

SCIENCE PROCESS SKILLS APPLICATION IN PRACTICAL ASSESSMENTS IN MAARA DISTRICT SECONDARY SCHOOLS, KENYA

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ABSTRACT

Science assessment studies reveal very little attention on testing Science Process Skills (SPS) emphasizing practical examination which is understudied in secondary schools. SPS have been described as mental and physical abilities and competencies which serve as tools needed for the effective study of science and technology as well as problem solving, individual and societal development. Lack of data to explain the assessment methods used and the consistency of application in secondary school biology practical makes the issues problematic. The availability and adequacy of facilities used for testing during the examinations which remain an issue for clarification. Biology is one of the most preferred science subjects in Kenya secondary schools, yet the extent to which practical science process skills are applied in assessment is largely understudied. The findings of this study gives basis to propose recommendations on how to solve problems associated with the application of science process skills in examinations. The study was conducted in Maara district in Tharaka Nithi County. Data was collected using questionnaires and analysis biology KCSE practical papers. The target population comprised form three secondary school students who take biology and their respective biology teachers. Stratified sampling method was used so as to capture the full range of variation among the schools and student body. A pilot study was conducted to test the instruments for validity. Data was collected using primary and secondary data, questionnaires were used collect primary data while secondary data was derived from the existing literature. Statistical Package for Social Sciences was used in data analysis. The findings of the research showed that most of the schools in Maara district do not adequately test students in science process skill in biology practical examination. Analysis biology KCSE practical examinations showed that drawing and measurement skills are not adequately tested. Students are also rarely given practical tests. There is no enough facilities in the laboratories for use during practical test. Further research should be done on other science subjects such as physics and chemistry so as to establish if the science process skills are tested in practical.

Key Words: science process skills, practical assessments, Maara District secondary schools

Introduction

Science ideas and models are concerned with the interpretation of phenomena and the needs to equip learners with broad based scientific knowledge (Newton 1998; Ogunniyi 1998). Science as a distinct discipline consisting of knowledge, activities and methods is important in understanding the natural phenomena and solving various problems in the modern society. National Assessment of Educational Progress (2009) argues that many schools do not adequately educate students in science. This problem is not confined to the developing countries but is being experienced in developed countries like United States as well (Mbugua 2009 cited in Sadker, 1994).

This study investigated the extent to which practical science process skills (SPS) are tested in secondary schools, which is understudied, the availability and adequacy of facilities used for testing during the examinations which remains an issue for clarification. Ultimately, lack of data to explain the assessment methods used and the consistency of application in secondary school biology practical makes the issues problematic. 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. However, it is not clear whether this importance is attached to the study of science in many countries. 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.

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. In Africa, science teaching in both primary and secondary is weak compared to developed countries and tends to emphasize rote learning without any appreciable expertise in science process skills, Ango, (2002). Akinbobola, (2010) study analyzes the science process skills in West African senior secondary school certificate physics practical examinations, the findings of the study indicated that the number of basic process skills is significantly higher than the integrated process skills in the West African senior secondary school certificate physics practical examinations in Nigeria. Hence there is need to investigate further the extent to which these SPS are applied in science practical.

The goal of education in Kenya is to promote economical, technological and industrial need for national development Ministry of Education Science and Technology (MOEST 1992). Yet, there is not much research conducted to show whether the youth are prepared scientifically to play effective and productive role in development of the nation. Industrial and technological developments in Kenya will depend on skills, knowledge and expertise in science hence appropriate training in sciences is necessary (Kenya Institute of Education 2006). Performance in science subjects at the secondary school level in Kenya has remained low (Kenya National

Examinations Council, 2009). This study will specifically look into practical assessment of biology, which is the most preferred in the district understudy.

Biology knowledge is important to equip the learner with knowledge to apply, improve and maintain the health of the individual family and community. Biology syllabus recommends teaching through discussion on practical activities, field trips, demonstration and project (KIE Teachers guide 2006). This encompasses theory and practical work. Shiundu and Amulando (1992) notes teaching methods or strategies currently recommended process-based approach of teaching to help students learn science process skills. These include laboratory work, field and project work. The curriculum developers in Kenya advocate for learner-centered approaches in teaching of science in secondary schools (Kenya Institute of Education 2006). Nevertheless, teaching science is predominately expository in secondary schools (Kiboss 1997; Mulei 2009; Nato 2009).

Practical work should be essential constituent of school science. This is important as practical work encourages science process skills like careful observation, accurate recording, development of various manipulative skills, classification, drawing and interpretive skills which provide foundation of science experience. Practical know-how brings experience in handling laboratory equipment. It arouses and maintains interest and attitude of curiosity to enable learners learn proper use of controls and presentation and interpretation of data. It also enables learners to verify scientific facts and principles already taught. Studies focusing on science process skills have concentrated on primary science curriculum and instructional strategies used by teachers and effect in student acquisition of process skills(Osodo 1988,Toili 1985) the issue on testing has not been addressed in secondary schools.

Importance of practical work in science has been recognized and greatly emphasized in national policy of education. Despite this, it has continued to be marginalized in schools. Most of the studies on performance in biology in the country have so far concentrated on aspect of theory delivery in classroom situation. Some of the research done in the country which dealt with aspects of practical work such as Wekesa (2003), Kiboss, 1997:1998) concentrated on the issue of innovation content delivery in terms of current technology. Mukachi (2006) laid emphasis or assessed the actual practice of practical work in laboratory setting in terms of practice of advocated teaching approaches but has not looked at assessment of practical work in biology. (Isaac, 2007), investigated the factors that influence performance in biology subject such as resources, environment, teacher qualification, cultural factors but did not look at assessment at school level.

Biology is one of the sciences which are compulsory in first two years of secondary education but most schools offer biology throughout the four years of the course. In KCSE, biology students are examined in three papers; two theory¹ papers and one practical² (KNEC, 2010).

¹ The theory paper comprise of paper 1 and paper 2 which consists of 80% of the entire examination

² The practical paper comprise of 20% of entire examination

Areas in cognitive domain which are central to practical work which are not assessed satisfactorily reveal that most schools use traditional written approaches, whereas observation and projects are rarely used. The tests are cognitively skewed and ignore other domains of learning related to practical. This raises questions on the validity of use of written practical as a means of testing practical abilities. KNEC (2007-9) in Maara District, biology is one of the most preferred science subjects in Kenya secondary schools, reporting a candidature of about 86% of all candidates taking KCSE. In 2010 for example, KCSE biology had a mean score of 4.2, physics 3.7 and chemistry 3.36. These were among the last five poorest performed subjects. However, there is no explanation about the underlying factors causing the poor performance situations.

