table 12 show that 77.91% of the teachers who participated in the study indicated that testing of experimenting skills was very ineffective, ineffective or only slightly effective in the KCSE biology practical assessment approach. They affirm that the students do not adequately exhibit their experimenting skills in tackling this paper. To them, this paper is weak in tapping their experimenting skills as acquired during their class work.

A small percentage of the teachers (22.10%), however, believe that the KCSE biology practical paper effectively tests the experimenting skills of the candidates. This is the total percentage of the respondents who indicated either 'Effective' or 'Very Effective'. According to these teachers, the practical paper allows the candidates to demonstrate their experimenting skills effectively. With a mean response score of 2.57, however, it is evident that the teachers perceive that the KCSE biology practical approach is only slightly effective in testing experimenting skills as science process skills. To them, therefore, the testing approach does not appropriately test the experimenting skills of the candidates.

4.5.2. Teachers' Perceptions on the Levels to which Experimenting Skills are Tested.

To further achieve the third objective of the study, teachers were required to indicate the extent to which experimenting skills are tested by the KCSE Biology Practical Assessment Approach. They were to indicate the extent of involvement in hands-on activities in the questions, provision of specimens for students to handle when answering questions, duration taken by the paper because of practical activities involved and whether the five steps in experimenting are followed. Their responses were categorised and scored in the range of one to five. 1 represented 'Strongly Disagree, 2 'Disagree', 3 'Undecided, 4 'Agree' and 5 'Strongly Agree'. Their responses, frequencies and means are presented in Table 14.

Table 13

Levels of Testing of Experimenting Skills (N = 86).

Aspects of Experimenting	**Responses and Frequencies**					
	1	**2**	**3**	**4**	**5**	**Mean**
Hands-on activities	16	23	26	20	1	2.62
Provision of specimens	31	27	20	5	3	2.09
Paper duration	21	29	32	3	1	2.23
Following five experimenting steps	12	24	18	27	5	2.87
Aggregate Mean						**2.45**

Out of 86 respondents, 65 respondents, representing 75.58%, indicated they strongly disagree, disagree or undecided that the biology practical testing approach involves hands-on activities. They believe that the KCSE biology testing approach does not adequately involve hands-on activities. With inadequacy of the hands-on activities, the teachers contend that the candidates may not have enough room for manipulation to warrant adequate testing of science process skills.

Twenty four point four two percent (24.42%) of the respondent teachers, however, indicated their agreement that the paper has enough hands-on activities for the candidates. There was only one respondent who 'Strongly Agreed' that the paper involves adequate hands-on activities. In the teachers' perspective, the candidates have adequate involvement in hands-on activities.

With a mean response score of 2.62 on this aspect of experiment involvement, it is evident that the teachers largely disagree that the KCSE biology practical testing approach involves adequate hands-on activities. It therefore implies that, in their perceptions, the questions in the paper are mostly minds-on just like in the theory papers in biology.

When asked on their level of agreement on the experimental aspect of provision of sufficient specimens to candidates during practical examinations, only 9.30% of the teachers agreed that the KCSE biology practical testing approach provided the candidates with enough specimens. This small percentage of teachers believes that the specimens provided are sufficient to be able to test the manipulative skills of the candidates as they handle the specimens.

However, on the same aspect of experimenting, an extremely large number of teachers (90.70%) either disagree or are undecided that this testing approach provides candidates with sufficient number of specimens to allow testing of their manipulative skills. This indicates that the teachers are not satisfied with the extent of provision of specimens during biology practical testing.

The mean response score of 2.09 further indicates that the teachers disagree with the assertion that this testing approach provides sufficient number of specimens to the candidates. In their opinion, the candidates do not access sufficient number of specimens to handle during examinations. They believe the paper ought to offer more specimens to be handled by the candidates to warrant being an ideal practical paper.

On paper duration, 95.35% of the teachers disagreed or were not sure that the KCSE biology practical approach paper offers sufficient duration for testing of science process skills. Fifty eight point one four percent (58.14%) of the respondents disagreed that the $1^{3/}{}_{4}$ hours allocated for the paper is not sufficient if science process skills are to be tested adequately. According to them, a science practical paper should be long enough to allow testing of the various science process skills that the learners encounter during their coursework. The paper should involve both hands-on and minds-on activities and so sufficient time should be allocated.

For the paltry 4.65% of the teachers, there is enough time duration for the testing of science process skills by the KCSE biology practical testing approach. They aver that the time allocated is still sufficient in testing the science process skills adequately. With a mean response score of 2.23, however, it is evident that teachers largely view the time allocated for the biology practical paper as insufficient in testing the science process skills. Given the number of science process skills acquired in the course of learning biology, it may not be possible to test them adequately in the one and three-quarter hours allocated for the paper. Moreover, the two theory papers take two hours each, totalling to four hours for theory testing. It appears illogical, therefore, to allocate only $1^{3}/_{4}$ for the single practical assessment paper. In any case, the practical papers in Chemistry and Physics take longer durations.

Teachers were then asked to indicate their level of agreement that the KCSE biology practical testing approach follows the five steps in experimenting when answering questions. These five steps are; Problem Identification, Hypothesis, Predictions, Test of Predictions and Evaluation of Hypothesis. The effectiveness of an experiment relies on following these steps in answering experimental questions. Sixty two point seven nine percent (62.79%) of them either disagreed or were not sure. Forty one point eight six percent (41.86%) of them flatly disagreed with this assertion. To them, therefore, the experimental questions are not as effective since they do not involve these five steps.