Statement of the Problem

Science is recognized globally both for economic well being of nations and because of the need for scientifically literate citizenry (Fraser & Walberg, 1995), but there are still challenges of effective testing at secondary schools levels. The problem is also experienced in many developed countries where teaching testing science practical is far below standard (Gardiner, 1997) in most African countries, there is comparative dismal performance in science which is often time as results of poor testing. In Nigeria a study done by (Akinbobola, A & Afolabi, F. 2010) indicated that the number of basic process skills is higher than the integrated process skills in West Africa senior secondary school. Although the government of Kenya recognizes “the role of science and technology in boosting wealth creation” (Kenya, Vision 2030, 2007) but lack of effective sciences testing in secondary schools is limiting the achievement of such objectives (Alego, 1987). In Maara district where this study was focused, Analysis of the, KCSE results for three years (2007-2010) show a majority of students have been performing below average (MOE Maara District Results Analysis 2007-2010). This study focused on the practical SPS in doing practical sciences assessment. KIE (2006) emphasizes laboratory activity, fieldwork, projects and demonstration as important practical aspects of biological sciences learning where SPS are incorporated. However, Biology is one of the most preferred science subjects in Kenya secondary schools, yet the extent to which practical SPS are applied in assessment is largely understudied. First, there is little attention to practical science process skills testing. The question is, how does this affect the development of competency in science skills among students? Second, the types of test tools used and their consistency use in secondary schools are inadequately addressed. Third there is limited data to explain the availability and adequacy of facilities for practical testing. Some of the research done in Kenya (Kiboss, 1997:1998; Wekesa 2003; Mukachi 2006; Isaac 2007) inform on the content delivery in terms of current technology, teaching approaches, factors affecting performance, but hardly not on testing of practical SPS.

Purpose of the Study

The purpose of this study was to investigate the extent to which practical science process skills are assessed in secondary schools in Kenya.

Research objectives

1. To find out whether the selected practical science process skills are applied in testing biology in secondary schools.
2. To establish the assessment methods applied in Biology practical in secondary schools.
3. To examine the availability and adequacy of facilities when testing biology practical in secondary schools.

Literature Review

Related Studies

Science assessment studies reveal very little attention on testing SPS emphasising written examination. According to Watson and MacRobbie (2004), traditional assessments of school science practical work tend to concentrate written product of an inquiry produced by an individual while Science Process Assessment appears to be a solution to examining the processes rather than just the products of science inquiry. In Singapore, the government overhauled its science practical assessment practices in schools (Ministry of Education 2003) replacing it with more process based continuous assessment. This signified that the process based assessment was found to be better than the product based.

Most of the assessment of students' performance in the science laboratory continues to be confined to conventional, usually objective, and paper and pencil measures. More sensitive measures of students' understanding of laboratory methodologies, the hypotheses and questions they generate from the laboratory experiences, and the practical skills they exhibit have all too often been neglected (Bryce & Robertson, 1985).

A study carried out by Annette and Theodore (1995) in the USA to determine how outcomes of multiple choice and hands on [manipulative] for science process skills were related when students grouped on basis of sex, race, ethnicity and poverty levels of fourth graders. They also related scores and scores of two alternative assessments. The findings were that all students performed better on hand on tests, social economic and ethnicity gap was reduced on hands on test. However the author overly focuses on the hands on test only (i.e. manipulative) without much attention on other SPS.

Comparative assessment of written and practical examination shows that practical assessment is better at assessing SPS. Bennet (2001) mapped the development of a feasibility study for practical assessment in Ireland where practical work has traditionally been assessed at the end of a compulsory secondary school through written exam questions. The feasibility study considered three modes of assessment: teacher assessment, an end of year practical examination and the use of an external examiner. The assessment was based on manipulative skills, observational and measurement skills, recognition and understanding of apparatus and understanding of the experimental work recorded in the notebook. One of the main findings of this study is that there was a low correlation between students' scores on the written practical questions and their scores in the feasibility study. Bennet , (2001)found out that the written exam questions were very limited as they tested only a few areas of procedural knowledge and areas such as analysis, synthesis and evaluation were not assessed at all. In addition, the marks were higher in the feasibility study than on the written exam and the rest of the questions testing theoretical conceptual knowledge. However some practical areas such as experimentation, drawing, SPS have not been studied.

Gardiner (1997) surveyed the quantity and quality of laboratory work conducted by grade 11 and 12 biology students in British Columbia high schools to analyze student performance on laboratory based questions on provincial examinations and to examine curriculum for recommended laboratory work. Findings indicate that frequency of laboratory work was low overall with quantitative activities much frequent than qualitative and laboratory exercises being confirmatory rather than investigative. Although the laboratory was adequately equipped teachers indicated that the curriculum and provincial examination limited the score for inquiry based course. Assessment technique are very limited and confirmed almost exclusively to paper and pencil, recall type test. This study however does not explain the adequacy of facilities for during examination.

A study by Linda et al (1995) on evaluation of student's performance on science laboratory process skills, which sample 147 respondents year 5 from six schools responded to laboratory process skills test which assess investigating, performing and reasoning in content areas of biology, chemistry and physics. The data was analyzed to provide information about students overall practical performance and to identify specific pre instructional conception and errors. Personalization, investigation and gender differences found in science achievement were absent when laboratory performance was used as criterion

Akinbobola (2010) analysis of the science process skills in West African senior secondary school certificate physics practical examinations in Nigeria for a period of 10 years (1998-2007). Ex-post facto design was adopted for the study. The 5 prominent science process skills identified out of the 15 used in the study are: manipulating (17%), calculating (14%), recording (14%), observing (12%) and communicating (11%). The results also show high percentage rate of basic (lower order) science process skills (63%) as compared to the integrated (higher order) science process skills (37%). The results also indicate that the number of basic process skills is

significantly higher than the integrated process skills in the West African senior secondary school certificate physics practical examinations in Nigeria. It recommended that the examination bodies in Nigeria should include more integrated science process skills into the senior secondary school physics practical examinations so as to enable the students to be prone to creativity, problem solving, reflective thinking, originality and invention which are vital ingredients for science and technological development of any nation. This affirms that SPS are increasingly found to be important learning science.

Alego (1987) studies in junior secondary school pupils' competence in some selected science process skill of observation, prediction, generalization and controlling variables found out that the nature of Kenya secondary schools is not process oriented as skills are not emphasized in syllabus although pupils are expected to acquire them informally through laboratory experiences. Junior secondary school pupils demonstrated low competency skill of observation, prediction, generalization and controlling variables. Performance in boys was better than those of girls in same skills. Despite the importance of this study, it falls short of explaining whether these skills are incorporated in examination. Further Toili (1985) investigated the relationship between acquisition of science process skill and achievement in science among class 7 pupils and found out that, there is positive correlation between performance in science process skill and science achievements, but similar studies are necessary at secondary level. The work is also general but focuses theory and practical without specifying which science process skills.

Osodo (1988) studied the relationship between the acquisition of science process skills and science solving problem among primary school pupils in urban and rural setting. The study focused on skills of quantification, prediction and classification. The study found out that boys performed better than girls in science process skill test. The pupils performed better in skill of quantification. The overall comment was that the level of skill of acquisition of skill was wanting, but it did not investigate specific science practical skills. The related studied shows that the Key SPS in practical assessment has been understudied and also the availability of materials in relation, to test and in administration. Finally, the analysis of the test remains largely under researched.

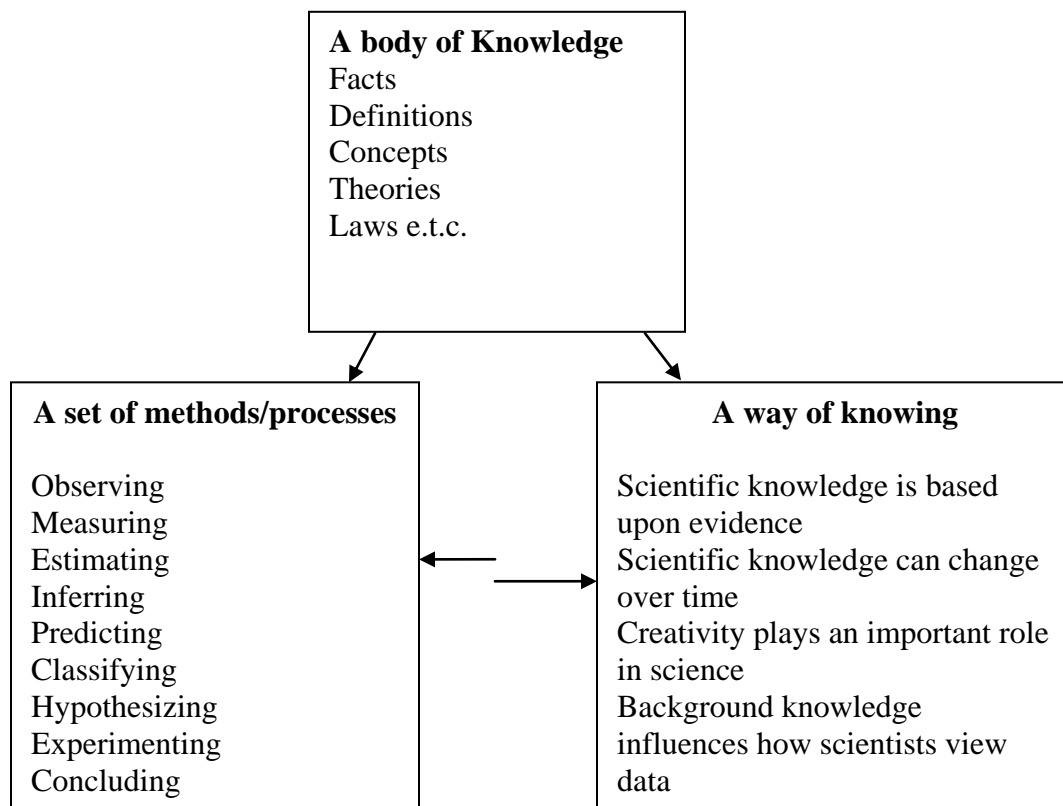
Science as Discipline

According to Medawar (1982), science is the systematic study of the properties of the physical world, by means of repeatable experiments and measurements, and the development of universal theories that are capable of describing and predicting observations. Abel & Lederman (2007) defined science as a way of knowing or a method of learning about nature. Yager & McCormack (1989) proposes that science has been viewed as a body of knowledge listing of facts, figures and theories and this has led to science instruction characterized by presentations of factual information and 'knowing and understanding' domain limited to students in developing the level of scientific literacy demanded by the needs of the society and the world.

Kenya needs to develop through science and technology education, a human resource capacity for rapid industrialization, which ensures economic growth and sustainable development (Changeiywo 2001). A report by Republic of Kenya (1996) suggested that if Kenya government is to meet her goal of industrialization by 2020, she should expand science and technology in order to produce the required human resource. Furthermore, other report by Kenya National Examinations Council (2003) revealed that although science is essential for industrialization, there has been a decline in academic achievement scores of secondary school students as well as low enrolment in the subjects in Kenya. The question is; does Kenya educate to archive such noble objectives in science?

Science educators have identified three domains of science that are critical to developing scientific literacy (figure 1). The first of these is the body of scientific knowledge. Of the three, this is the most familiar and concrete domain, and includes the scientific facts, concepts, theories, and laws typically presents in science textbook (Bell, R.L, 2008), but studies are necessary to find out of these domains are applied.

Figure 1: The three domains of science



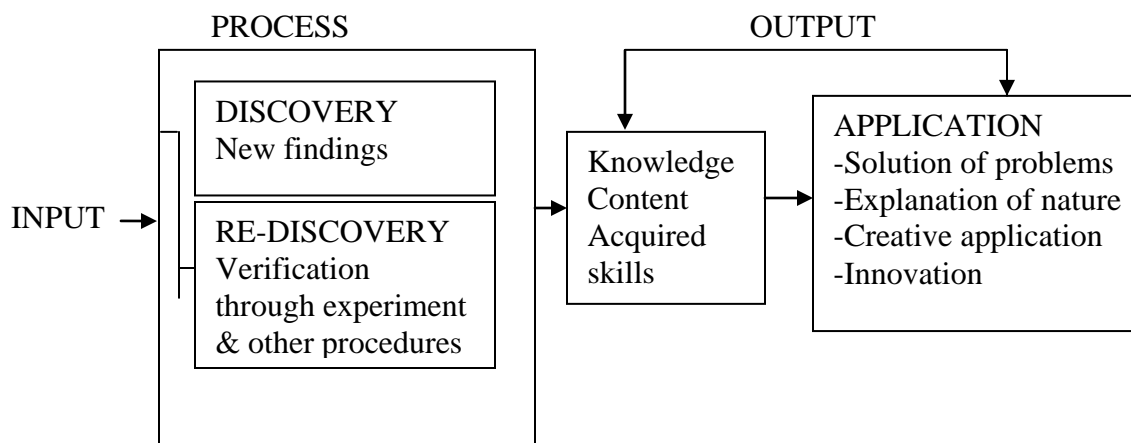
Source: Bell, R.L (2008) Teaching the nature of science through process skills: Activities for grades 3- 8. New York: Allyn & Bacon/ Longman.

Second domain is the way of knowing which is the way of acquiring scientific knowledge, this is through investigating to get evidence by experimenting. The third domain is the method or the process to be applied during investigation. Whether these processes are assessed in order to establish students' competency remains a question.

Science Education

In any curriculum, science education is acknowledged as means of providing knowledge and skills for development of various spheres of life. Science is relied upon for technological and industrial development. Understanding and mastery of scientific process is the key to this realisation. Piaget (1973) points out that, to understand is to discover or reconstruct by discovery and such conditions must be complied with if future individuals are to be formed who are capable of production and creativity and not simply repetition. The process for effective learning in biology is generally the case in other sciences and should follow the sequence outlined below.

Figure 2: Process Leading to Understanding of Science



Scientific inquiry and understanding how scientific inquiry should be carried out in school should occupy a central position in science education (Driver, Leach, Millar & Scott, 1996). School science practical work is seen as an important component of science curriculum worldwide as it holds the promise of bridging the gap between theoretical science and the empirical evidence that helps build scientific theories (Hodson, 1990).

Education in science emphasizes that science is both a way of knowing and a body of knowledge; it also emphasizes integrating scientific inquiry with scientific knowledge. According to the International Academy of Education (IAE) 2007 education in science serves three purposes. First, it prepares students to study science at higher levels of education. Second, it prepares students to enter the workforce, pursue occupations, and take up careers. Third, it prepares them to become more scientifically literate citizens. The relative priority and alignment of these three purposes varies extensively across countries and cultures and in Kenya, the emphasis on science has yet to be tested in terms of its application.