Thirty seven point two one percent (37.21%) of the respondents agreed that the KCSE biology practical questions follow the five steps in experimenting in answering them. They believe, therefore, that the experiments are effectively set since the candidates follow the five steps in experimenting when answering the questions. However, with a mean response score of 2.87, it can be concluded that, in the perceptions of the teachers, the practical questions set do not follow the five steps in experimenting when answering them. The teachers assert that the testing approach is not as effective as it ought to be in testing the experimenting skills of the candidates as it does not allow the candidates to follow the five steps in experimenting.

The aggregate mean response score of 2.45 for the four aspects of experimenting shows that the teachers' mean response was 'Disagree'. This implies that, according to the teachers, the KCSE biology practical assessment approach does not give opportunities for the candidates to carry out experiments to a satisfactory extent. They disagreed with the assertion that this approach tests the experimenting skills to a good extent. All the four aspects of experimenting considered in this study were rated poorly by the teachers.

4.6. Teachers' Perceptions on the Influence of the KCSE Biology Practical Assessment Approach on Learners' Achievement in Biology.

The fourth objective of the study was to determine how the KCSE biology practical assessment approach affects learners' achievement in biology. It was to indicate the opinion of teachers on whether the students' achievement in biology is being enhanced by the KCSE Biology Practical Assessment Approach. The teachers were to indicate their level of agreement on the assertion that the KCSE biology practical assessment approach enhances learners' achievement in biology. Their responses were categorised and scored in the range of one to five. 1 represented 'Strongly Disagree', 2 'Disagree', 3 'Undecided' 4 'Agree' 5 'Strongly Agree'. Their responses, frequencies and percentages are presented in Table 14.

Table 14

Influence of KCSE Biology Practical Assessment Approach on Learners' Achievement (N = 86).

Response	Score	Frequency	Percentage
Strongly Disagree	1	12	13.95
Disagree	2	19	22.09
Undecided	3	31	36.05
Agree	4	19	22.09
Strongly Agree	5	5	5.81
	Mean = 2.84		

Results in Table 14 show that 36.04% of the respondent teachers either disagreed or strongly disagreed when asked whether the KCSE biology practical assessment approach has improved students' achievement in biology. Thirty six point zero five percent (36.05%) of the teachers were undecided. According to the teachers who disagreed, the setting of this paper does not enhance the performance of the candidates in this paper and in biology in general. The paper does not allow the students to score highly in biology since it does not adequately take a practical orientation.

Twenty seven point nine percent (27.9%) of the teachers indicated their agreement to the assertion that this testing approach enhances students' achievement in biology. The percentage includes those who agreed and those who strongly agreed. According to them, this paper contributes to good performance by students in biology. They aver that students' find it easy to score well in this paper and finally improves their achievement in biology as a subject. However, with a mean response score of 2.84, it is clearly evident that teachers either disagree or are not sure that the KCSE biology practical assessment approach improves students' achievement in biology. In the teachers' perceptions, therefore, the students do not do well in the practical paper and so this finally lowers students' achievement in biology.

4.7. Discussion of Results

4.7.1 Teachers' Perceptions on Testing of Observation Skills by the KCSE Biology Practical Assessment Approach.

The results of the study indicate that, in teachers' perceptions, the KCSE biology practical assessment approach does not effectively test observation skills as science process skills. Eighty three point seven two percent (83.72%) of teachers who participated in the study indicated that testing of observation skills was very ineffective, ineffective or only slightly effective in the KCSE practical assessment approach. According to them the paper does not effectively test observation skills as science process skills. Only 16.28% of the teachers view the testing of observation skills in the KCSE biology practical assessment approach as either effective or very effective. A very small percentage of 5.81% of teachers rated the testing of observation skills as 'Very Effective'.

With a mean response score of 2.83, it implies that the teachers perceive the testing of this skill as only slightly effective in the KCSE practical assessment approach. The teachers therefore affirm that testing of this skill is not adequate and so the paper fails to assess the students' competence in observation skills. However, in their study, Ongowo and Indoshi (2013) found that observation skill is the most frequently tested science process skill at 32.24% by the KCSE biology practical examinations. They also established that basic science process skills, like observation, are more frequently tested at 73.73% than integrated science process skills, like experimenting and control of variables, at 26.27%. The study was carried out to ascertain the science process skills tested by the KCSE biology practical examinations.

In their study, Gacheri and Ndege (2014) established that observation skills are tested by the KCSE biology practical paper. They asserted that the paper adequately tests observation skills as basic science process skills. Their study was conducted to ascertain science process skills application assessments in Maara district secondary schools in Kenya. In a study by Chigumbura (2016), the most utilised basic science process skills were found to be communication, observation, identification, classification, comparison, description and calculation. His study was conducted to ascertain the use of science process skills by grade 11 physical science learners in Gauteng province, South Africa.

The findings of this study do not reflect some of the broad aims of biology Syllabus (KIE, 2002). The three broad aims one, three and four requires that a study of biology should enable the learner to be able to communicate biological information in a precise clear and logical manner; relate and apply relevant biological knowledge and understanding to social and economic situations in rural and urban settings and to observe and identify features of familiar and unfamiliar organisms, record the observations and make deductions about the functions of parts of the organisms respectively. The skills of observation, therefore, remain key to the study of biology. An ideal practical testing should involve the testing of these skills as a science process skill.

4.7.2 Teachers' Perceptions on Testing of Controlling Variables Skills in the KCSE Biology Practical Assessment Approach.