Educating in Science

According to the National Research Council, 1996 teachers are challenged to engage students in a broader view of science one that addresses the development of scientific knowledge and the very nature of the knowledge itself, but no comprehensive study exists to show whether this is done accordingly, even though science teachers are increasingly being encouraged to teach about the nature of science. Education in science has three major aspects (Hodson, 1993). Learning science is acquiring and developing conceptual and theoretical knowledge. Learning about science, this is developing understanding of the nature and methods of science, and an awareness of the complex interaction between science and society. Doing Science is engaging in and developing expertise in scientific inquiry and problem solving. If education in science is about making sense of the physical world and understanding the conceptual and procedural knowledge that scientists have developed to assist them in that task, a first step in science education must be familiarization with world, hence, laboratory work is essential because it may be a way of experiencing at first hand of phenomenon and event that science addresses.

Student need to experience what has been learnt in theory in order to be at first hand and handle objects and organisms for themselves to in order to build up a stock of personal experience Woolnough & Allsop (1995). Hodson (1993) further adds that conceptual development and refinement is assisted by encouraging a student to explore, elaborate and test their existing ideas against experience, both real experience and contrived experience of scientific experiment, then laboratory work and investigation in the field have an important role to play, but only when such activities are theoretical and well understood by the learner. Students can only develop their procedural knowledge and process skills within particular theoretical contexts. Process of science changes ones conceptual understanding and process skills that play a crucial role in development of understanding, encouraging students to deploy the process of science in a way to developing their conceptual understanding Hudson (1993) but in Kenya it is hard to explain whether this is happening without further studies.

Teaching Science

Traditionally the deductive approach was used; here the teachers present the concepts, their logical (deductive) implications and gives examples of application. To be used, the children must be able to handle abstract notions, what makes it difficult to start teaching science before secondary education. In contrast, Inductive approach gives more space to observation, experimentation and the teacher- guided construction by the child of his /her own knowledge (OECD, 2006). The reversal of science teaching pedagogy from mainly deductive to inquiry based method provides the means to increased interest in science. Inquiry-based science education (IBSE) has proved its efficacy at both primary and secondary levels in increasing children's and students' interest and attainments levels while at the same time stimulating teacher motivation. IBSE is effective with all kinds of students from the weakest to the most able and is fully compatible with the ambition of excellence. Moreover IBSE is beneficial to

promoting girls' interest and participation in science activities. Finally, IBSE and traditional deductive approaches are not mutually exclusive and they should be combined in any science classroom to accommodate different mindsets and age-group preference (OECD, 2006). The question is whether this is applicable in teaching and assessment of sciences.

Practical Aspect in Science Education

Science practical skills have been emphasized in many learning education systems in the world (Lynch 1978, Weiss 1978, Woolnough and Betty 1982), but without an absolute agreement on assessment strategies. Hodson (1990) study on Assessment of practical Work, argues that "since 1960s, numerous curriculum development projects have emphasized on hands- laboratory based practical work" as effective learning methods. The study however, raises critical concerns that the increasing emphasis on skill-based approach, increases workload of teachers and reduces their scope of making judgment and tend to trivialize learning. Bennet (2001) argues that, "written examinations" "cannot adequately assess the range of practical abilities." The study however, makes a much generalized claim that, "school science curricula of many countries have "a clear commitment" to practical assessment, which is not substantiated as true for every country. Bryce and Robertson (1985), have for instance, stated that the fundamental problem is that "the poor implementations of practical work in schools" is what considerably undermines effective learning.

Practical science skills assessment have featured significantly, for example in Britain, since 1970s underscoring its importance, but lack of a clear agreement on what is to be taught and assessed in scientific inquiry has been seen as ambivalent. The methodological issues related to the way science should be studied and assessed, particularly whether the Ministry of Education guidelines are adhered to in secondary schools in Kenya remain understudied. The general dismal performance in sciences compared to art-related subjects is frequently highlighted by the media issues (KNEC 2009), and is urgent for empirical investigations. The questions that beg answers are; do Kenya secondary schools apply important aspects of practical science like demonstration, laboratory activities, field and project activities? In Maara district where this study focuses, analysis of KCSE examinations results from 2007- 2010, show as consistent trend, where biology performances ranks below average. Although such results are helpful to explain how schools are performing, they hardly give any reasons to link results with the way students are assessed, particularly fundamental to students of science. This study is therefore, pertinent as it questions whether biology is assessed within the proven science process skills.

Science Process Skills

Science process skills are activities that contribute to scientific learning (Brotherton et al 1996), but it is not clear if these methods are used in collecting and gathering or deriving and disseminating scientific knowledge in Kenya effectively. Ostlurd (1998) indicates that sciences

processes skills are basically problem-solving tools used to gather information and test inferences or provide explanation for natural phenomena. Science process skills have been described as mental and physical abilities and competencies which serve as tools needed for the effective study of science and technology as well as problem solving, individual and societal development (Nwosu and Okeke, 1995).

There are many process skills encompassed in the conduct of scientific inquiry. Among the science process skills but it is not clear whether they are engendered in the teaching and studying of science are those of measuring, observing, classifying, inferring, predicting, communicating, interpreting data, making operational definitions, posing questions, hypothesizing, experimenting and formulating models(Ango,2002).

Kenneth.R. et.al.(1983), listed science process skills that a learner , should acquire and be able demonstrate these are :- observing, describing, following direction , communicating , designing an investigation, synthesizing, measuring, sequencing, recognizing relations , interpreting graphs, organizing graphs , recording, controlling variables, inferring, analyzing, making judgments, generalizing ,practicing , hypothesizing , using spatial relations. According to Bybee et al. (1989) and Ango (1992), SPS are categorized into basic SPS and integrated SPS basic and integrated process skills. The basic (simpler/low order) process skills provide a foundation for learning the integrated (more complex /high order) skills. Basic science processes are vital for science learning and concept formation at the primary and junior secondary school levels. More difficult and integrated science process skills are more appropriate at the secondary and tertiary school levels for the formation of models, experimenting and differencing, The basic science process skills comprised of observing, measuring, classifying, communicating, inferring, using number, using space/time relationship and questioning while integrated science process skills are controlling and manipulating variable, hypothesizing, defining operationally, formulating models, designing experiment and interpreting data. While both basic and integrated science process skills are relevant and appropriate at the senior secondary schools level, their effectiveness can only be explained with critical research.

According to (Whitelegg and Tresman 1993), science process skills consist of two categories. First, cognitive science process skills, which cover intellectual abilities of recall and perfection of knowledge interpretation of information and problem solving. These skills are applying inferring, hypothesis, predicting, classifying, planning, discussing, questioning, interpreting, evaluating and presenting. Second, consist of practical science process skills (manipulation and observational skills). These skills impact knowledge in investigating, recording and interpretation, observing, drawing, demonstrating and illustrating (Whitelegg and Tresman 1993). The concern for this study is the following practical sciences process skills; manipulating, observation, drawing reporting and interpretation measuring and experimentation.

Manipulating

Conceptions of contemporary best practice of teaching and studying emphasize that students should be involved in the study process through manipulation of equipment and objects and through participation in any scientific activities pertinent to a given situation in effective guided study (Ango, 2002). Good science teaching must be based on observation and experiment and there can be no substitute for these (UNESCO, 1962). Ango (1986) notes the importance of practical experiences in science teaching and learning in this way: A learner acquires more in a science learning situation when given the chance to perform certain activities which include, manipulating apparatus, classifying data, designing experiments, forming hypotheses to making inferences and verifying results. In A learner is expected: to select appropriate apparatus or instruments for performing experiment, arrange assemble/set apparatus systematically, perform the experiment with reasonable efficiency and accuracy and locate and rectify errors in apparatus. These claims are important but have yet to be evaluated to find out whether the learners in Kenya secondary schools acquire them.

Observation

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 characterization 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.

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.

Drawing Skills

This skill subsumes other skills like observing and reporting; the learner is expected to make proper observation tables, draw circuit diagrams or experimental setups, label diagrams correctly, draw graphs from observed data correctly. . Hien (1987) recommends a variety of approaches to be used to assess hand on learning, including observing student at work, examining things they manipulate evaluating sciences related drawing and writing. It is not clear whether the practical test address that

Reporting and Interpretative skills

Interpret means to derive more information from presenting a situation. It involves getting much information as possible from records or presentation that are made. As an activity interpreting succeeds other processes which more frequently follow the order, observing, recording, discussion, interpreting. Scientific inquiry is empirical in nature. Through observation and experiments, data are gathered. Once collected, the data need interpretation so that meaning and sense can be related to the data.

Interpreting and inferring are critically determinant activities of science. Information gathered from scientific investigation usually is not readily useful and meaningful to other scientists and the wider community. Data have to be analyzed and interpreted, and inferences have to be made to produce and extend knowledge which is to have usefulness and meaningful applications for life (Ango, 2002). While the learner should be able to; make proper plan for recording observations, record the observations / Data/ information correctly & systematically, classify and categorize organisms, make correct calculations/predictions and interpret the observations and results correctly, only critical studies can explain the extent to which this is applied in Kenya.

Measuring

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.

Measuring involves evaluation, which entails value judgments. James (1963) defined measurement as a process which involves comparison of an entity with a standard unit of measurement which has been arbitrarily determined. In measuring learners are expected to; compare and order objects by length, area, weight, and volume, etc. measure properties of objects or events by using standardized units of measuring volume, mass, weight, temperature, area, length, and time, using appropriate units and appropriate measuring instruments. Do Kenya secondary schools follow this meticulous measurement skills?

Experimentation

This the process by which one carries a scientific test in order to study unfolding results and gain knowledge. It also involves, analyzing and presenting. For Gagne (1963), expertise in scientific inquiry is the ultimate objective of science education. The conception of teaching and

conducting guided study of science and scientific inquiry and the nature of science are rooted deeply in the activities and experiments which students under guidance undertake.

Stone (1972) suggested following steps in experimenting; identifying the problem, hypothesizing to guide investigation, propose ways of gathering data from controlled experiment, observation, reading, and other pertinent sources, carrying an investigation to gather the data, summarizing the data to conclude about the adequacy of hypothesis. Learners are expected to; design an investigation to test a hypothesis. Conduct simple experiments. Recognize limitations of methods and tools used in experiments, i.e. experimental error. Utilize safe procedures while conducting investigations.

Assessing Practical Science Process Skills

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.

Huary and Rillero (1994), study on views of teachers on evaluation and assessment of hands on learning and teaching suggest that hands on learning can be evaluated in two ways. One way is to have student explain the process of experiment they experienced and why it works the way it does. The other way is to evaluate is to give short quizzes or test to see if they can explain thing in written form. To determine if the student is able to do science, he/ she must engage in performance based assessment in this context the student works with materials to answer questions. Assessment must be designed so that the answers cannot be obtained by other means. Materials should be similar to student. Instructional activities that use manipulative help teachers to address broad range of conceptual knowledge, scientific personal attitudes (Flick 1993). It is difficult to evaluate which method is used due to lack of data.

Laboratory practical exams have been used to assess student attainment of science process skills. For individuals assessment each student must perform all the manipulation of equipment and materials to answer question (Stensvold and Wilson, 1993). Assessment of practical can also be through unobtrusive observation, observation of student can be in small groups, the whole class or even individualized. The teacher should make brief and even cryptic remarks of observation. The comments are recorded in index cards to save as records of progress and attainment to used plans. Evaluation form can be used as an instrument to measure activity based science process skill. The form is a derivative in part from analysis of Benjamn – Bloom Taxonomy of Educational objective and analysis of middle school science activities. Student behavior is listed from low level to high level skills. Instructions given guide the teacher to a student name by skill when they observe in class. Use of portfolios effective means of realizing comprehensive assessment. A portfolio is a collection of document that contains evidence of achievement.

Evidence presented in portfolio may be worksheet laboratory reports, raw data, first drafts diagram of lab equipments.

The question of the assessment tools that are necessary in sciences has been a central issue in many scientific debates. Huary and Rillero (1994), acknowledge that there is considerable evidence to suggest that assessment can focus on learning activities in science classrooms. They further assert that the way teachers assess student and what they assess has major impact on the activities which emphasizes rote learning of algorithms to solve exercises similar to those that are included on the test. Although assessment schemes are designed to provide students with opportunities to represent what they know to identify aspects of science that need to be explained, teachers at the classrooms levels are encouraged to use variety of methods to assess student knowledge acquisition such as traditional paper and pencil method, personal oral interviews and performance test (Flick, 1993). In addition, Hien (1987) asserts that instructional activities that are concrete manipulative skills help teacher's addresses broad range and conceptual knowledge recommending a variety of approaches to be used assess hand on learning, including observing student at work, examining things they manipulate evaluating sciences related drawing and writing.

The proposed study concurs with these arguments but the extent to which they are applied in performances based assessment remains questionable. Some teachers use an obstructive observation. Teachers find it useful to observe, individual student, small group or whole class. Teachers observation are recorded in writing .The remark maybe quite be brief even cryptic, but should specify in some way what is seen but not just teachers judgment, of its quality. Recorded comments can be used to judge progress, attainment grades or further planning of instructor.

Stensvold and Wilson (1993) cited the use of science activity evaluation form to measures activity-based science process skills. These indicate that the form derived in part from analysis of Bloom's taxonomy of educational objectives and analysis and middle school science activities. Science activity evaluation form can be used to evaluate the work for students to identify activities or if curricula only engage students in predominantly low-level knowledge skills.

.Moreover, portfolios (long-term information collection) are also becoming increasingly important assessment tools in science learning and teaching. Portfolio itself is an assessment. Assessment comes from leader judgment and material in respect to criteria set (Flick, 1993). Traditional paper pencils multiple choice approach cannot be used alone to assess full range of learning that involves activity, demonstration or experientially-based learning. Science learning requires some degree of active expression beyond to small set of standardized test items (Judith 2001, Haury and Rillero 1994).They recommend using frequent verbal explanation using assessment strategies that incorporate performance tasks, developing observation checklist and compiling portfolios and student work. However such assessment strategies are not common in Kenyan schools .This study aims at investigating the assessment methods used in testing science process skills in biology practical activities.

Testing Practical Skills in Biology

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. KNEC makes use of practical test/examination to assess students' acquisition of various biology practical skills. In these tests, students are required to carry out certain biology practical activities following some given instructions. The scores of the students obtained through the marking of their practical works indirectly indicate the levels of biology practical process skills they could demonstrate during the practical examination. This mode of assessment is also adopted by biology teachers who prepare the students for Kenya Secondary School Certificate Examination (KCSE). This mode of assessment influences the teaching methods adopted by teachers. Also, students' learning style is influenced in such a way that they always try to find certain correct responses or answers irrespective of the procedures adopted.