The results of the study show that, in the perceptions of teachers, the testing of controlling variables skills as science process skills by the KCSE biology practical assessment approach is ineffective. The majority of the teachers (88.37%) indicated that testing of controlling variables skills in the KCSE practical assessment approach is either very ineffective, ineffective or slightly effective. They argue that the approach used does not allow the candidates to be in a position to effectively control variables in experimental set-ups.

The mean response score was 2.41, implying that teachers, on average, view the testing of this skill of control of variables as ineffective in the KCSE biology practical assessment approach. They were of the view that this skill is not effectively tested as is prescribed in the biology syllabus. Most practical activities undertaken during the learning process emphasise this skill but its testing is ineffective. This finding is in agreement with findings of a study carried out by Ongowo and Indoshi (2013). In their study, controlling variables skill was not among the five most frequently tested science process skills by the KCSE biology practical paper. The study was carried out to ascertain the science process skills tested by the KCSE biology practical examinations. The study covered ten years of KCSE examinations, from 2002 to 2012.

The findings of this study are in agreement with Ewers (2001) who asserts that biology practical assessment approach should be that which poses the demand of doing science on the learners, as opposed to simply hearing, writing or reading about it. It should engage students and allow them to test their own ideas and build their own understanding. This can only be achieved if the candidates are given opportunities to operate in full experimental set-ups where they are able to set up and control variables.

Obiekwe (2008) noted that science teaching and testing which lays a lot of emphasis on content and theoretical methods neglecting the practical activity does not enhance acquisition of relevant skills. Such teaching and testing methods will only allow learners to grasp the theoretical knowledge without appropriate acquisition of the practical skills. Teachers will only expose the learners to the content as it is tested without involving them in practical activities that require them to control variables.

4.7.3. Teachers' Perceptions on Testing of Experimenting Skills by the KCSE Biology Practical Assessment Approach.

The results of the study show that, in the view of teachers, the experimenting skills as science process skills are not effectively tested by the KCSE biology practical assessment approach. Seventy seven point nine one percent (77.91%) of the teachers who participated in the study indicated that testing of experimenting skills was very effective, ineffective or only slightly effective in the KCSE biology practical assessment approach. They affirmed that the students do not adequately exhibit their experimenting skills in tackling this paper. According to the teachers, this paper does not provide students with the opportunity to put the extra skills acquired into practice. A small percentage of the teachers (22.09%), however, believe that the KCSE biology practical paper effectively tests the experimenting skills of the candidates.

The findings are in agreement with the findings of a study by Ongowo and Indoshi (2013). They established that only 12.21% of the science process skills tested by the KCSE biology practical paper are experimenting skills and that only 26.27% of integrated science process skills are tested by the paper. The study was carried out to ascertain the science process skills tested by the KCSE biology practical examinations. The study covered ten years of KCSE examinations, from 2002 to 2012.

The findings of this study also agree with the findings of a study by Gacheri and Ndege (2014). They established that students are rarely tested in practical work in Kenya secondary schools. Their study was conducted to ascertain science process skills application assessments in Maara district secondary schools in Kenya. The lack of tests in practical work is largely attributed to lack of science resources and facilities.

According to Visser, (2000), the complete process of science cannot be learned by merely reading, listening, memorising or problem solving but effective teaching requires active mental involvement. All sciences are built with information from direct experiments and the nature of the subject rests heavily on the interaction between the theory and the experiment. For conceptualisation to occur, learners must be both mentally and actively involved. For this reason, the experimenting skills of the learners gathered over the study period need to be effectively assessed both formatively and summatively. The KCSE biology practical assessment approach has therefore failed with respect to this.

The findings are however, not in agreement with the view expressed by Benard and Benard (2005). They assert that use of experiments as teaching tools in the classroom has been steadily increasing over the past two decades since their pedagogical advantages have become more apparent. Becker (2000) posits that the primary advantage of experiments is their ability to get the students to be actively involved in the class and in the learning process. The experimenting skills must, therefore, be essentially tested if the KCSE biology practical testing approach has to remain relevant and exciting to the learners. In a study by Gacheri and Dege (2014), analysis of biology KCSE practical examinations showed that drawing and measurement skills were not adequately tested. Students were also rarely given practical tests in schools. Their study was conducted on science process skills application assessments in Maara district secondary schools, Kenya. The infrequency of tests in schools was attributed to inadequate teaching and learning resources and facilities.

The findings of this study agree with the findings of Abrahams and Millar (2008) who posit that teachers need to devote a greater portion of their lesson time to helping students use ideas associated with the phenomena they have produced rather than seeing the successful production of the phenomenon as an end to itself. Adequate assessment of science process skills would enable the entire stakeholders discover whether during learning the learners were subjected to activities that allowed for sufficient exchange of ideas. They aver that a science practical process should be taught and evaluated and not just its product. The experimenting skills of the students should, therefore, be effectively tested as a student works towards any given scientific product.

According to Kagete and Nthiga (2006), practical work is an essential component of science and vocational subjects. The findings are also in agreement with Bennett and Kennedy (2001), who believed good quality, appropriate biology experiments and investigations are the key to enhanced learning and clarification and consolidation of theory. They claimed Biology experiments aim at equipping the learners with the knowledge, attitude and skills necessary for preserving the environment. Since we test what has been taught, the assessment approach should contain all the skills imparted on students during teaching.

The findings also agree with Nzewi (2008) who asserted that practical activities can be regarded as a strategy that could be adopted to make the task of a teacher (teaching and testing) more real to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matters. This would later translate into testing the corresponding skills which have been taught. Practical activities in biology provide opportunities for students to actually do science as opposed to learning about science. The experimenting skills should therefore be necessarily taught and tested.

On the extent to which experimenting skills are tested, the study further established that teachers disagreed that the testing approach involves adequate hands-on activities. Seventy-five point five eight percent (75.58%) of them indicated they strongly disagree, disagree or undecided that the biology practical testing approach involves adequate hands-on activities. They believe that the KCSE biology testing approach does not adequately involve hands-on activities. With inadequacy of the hands-on activities, the teachers contend that the candidates may not have enough room for manipulation to warrant adequate testing of science process skills.

Twenty four point four two percent (24.42%) of the respondent teachers, however, indicated their agreement that the paper has enough hands-on activities for the candidates. There is only one respondent who 'Strongly Agreed' that the paper involves adequate hands-on activities. In their perspective, the candidates have adequate involvement in hands-on activities. With a mean response score of 2.62 on this aspect of experiment involvement, it is evident that the teachers largely disagree that the KCSE biology practical testing approach involves adequate hands-on activities. It therefore implies that, in their perceptions, the questions in the paper are mostly minds-on just like in the theory papers in biology.

This finding is supported by Adey and Shayer (1994) who pointed out that the mere recall of knowledge without the ability to transfer it in a working situation later on cannot be viewed as acquisition of a good standard of quality, which the goals of education intend to achieve in a society. The essence of practical work in any of the pure sciences, and indeed in real life situations, is to expose the learners to a glimpse of the actual work environment where theories are translated into work output. The testing of such practical skills, therefore, needs to involve more of doing than explaining. This justifies the need to include more hands-on activities than minds-on activities in any biology practical assessment tool.

This finding is further supported by Michael (2006) who posits that in science education, one route to achieve better performance is the active student-centred methods of school work such as class discussions, excursions, field work, problem solving, with laboratory work as a flagship. The students are best made active by engaging them in hands-on activities. A practical assessment that does not allow and test the involvement of candidates in hands-on activities is therefore not appropriate.

The findings also agree with the findings of Costu, Unal and Ayas (2007), Unal (2008) and Bilgin (2006) who argued that hands-on activities done in experimenting enables learners' to enhance their understanding and replace their misconceptions with the scientific ones, develop positive attitudes toward science and encourage their creativity in problem solving as well as promoting student independence. They emphasise that children learn better when they can touch, feel, measure, manipulate, draw, make charts, record data and when they find answers for themselves rather than being given the answer in a textbook or lecture. It is not possible to achieve this with an assessment approach whereby only very few hands- on activities are involved.

The study also established that, in teachers' perspective, the KCSE biology practical assessment approach does not provide sufficient specimens for the candidates to handle during examinations. When asked on their level of agreement on the experimental aspect of provision of sufficient specimens to candidates during practical examinations, only 9.30% of the teachers agreed that the KCSE biology practical assessment approach provided the candidates with enough specimens. This small percentage of teachers believes that the specimens provided are sufficient to be able to test the manipulative skills of the candidates as they handle the specimens.

However, on the same aspect of experimenting, an extremely large number of teachers (90.70%) either disagreed or were undecided that this testing approach provides candidates with sufficient number of specimens to allow testing of their manipulative skills and elicit students' interest. This indicates that the teachers are not satisfied with the extent of provision of specimens during biology practical testing.

The mean response score of 2.09 further affirms that the teachers disagreed with the assertion that this testing approach provides sufficient number of specimens to the candidates. In the teachers' opinion, the candidates do not access sufficient number of specimens to handle during examinations. They believe the paper ought to offer more specimens to be handled by the candidates to warrant being an ideal practical paper.

This finding is supported by Winter, Lemons, Bookman and Hoose, (2001) who argue that practical work is a central theme of lessons and assessment in the natural sciences. They insist that a student cannot be considered to have acquired science practical skills without handling and manipulating specimens and apparatus. An ideal practical paper, therefore, would be that which provides the candidates with ample opportunities to have access to, observe and manipulate specimens and apparatus. The KCSE biology practical assessment approach has failed in this by only providing very few or no specimens and apparatus at all.

On paper duration, the study indicated that the teachers disagreed that the KCSE biology practical paper offers sufficient duration for testing of science process skills. Ninety-five point three five percent (95.35%) of the teachers disagreed or were not sure that the KCSE biology practical approach paper offers sufficient duration for testing of science process skills. Fifty eight point one four percent (58.14%) of the respondents disagreed that the $1^{3/}{}_{4}$ hours allocated for the paper is not sufficient if science process skills are to be tested adequately. According to them, a science practical paper should be long enough to allow testing of the various science process skills that the learners encounter during their coursework.

For the paltry 4.65% of the teachers, there is enough time duration for the testing of science process skills by the KCSE biology practical testing approach. They aver that the time allocated is still sufficient in testing the science process skills adequately. With a mean response score of 2.2326, however, it is evident that teachers largely view the time allocated for the biology practical paper as insufficient in testing the science process skills. Given the number of science process skills acquired in the course of learning biology, it may not be possible to test them adequately in the one and three-quarter hours allocated for the paper.

Moreover, it is interesting that the two theory papers done in biology cover two hours each, translating to a total of four hours for the theory testing (KNEC, 2005). It indicates that this testing approach does not give sufficient weight to the testing of practical skills, given the amount of time allocated. Compared to practical papers in Chemistry and Physics, this paper is still rated lowly in terms of time allocation since in the two subjects the practical papers run for $2^{1}/_{4}$ hours each.