The process approach method of teaching science is meant to foster inquiry and manipulative skills in students and discourage rote learning. This method embraces other methods of science teaching and is mainly activity based, superior to those in which the students are not actively involved in learning process (Akinbobola, 2008). This reason has made the KNEC to stipulate that practical work should form the basis of teaching. During examination, the practical work is also assessed separately. Currently, biology being one of the sciences taught in secondary schools is taught both in theory and practical. In both internal and external examinations, practical biology is assessed separately as an integral part of the subject but there is limited understanding the validity of the practical paper in terms of SPS.

Facilities for Testing Science Practical

The concept of physics chemistry and biology are learnt through investigatory approach and experimental approach. The learners interact with instructional materials and apparatus to enhance learning. The teacher provides classroom, laboratory or field environment where students can experience, see, and feel the concept being learnt (Das, 1992).

Laboratory

The laboratory work has been a focal point for science teaching since the 18th century to present day (Timir,1976), but the quality and quantity of laboratory service has been questioned as an issue of contention. Studies in British Columbia show that, "although the laboratory was equipped adequately, the curricula as the provincial examination limited the scope for an inquiry based course (Gardner et al., 1997). This shows a lack of correlation between examination bodies and teaching. The findings that "laboratory activities are being conducted less than recommended in the course outline," raise fundamental questions regarding the efficiency in

student assessments. Hodson *ibid*; Roth (2002), have claimed that school laboratory activities are “ill-conceived” and “unproductive” and many students little about science and do not engage in doing science.

The laboratory central and distinctive role in science education has been able to enhance the hands on activities (Hofstein, 2003, Gardener 1975). According to Jenkins (2007), laboratory comprises a range of factual investigation, exercises and skill. In learning laboratory complements theories, bridged the knowledge gap between abstract ideas and reality. Laboratory experiences provide opportunities for students to interact directly with the material world (or with data drawn from the material world), using the tools, data collection techniques, models, and theories of science (Edgar, Jenkins, (2007). The purpose of laboratory work in science education includes helping students learn science through the acquisition of conceptual and theoretical knowledge, and helping them learn about science by developing an understanding of the nature and methods of science. Laboratory work also enables students to do science using the protocols of scientific inquiry. Furthermore, the laboratory work should stimulate the development of analytical and critical skills and create interest in science (Christina and Grelsson (2006), an issue which needs to be examined.

Teaching and assessment of science is greatly influenced by availability of instructional materials and science equipment and physical facilities. The basic requirements for a science laboratory include the basic equipment and chemicals, source of heat, water, sufficient space for students, elaborate system of water piping, sinks and drainage system. Some researchers Hudson,(1990), Roth ,(2002) town down,(2006) have claimed that school laboratory activities conceived confused and unproductive that many students learn little about science and do not engage in doing science. Eshiwani (1993) observed that quantities of chemistry materials and equipments allocated to students and how well amount of equipments and materials are organized and managed raise student performance. This argument is supported by Mbugua,(2009) who observed that availability of materials influenced student’s performance in chemistry. Many schools are severely handicapped by lack of equipments. Kenya being a developing country may find it difficult to establish a system of science education based on model of more advanced nations which can afford advanced and expensive equipments in school laboratories. Science teaching and assessment should take place in laboratory where possible. Many schools lack laboratories for teaching science subjects and basic requirements for science laboratory. Lack of laboratory and equipments has affected standard s in science performance in Kenyan schools (republic of Kenya 1999).

According to Musoko, (1993) the condition of science laboratories in Kenyan schools are far from being satisfactory. Not all schools have science laboratories and in many schools science rooms serve as laboratory for biology chemistry and physics. A study carried out by Mbugua (2009) on influence of school related factors on chemistry performance in secondary school revealed that there is significance relationship between adequacy of facilities and chemistry

performance although the relationship was weak. He identified the causes of poor performance as lack of materials laboratory manuals for teaching preparation and inadequate textbooks.

Physical facilities and instructional materials are fundamental to effective assessment, but the extent to which these are available and adequate is not known due to lack of research the school targeted in this study. Most of data available is from the Ministry of Education and mainly focuses on KCSE performances. Although KIE conducts the assessment on physical and instructional materials (KIE, 2007), it is done on the whole country giving more general conversation without much detail in each district. The sampling is broad to be of any meaningful relevance in understanding of the status of physical and instructional materials in every district. Furthermore, these are done to assess the adequacy in the delivery of the instruction level, but their availability adequacy during testing is hardly established.

Theoretical Framework

This study adopted the theory of discovery learning by Jean Piaget (1973). In his book *To Understand is to Invent*. Piaget argues that understanding comes from discovery. Furthermore, without understanding production and creativity are lost. Hence, the individual is caught in repetition. Discovery learning encompasses an instructional model and strategies that focus on active, hands-on learning opportunities for students. Piaget describes three main attributes of discovery learning as; 1) exploring and problem solving to create, integrate, and generalize knowledge, 2) student driven, interest-based activities in which the student determines the sequence and frequency, and 3) activities to encourage integration of new knowledge into the learner's existing knowledge base.

The first attribute of discovery learning is a very important one. Through exploring and problem solving, students take on an active role to create, integrate, and generalize knowledge. Instead of engaging in passively accepting information through lecture or drill and practice, students establish broader applications of skills through activities that encourage risk-taking, problem solving, and an examination of unique experiences (Bicknell- holmes and hoffmans, 2000).

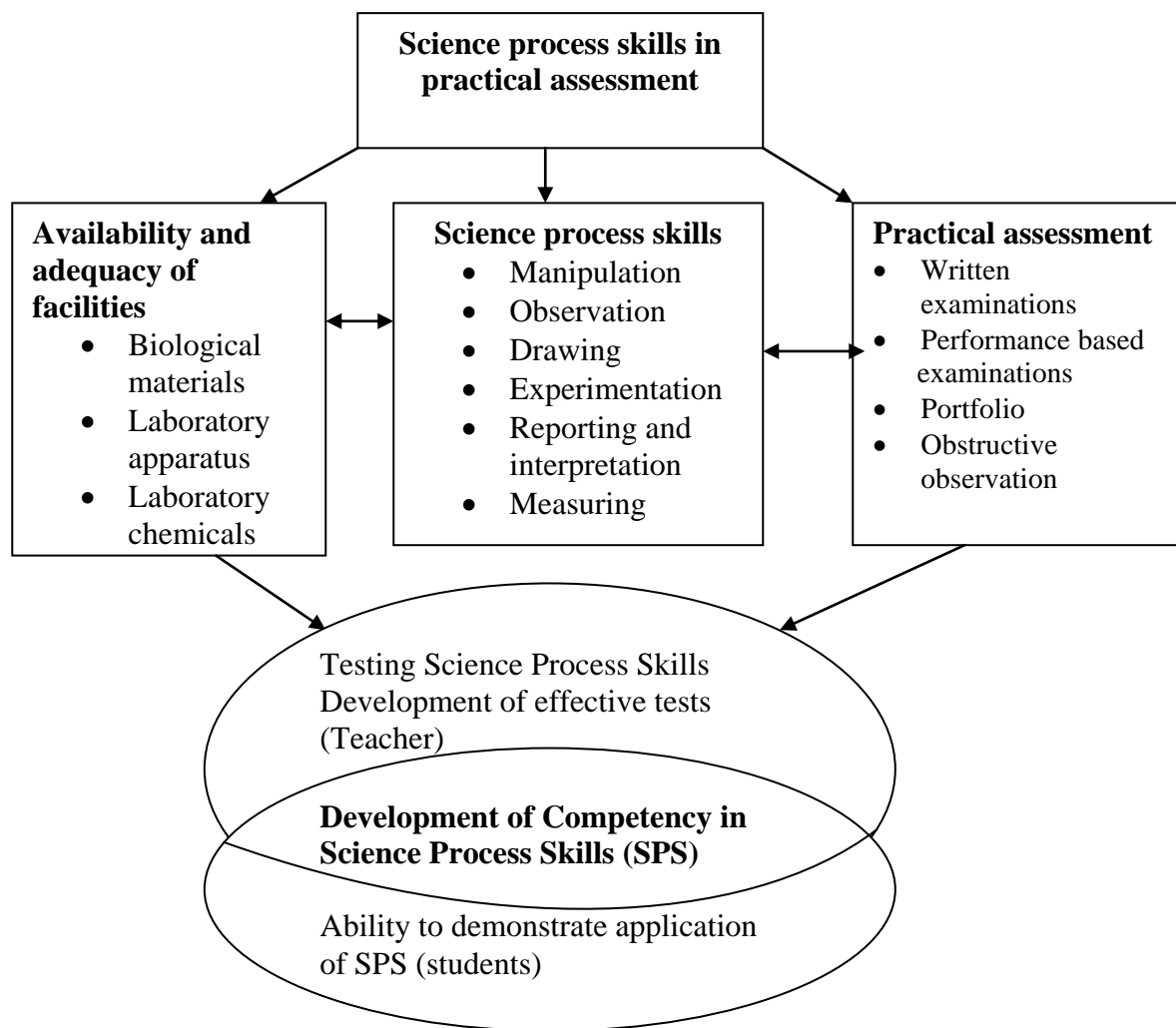
Dewey (1997) believed that children were naturally motivated to actively learn and that education only served to make more learning. Dewey saw children as participants in their learning rather than receivers of their learning. The teacher role is to present students with materials, situations and occasions that allow them to discover new learning. In active learning, the teacher confidence in the child's ability to learn on its own is important. Science process focuses on the acquisition and the use of process skills. It also emphasise the process being taught. It draws attention to the following process skills applying, interpreting, classifying, investigating, evaluating, observing, experimenting, predicting, hypothesizing, raising question and inferring. The modern trend in science instructions is of stressing the acquisition of the process of learning the subject rather than mere acquisition of the content of the subject. According to Rezba (1999) in the earliest grades students spend a larger amount of time using

skills such as observation and communication. As the students get older they spend more time using the skills of inference and prediction. Classification and measurement tend to be used across the grade levels more evenly, partly because there are different ways to do classifying, in increasingly complex ways, and because methods and systems of measuring must also be introduced to children gradually over time. This study consider learning by discoverly while integrating the science process skills together and gradually developing abilities to design fair tests as essential in successive grade levels.

Conceptual Framework

The conceptual framework explains the interplay between the independent variable and the dependent variable. It further explains the interplay relationship between the independent, dependent with the intervening variable.

Figure 3: Conceptual Framework



Source: Author (2011)

The above conceptual framework shows that practical skills are best assessed through use of practical test. A practical test serves as an effective tool for science process skills of manipulation, observation, drawing, reporting and interpretation, experimentation and measuring which are essential in learning science. Adequate facilities are essential in order to administer a test that assesses these skills. The interaction between teacher ability to develop and administer the test and the students' ability to demonstrate application of SPS in a test is integral in development of competency in those skills.

Relationship of Theoretical Framework and Conceptual Framework

Discovery learning encompasses an instructional model and strategies that focus on active, hands-on learning opportunities for students. Understanding comes from discovery. The major inputs in discovery learning in sciences involves; new findings, verification through experiments and other procedures, its output involves knowledge content, acquiring skills, solution of problems, explanation of nature, creative application and innovation. On the other hand, science process focuses on the acquisition and the use of process skills. It draws attention to the following process skills applying, interpreting, classifying, investigating, evaluating, observing, experimenting, predicting, hypothesizing, raising question and inferring. The theoretical framework tries to address acquisition of the skills thorough active learning in general but it falls short of describing how it is tested to attain competency. The conceptual framework aides by addressing the shortfalls of the theoretical framework.

Research Design

This was a descriptive survey study. This is normally used to obtain information on current phenomenon and uses a sample of the population to represent the whole population. The sample studied is then generalized within the larger population. This design relevant for this study not all the schools will be studied. The study focused a non- experimental quantitative survey, helped obtain the facts on science process skills, including statistically established quantities, such as the percentage of SPS that was tested. Moreover, it focused qualitative approach which helped to describe which help describes the reality of SPS, e.g., availability of facilities. The study was not focused on the causative factors and did not therefore concerned with why questions, rather with what questions. The survey therefore explain the extent to which the science process skills are incorporated in the biology practical tests, the practical science process together with the facilities and testing tools were described.

This study had two main phases. First, practical science process skills, the teachers and students were required to demonstrate whether they apply these in testing. In addition the KNEC exams were reviewed with a view to explain whether they reflect the process skills so determine their validity. In the study focused on issues, first assessment of attainment of science process skills in determining students' knowledge. Secondly, study focused the availability and adequacy of facilities when testing practical process skills.

Target Population and Size

The sample population for this study derives from, students and teachers in Maara district secondary schools. The targeted schools were all the 44 schools in the district. There are 44 schools in Maara District, which are classified in different ways. Nine are provincial schools and thirty five are district schools. The study targeted form 3 students since they are the most experienced. Each class has an average 45 biology students. The form 3 students were from one of the biology classes in each school sampled randomly. This gives a target population of students as 1980. The study targeted 1 form 3 biology teacher from each school in the district. This gives a target of 44 biology teachers. Forms 4's were not considered since they were doing exams at the time of study. The total target population was therefore 2024.

Sampling Procedures

This study used a stratified sampling method so as to capture the full range of variation among the schools and student body. From the 44 targeted schools, the researcher categorized the schools on basis of performance i.e. most performing with mean score of 8, Average performing with a mean score of 6, Low performing with mean score of 4. There are only 2 schools with a mean score above 8, 29 were average performers while 9 were low performers. 30% of the strata were chosen as sample size. This gave a sample size of 13 schools which were randomly selected. The study randomly selected one form 3 biology teacher from each school giving a sample size of 13 teachers. 30% of the 45 students in each class was selected randomly to give a sample of 13 students from each school resulting to a sample size of 169 students. 30% was used since Patton (2002) argues that 30% of the target population is enough in a descriptive survey study. In total, the study sample size was 182 respondents.

Methods of Data Collection

The instruments that were used to collect data for this study are analysis of the KNEC examination across a guideline and questionnaire. Standardized KCSE papers were analyzed from 2006 - 2010 to provide a data on Science Process Skills in order to find out the current trend. The Questionnaire was used to collect data from the biology teachers and from three biology students. The questionnaire included closed-ended and open-ended questions. In closed-ended questions, the respondents' response was limited to ticking the correct answer. From closed - ended questions, a specific answer was required from the respondent. The open – ended questions gave the respondent a chance to discuss further on a particular issue. The secondary data were collected by way of comprehensive reading of books, journal found in the library and internet.