On the last aspect of experimenting, the study established that teachers believe that the KCSE biology practical assessment approach does not follow the five steps of experimenting when answering questions. Teachers were asked to indicate their level of agreement that the KCSE biology practical testing approach follows the five steps in experimenting when answering questions. These five steps are; Problem Identification, Hypothesis, Predictions, Test of Predictions and Evaluation of Hypothesis. The effectiveness of an experiment relies on following these steps in answering experimental questions. Sixty two point seven nine percent (62.79%) of them either disagreed or were not sure. Forty one point eight six percent (41.86%) of them flatly disagreed with this assertion. To them, therefore, the experimental questions are not as effective since they do not involve these five steps.

Thirty seven point two one percent (37.21%) of the respondents agreed that the KCSE biology practical questions follow the five steps in experimenting in answering them. They believe, therefore, that the experiments are effectively set since the candidates follow the five steps in experimenting when answering the questions. However, with a mean response score of 2.87, it can be concluded that, in the perceptions of the teachers, the practical questions set do not follow the five steps in experimenting when answering them. The teachers assert that the testing approach is not as effective as it ought to be in testing the experimenting skills of the candidates as it does not allow the candidates to follow the five steps in experimenting.

According to Kagete and Nthiga (2006), the learner is expected to know the requisite apparatus and procedures before carrying out the experiments. This is important in enabling the learner to effectively follow the five steps in experimenting. Provision of clear procedures and apparatus enables the candidates to identify problem, hypothesise, predict, test the predictions and evaluate the hypothesis. Failure of the KCSE biology practical testing approach in following these steps, as perceived by the teachers, renders it inappropriate in testing science process skills.

In a study by Chigumbura (2016), it was found that experimenting skills as integrated process skills are poorly utilized by the Grade 11 Physical Science Learners. The study was conducted to establish the extent of use of science process skills by Grade 11 Physical science learners in Gauteng province, South Africa. According to Monica (2005), the traditional assessment of process skills through practical work only, has practical constraints, particularly in large under resourced classes. This makes the teachers and other examiners avoid assessment of such skills. Her study was conducted to develop and validate a test of integrated science process skills for the further education and training learner.

4.8.4. Teachers' Perceptions on the Influence of KCSE Biology Practical Assessment Approach on Learners' Achievement in Biology.

The results of the study show that, according to the teachers, the KCSE biology practical assessment approach does not improve learners' achievement in biology. Thirty-six point zero four percent (36.04%) of the respondent teachers disagreed when asked whether the KCSE biology practical assessment approach has improved students' achievement in biology while 36.05% of the teachers were undecided. According to the teachers who disagreed, the setting of this paper does not enhance the performance of the candidates in this paper and in biology in general. The paper does not allow the students to score highly in biology since it does not adequately take a practical orientation.

Twenty seven point nine percent (27.9%) of the teachers indicated their agreement to the assertion that this testing approach improves students' achievement in biology. According to them, this paper contributes to good performance by students in biology. They aver that the students find it easy to score well in this paper and finally improve their achievement in biology as a subject. However, with a mean response score of 2.84, it is clearly evident that teachers either disagreed or were not sure that the KCSE biology practical assessment approach improves students' achievement in biology. In the teachers' perceptions, therefore, the students do not do well in the practical paper and so this finally lowers students' achievement in biology.

In a related study, Chigumbura (2016) established that science process skills have an impact on learner performance in examination tasks and understanding new science topics. This directly points at a relationship between acquisition of science process skills and performance in examination. The study was carried out to establish the extent of use of science process skills by grade 11 physical science learners in Gauteng province, South Africa.

The findings are in agreement with the findings of Shymansky, Kyle and Alport (1983). Data from meta-analyses by Shymansky, *et al*. on student performance across these activity-based programs, in terms of performance clusters (achievement, perceptions, a nd so on) and a composite performance measure show that students in the hands-on programs outperformed their traditional elementary school counterparts by 9 percentile points.

According to Ongowo and Indoshi (2013), the performance of students in the Kenya National Examinations Council in Biology practical examinations has been below average. For instance, in the years 2008, 2009 and 2010 the students scored means of 17.30, 15.86 and 18.42 respectively out of 40 (KNEC, 2011). The scores that students obtain from their practical examinations are indirect reflections of the process skills they could display during the practical examination. At the same time, the final score that a candidate scores in biology is contribution of both the theory examination and the practical examination scores. According to Afolabi and Akinbobola (2010), the practical assessment score of a student is a reflection of the teaching approach that a teacher employed during the learning situation especially the process approach.

These findings are in agreement with Nwagbo (2008) who stated that the use of practical activities (approach) to the teaching and testing of biological concepts should be a rule rather than an option to biology teachers if we hope to produce students that would be able to acquire the necessary knowledge, skills and competence needed to meet the scientific and technological demands of the nation. According to him, it is not enough for the teaching of biology to take a practical approach but its testing should equally be practical-oriented to motivate the learners to perform well. In their assertion, therefore, learners would perform better in science subjects if more science process skills are tested, especially practical skills.

Mwangi and Wachanga (2004) emphasise that teaching methods that allow students to use all their senses also enhance effective learning and students' achievement. They mentioned this in support of experiment teaching method. Taylor (2004) argues that experiments boost students' scores on standardised tests for understanding college economics. Dickie (2006) also found an overall improvement in students score using experiments, same to Ball, Eckel and Rojas (2006) who found that experiments improved the overall marks on the final examination. They also found that experiments significantly improved teaching evaluations and make students find the lessons stimulating.

The study further established that, in teachers' perceptions, the KCSE biology practical approach does not positively influence learners' interest in biology. Majority of teachers (62.79%) disagreed that the KCSE biology practical testing approach positively influences the learners' interest in biology. Eleven point six three percent

(11.63%) of the teachers was undecided on this issue. It implied that a great majority of the teachers believe that students' interest in biology is not boosted by this approach of testing.

Twenty five point five eight percent (25.58%) of the teachers, however, agree with the assertion that this testing approach has enhanced students' interest in biology. According to them, the setting of the paper is appropriate in raising and sustaining the interest of the learners in biology. However, with a mean response score of 2.53, it is telling that the teachers disagree or are undecided on whether the students' interest in biology is improved by this assessment approach. It implies that, in teachers perceptions, the questions set in this approach do not elicit and sustain the students' interest and hence the entire biology as a subject.

The findings are also in agreement with Sorgo and Spernjak (2009), who assert that inquiry and problem-based hands-on activities, laboratory and field work in teaching and testing not only make it possible to transfer knowledge on higher order cognitive levels and to teach experimental and practical skills, but also to ignite an interest in science among students. It makes it explicit that learners develop more interest in biology and activate higher order thinking when teaching and setting of biology take more practical orientation. The current KCSE biology practical testing approach limits learners in terms of hands-on activities and therefore, learners' interest in biology is heavily dwarfed.

Wilkinson and Ward (1997) compared the opinions of students of different achievement levels, and the opinions of students with their teachers, regarding the aims of practical work. Both students and teachers ranked "to make science more interesting and enjoyable through actual experience" as the most important aim. Any practical approach to teaching and testing of sciences is meant, therefore, to raise and sustain learners' interest towards the subject. Science practical teaching and assessment are therefore meant to make the science subjects interesting and enjoyable to both the teachers and learners. The KCSE biology practical assessment approach is not able to make biology as a subject interesting to the learners as shown by the results of this study. It may appear that this approach may need to be restructured to be able to meet its deemed objectives.

Obiekwe (2008) noted that science teaching and testing which lays extreme emphasis on content and theoretical methods neglecting the practical activity does not enhance acquisition of relevant skills. This negligence and 'shy-away' attitude from activity oriented- method of teaching and testing has led to abstraction which makes the students less active and more prone to rote memorisation. It translates that less active students are less interested in learning and finally perform poorly in examinations. The practical paper therefore needs to be more activity-oriented to raise and sustain the students' interest in the subject. Science learning is expected to produce individuals that are capable of solving their problems as well as those of the society. Such individuals are expected to be autonomous, confident and self reliant.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of findings of the study, draws conclusions from the findings and gives recommendations based on the findings. Section one gives the summary of findings and section two the conclusions of the findings. Section three presents the recommendations that were made from the findings while the last section gives suggestions for further research to be conducted on the KCSE Biology Practical Assessment Approach in particular and Assessment of Science Process Skills in general.

5.2 Summary of Findings

The main purpose of this study was to investigate the perceptions of teachers on effectiveness of the KCSE Biology Practical Assessment approach in Testing Science Process Skills in Siaya County. Results showed that the KCSE Biology Practical Assessment Approach does not effectively assess acquisition of science process skills in its candidates, in teachers' perceptions.

The study established that, in teachers' perceptions, the KCSE biology practical assessment approach is ineffective in testing observation skills as science process skills. Eighty three point seven two percent (83.72%) of the teachers who participated in the study indicated that testing of observation skills was either ineffective or only slightly effective in the KCSE practical assessment approach. According to them the paper does not effectively test observation skills as science process skills. Only 16.28% of the teachers viewed the testing of observation skills in the KCSE biology practical assessment approach as either effective or very effective. A very small percentage of 5.81% of teachers rated the testing of observation skills as 'Very Effective'. With a mean response score of 2.83, it implies that the teachers perceive the testing of this skill as only slightly effective in the KCSE practical assessment approach. The teachers therefore affirm that testing of this skill is not adequate and so the paper fails to assess the students' competence in observation skills.

The results of the study show that, in the perceptions of teachers, the testing of controlling variables skills as science process skills by the KCSE biology practical assessment approach is ineffective. The majority of the teachers (88.37%) were convinced that testing of controlling variables skills in the KCSE practical assessment approach is either very ineffective, ineffective or slightly effective. They argue that the approach used does not allow the candidates to be in a position to effectively control variables in experimental set-ups. The mean response score was 2.41, implying that teachers, on average, view the testing of this skill as ineffective in the KCSE biology practical assessment approach. They are convinced that this skill is not effectively tested as is prescribed in the biology syllabus. Most practical activities undertaken during the learning process emphasise this skill but its testing is ineffective.

The study has shown that, in the view of teachers, the testing of experimenting skills as science process skills is ineffective by the KCSE biology practical assessment approach. Seventy seven point nine one percent (77.91%) of the teachers who participated in the study indicated that testing of experimenting skills was very effective, ineffective or only slightly effective in the KCSE biology practical assessment approach. They affirmed that the students do not adequately exhibit their experimenting skills in tackling this paper. To them, this paper is weak in tapping the students' experimenting skills as acquired during their class work. A small percentage of the teachers (22.10%), however, believe that the KCSE biology practical paper effectively tests the experimenting skills of the candidates. With a mean response score of 2.57, however, it is evident that the teachers perceive that the KCSE biology practical approach is only slightly effective in testing experimenting skills as science process skills. To them, therefore, the testing approach does not appropriately test the experimenting skills of the candidates.

The extent of experimenting as indicated by four aspects used in this study was found to be poor, according to the teachers. The aggregate mean response score of 2.45 for the four aspects of experimenting shows that the teachers' mean response was 'Disagree'. This implies that, according to the teachers, the KCSE biology practical assessment approach does not give opportunities for the candidates to carry out experiments to a satisfactory extent. They disagreed with the assertion that this approach tests the experimenting skills to a good extent. All the four aspects of experimenting considered in this study were rated poorly by the teachers.

The results of the study show that, according to the teachers, the KCSE biology practical assessment approach does not improve learners' achievement in biology. Thirty-six point zero four percent (36.04%) of the respondent teachers disagreed when asked whether the KCSE biology practical assessment approach has improved students' achievement in biology while 36.05% of the teachers were undecided. According to the teachers who disagreed, the setting of this paper does not enhance the performance of the candidates in this paper and in biology in general. The paper does not allow the students to score better in biology since it does not adequately take a practical orientation. Twenty seven point nine percent (27.9%) of the teachers indicated their agreement to the assertion that this testing approach improves students' achievement in biology. However, with a mean response score of 2.84, it is clearly evident that teachers were not sure that the KCSE biology practical assessment approach improves students' achievement in biology. In the teachers' perceptions, therefore, the students do not do well in the practical paper and so this finally lowers students' achievement in biology.

5.3 Conclusions

i. In teachers' perceptions, the KCSE Biology Practical Assessment Approach does not effectively test the observation skills of the learners as science process skills.

ii. In teachers' perceptions, the KCSE Biology Practical Assessment Approach does not effectively test controlling variables skills of the learners as science process skills.

iii. In teachers' perceptions, the KCSE Biology Practical Assessment Approach does not effectively test experimenting skills of the learners as science process skills. The extent of experimenting on the basis of the four aspects of experimenting used in the study was found to be poor.

iv. In teachers' perceptions, the KCSE Biology Practical Assessment Approach does not improve learners' achievement in Biology.

5.4 Recommendations

Based on the findings of this study, the researcher made the following recommendations that could be implemented to improve the KCSE Biology Practical

Paper and other science practical papers to make them more precise in assessing the science process skills of the learners:

i. The three questions set in biology practical paper should be practical-oriented requiring hands-on activities to give the candidates more opportunities to demonstrate science process skills. Minds-on activities should be limited to the theory papers or to principles that cannot be tested through hands-on activities.

ii. The KCSE biology practical paper should aim at testing of both basic and integrated science process skills.

iii. The examination duration for the KCSE Biology practical paper should be extended to $2^1/_4$ hours from the current 1¾ hours like other practical papers. This is necessary to allow enough time for the candidates to exhibit more science process skills as they learn them in class. It will also give the candidates ample opportunity to communicate effectively the scientific findings.

iv. The KEMI syllabus should be aligned in terms of scope and objectives. This is to ensure that teaching and testing of the science process skills are synchronised to improve students' achievement in Biology and their interest in Biology.

5.5 Suggestions for Further Research

In this study some factors have not been properly accounted for due to its scope. It is therefore suggested that further research should be done on some topics related to this one. In this view, the following are recommended for further research in the area of assessment of science process skills in general, Biology science process skills and the KCSE Biology Practical Assessment Approach:

i. Whether the new KCSE biology practical assessment influences teachers' attitude toward biology laboratory lessons.

ii. The Influence on attitude of students towards biology laboratory practical lessons by the KCSE assessment approach used in biology.

iii. The relationship between prior biology confidential instructions papers containing a list of apparatus and specimens and performance in biology practical exams.

iv. The relationship between teaching and testing of biology practical skills.

v. Students' opinions on the extent to which the use photographs and photomicrographs enables them acquire experimenting and manipulative skills in biology practical lessons.

vi. Whether prior provision of confidential instructions to Biology teachers to prepare specimens and apparatus results in cheating in Biology practical examinations.

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APPENDIX I

KREJCIE AND MORGAN'S TABLE OF SAMPLE DETERMINATION FROM A FINITE POPULATION.

Required Sample Size†

Population Size	Confidence = 95%				Confidence = 99%			
	Margin of Error				Margin of Error			
	5.0%	3.5%	2.5%	1.0%	5.0%	3.5%	2.5%	1.0%
10	10	10	10	10	10	10	10	10
20	19	20	20	20	19	20	20	20
30	28	29	29	30	29	29	30	30
50	44	47	48	50	47	48	49	50
75	63	69	72	74	67	71	73	75
100	80	89	94	99	87	93	96	99
150	108	126	137	148	122	135	142	149
200	132	160	177	196	154	174	186	198
250	152	190	215	244	182	211	229	246
300	169	217	251	291	207	246	270	295
400	196	265	318	384	250	309	348	391
500	217	306	377	475	285	365	421	485
600	234	340	432	565	315	416	490	579
700	248	370	481	653	341	462	554	672
800	260	396	526	739	363	503	615	763
1,000	278	440	606	906	399	575	727	943
1,200	291	474	674	1067	427	636	827	1119
1,500	306	515	759	1297	460	712	959	1376
2,000	322	563	869	1655	498	808	1141	1785
2,500	333	597	952	1984	524	879	1288	2173
3,500	346	641	1068	2565	558	977	1510	2890
5,000	357	678	1176	3288	586	1066	1734	3842
7,500	365	710	1275	4211	610	1147	1960	5165
10,000	370	727	1332	4899	622	1193	2098	6239
25,000	378	760	1448	6939	646	1285	2399	9972
50,000	381	772	1491	8056	655	1318	2520	12455
75,000	382	776	1506	8514	658	1330	2563	13583
100,000	383	778	1513	8762	659	1336	2585	14227
250,000	384	782	1527	9248	662	1347	2626	15555
500,000	384	783	1532	9423	663	1350	2640	16055
1,000,000	384	783	1534	9512	663	1352	2647	16317
2,500,000	384	784	1536	9567	663	1353	2651	16478
10,000,000	384	784	1536	9594	663	1354	2653	16560
100,000,000	384	784	1537	9603	663	1354	2654	16584
300,000,000	384	784	1537	9603	663	1354	2654	16586

APPENDIX II

BIOLOGY PRACTICAL TEACHERS' QUESTIONNAIRE (BPTQ)

I am a student at Egerton University in field work to collect data towards fulfilment of the course requirements. This questionnaire will be used for the purpose. The information required by this questionnaire shall purely be used for research purposes. Your response is voluntary and shall strictly remain confidential. You are requested to be as truthful and objective as much as possible.

1. School Name: ___________________________ Sub-county: [1] Rarieda [2] Bondo [3] Siaya [4] Gem [5] Ugenya [6] Ugunja.

Part A: General Information

Please **tick** (√) the appropriate response in the following section seeking personal Information about yourself.

2. Age (years)	**3. Gender**	**4. Level of Qualification**	**5. Teaching Experience**
[1] Under 35	[1] Male	[1] Diploma	[1] Up to 10yrs
[2] 36 – 40	[2] Female	[2] Degree	[2] 11 – 15yrs
[3] 41 – 45		[3] Masters	[3] 16 – 20yrs
[4] 46 – 50		[4] Other (Specify---------------	[4] 21yrs and above
[5] Over 51		-------------------------------------	

B. Perceptions of Teachers on Assessment of Science Process Skills by the new KCSE biology Practical Assessment Approach.

Please give your opinion on the effectiveness of assessment of each of the following Science Process skills by indicating the response that reflects their level of testing by the Biology Practical Paper assessment approach. Write the appropriate numbers in the parentheses that follow every skill using the following scale:

Very ineffective (1) Ineffective (2) Slightly effective (3) Effective (4) Very effective (5)

	Science Process Skill	
6	Observation skill	( )
7	Measurement skill	( )
8	Classification skill	( )
9	Quantification skill	( )
10	Inferring skill	( )

11 Predicting skill ( )

12 Communication skill ( )

13 Interpreting data skill ( )

14 Controlling variable skill ( )

15 Operational definition skill ( )

16 Hypothesizing skill ( )

17 Experimenting skill ( )

Part C: Perceptions of teachers on the Extent to which Experimenting skills are tested by the New KCSE Biology Practical Assessment Approach.

Please consider each of the following statements on the extent to which Experimenting skills are tested in the KCSE Biology Practical Paper Assessment Approach. Write the appropriate numbers in the parentheses that follow every statement using the following scale:

Strongly Agree (1) Agree (2) Undecided (3) Disagree (4) Strongly Disagree (5)

18. Most questions in the paper involve hands-on activities. ( )
19. Specimens are provided to students to handle when Answering all questions. ( )
20. The paper takes a long period because of the many practical Activities involved. ( )
21. The five steps in experimenting (Problem identification -->Hypothesis-->Predictions-->Test of Predictions--> Evaluation of Hypothesis) are followed when answering most question. ( )

Part D: Perceptions of Teachers on the Influence of the KCSE Biology Practical Assessment Approach on Learners Achievement in Biology.

Please consider each of the following statements on the Effect of the New Testing Approach on Learners Achievement in Biology. Write the appropriate numbers in the parentheses that follow every statement using the following scale:

Strongly Agree (1) Agree (2) Undecided (3) Disagree (4) Strongly Disagree (5)

i. KCSE biology practical assessment approach has improved students' achievement in biology ( )

ii. The nature of questions contained in the new biology practical paper makes it interesting to the candidates. ( )

Part E: Perceptions of Teachers on Possible Improvements on the New KCSE Biology Practical Assessment Approach.

In your opinion, what improvement can be made on the new KCSE biology practical assessment approach?

____

____

____

____

Please check if you have answered all the questions.

Thank you for taking your time to fill my questionnaire.

Date of data collection………………….2013

APPENDIX III

SIAYA COUNTY MAP

Source: Google Earth Maps, August, 2013.

APPENDIX IV

RESEARCH AUTHORIZATION LETTER

APPENDIX 5
RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. FRANCIS OTIENO OUKO
of EGERTON UNIVERSITY, 0-40604
RAGENGNI,has been permitted to
conduct research in *Siaya County*

on the topic: *TEACHERS' PERCEPTION ON EFFECTIVENESS OF THE NEW KCSE BIOLOGY PRACTICAL ASSESSMENT APPROACH IN TESTING SCIENCE PROCESS SKILLS IN SECONDARY SCHOOLS IN SIAYA COUNTY, KENYA.*

for the period ending:
31st December,2013

Applicant's Signature

Permit No : NACOSTI/P/13/2546/199
Date Of Issue : 1st November,2013
Fee Recieved : Kshs khs1000.00

Secretary
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 Officers 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

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 541

CONDITIONS: see back page