Methods of Data Analysis

The data from the questionnaire were analyzed using Statistical Package for Social Sciences (SPSS). Then both the primary and secondary data were reviewed together to establish their mutually, complementarities and the results were given in descriptive form, and use of relevant tools such as pie charts, graphs, and hectographs. Then, major collection was drawn from the findings upon which key recommendation were drawn, including suggestions for further research.

Summary of the findings

The study aimed to find out the science process skills application in practical assessments in Maara district secondary schools, Kenya. The researcher singled out three factors; selected practical science process skills applied in testing biology, the assessment methods used in secondary school biology practical and examine the availability and adequacy of facilities when testing biology practical. From the data analyzed the researcher was able to come up with the following findings:

Whether the selected practical science process skills are applied in testing biology

From the findings, majority 57% of the students agreed that the biology test require one to assemble apparatus as one of the manipulative skills tested. The 81% of the students agreed that the test requires one to handle apparatus while 60% disagreed that the test require one to locate errors in apparatus. This shows that not all the manipulative skills are observed in the teaching of biology in Maara district secondary schools. Majority 77% of the biology teachers disagreed that they often use real biological specimen. Teachers 85% agreed that they quite often use diagrams, while 92% disagreed that they apply micrographs in teaching of biology. 78% use photographs while 77% said the test requires a student to observe specimen or reaction. The test also requires a student to identify the changes in reaction since a majority 76% agreed with the statement. It can be therefore be deduced that not all the observation skills are applied in the testing of practical biology as a subject. This might be resulting into poor performance in the subject.

From the findings, majority (61%) of the teachers said the students are tested on drawing neat proportional well labeled diagrams. They however majority 77% said they rarely draw observation table and graphs in the practical test. KCSE biology practical never test students in drawing skills. Reporting and interpretation skills Majority 84% of the students said they often are required to accurate record observation. Majority 92% also said that they often are required to classify specimen. However the students' respondents said they rarely make calculations, they do not use formulas to report results. Majority 65% report using correct symbols, units, terms, and chemical equations. 64% said are tested on interpretation of the results.

Majority 77% of the students disagreed that they are required to measure length, 86% also disagreed that they measure area as they compare and order objects. This is against the KCSE requirements of testing in biology practical. Majority 59% disagreed they use weight while 63% disagreed they use volume. Measuring skills only length is included in 2008 and volume in 2010. Majority 75% of the students agreed that they are required to design experiment investigating a phenomenon whereby they are supposed to formulate a procedure to be followed in the test. This means that the students are tested in experimentation during their biology practical. They are however not tested in the KCSE biology practical examination as it should be.

Assessment tools used in secondary school biology practical

From the findings, majority 84% of the respondents said they often written examination while the 92% of the students said they rarely follow portfolio i.e. information collected for long period. Obstructive observation was not shown clearly from the findings since the respondents did not have a clear cut. The students are rarely tested in practical work. It is clear from the findings that majority 84% of the teacher respondents give form 3 students practical tests more often than other classes. The form 2's follow at 62% while forms 1's are least considered at 54%. Teachers scored student achievement mostly by marking the final products. They rarely scored student at during practical and they never used evaluation forms

Availability and adequacy of facilities when testing biology practical

Majority of the respondents highlighted electricity, water sinks, drainage system, benches and reliable gas system as facilities that are inadequate in their schools. A majority of 71% said there is no adequate electricity while 77% pointed out the water sinks. 71% said the gas system was not reliable. There cannot be Biology practical test done properly according to the required standards if there are no enough facilities in the laboratories as depicted. Majority 54% of the biology teachers said the biology material in terms of plant and animal specimen is inadequate. Laboratory apparatus are also inadequate since majority said there is inadequate test/boiling tubes, it was also said there is inadequate microscopes. The respondents also said there is inadequacy of permanent slides, beakers, reagent bottles, droppers, delivery tubes, measuring apparatus, hand lens and mortar and pestle. The lab chemicals are also depicted as inadequate. Majority said the reagents for food test are inadequate while some said the test solutions are also inadequate. Teachers pointed out the enzymes as also being inadequate.

Conclusions

In conclusion, majority of the students agreed that the biology test require one to assemble apparatus as one of the manipulative skills tested. The students agreed that the test requires one to handle apparatus while disagreed that the test requires one to locate errors in apparatus.. This shows that not all the manipulative skills are observed in the teaching of biology in Maara district secondary schools. In KCSE manipulative skills tested are also minimal. Biology teachers disagreed that they often use real biological specimen. Teachers agreed that they quite

often use diagrams, while many disagreed that they apply micrographs in testing of biology. However in KCSE photographs are mostly used and real specimen are never used in a test. The test also requires a student to identify the changes in reaction since a majority agreed with the statement. It can be therefore be deduced that the observation skills are applied in the testing of biology as a subject. The students are also not tested on all aspects of drawing, this applies also in KCSE. They are however tested on reporting and interpretation at both school level and in KCSE examination. They are rarely tested on measuring skill by the teachers as well as in KCSE.

In experimentation skill findings show that majority of teachers provide students with all the details on how to carry out experiment. They rarely provide student with the opportunity for inquiry based learning process. However in KCSE student are tested on ability to carry out an investigation. In assessment of practical science process skills, majority of the respondents said they often use written examination while the others said they rarely follow portfolio i.e. information collected for long period. Obstructive observation was rarely used. The students are rarely tested in practical work. It is clear from the findings that majority of the teacher respondents give form 3 students practical tests more often than other classes. Teachers only score student by marking end product.

Majority of the respondents highlighted electricity, water sinks, drainage system, benches and reliable gas system as facilities that are inadequate in their schools. A majority of said there is no adequate electricity while some pointed out the water sinks. Majority said the gas system was not reliable. There cannot be Biology practical test done properly according to the required standards if there are no facilities in the laboratories as depicted. There are inadequate facilities in the biology laboratories in Maara district. This is so since majority of the biology teachers said the biology material in terms of plant specimen is inadequate. Laboratory apparatus are also inadequate since majority said there is inadequate test/boiling tubes, there is also inadequate microscopes. The respondents also said there is inadequacy of permanent slides, beakers, reagent bottles, droppers, delivery tubes, measuring apparatus, hand lens and mortar and pestle. The lab chemicals are also depicted as inadequate. Majority said the reagents for food test are inadequate while majority said the test solutions are also inadequate. Some pointed out enzymes as also being inadequate. This study shows that the common resources are not adequate during practical tests.

Recommendations

Having carried out a descriptive survey design on testing of practical science process skills in biology, it is found that most teachers do not apply SPS adequately in practical tests. Therefore there should be proper formulation of guidelines that the biology teachers ought to follow in the development of practical test items in order to validly test SPS.

KNEC should include more of manipulative drawing and measuring practical science process skills into the secondary school Biology practical examinations so as to enable the students to be prone to creativeness, problem solving, reflective thinking, and invention which are critical for science and technological development of any nation.

Students at secondary schools level should be given the opportunity to handle real specimen and manipulate materials, tools and equipment in the laboratories to enable them test their ideas experimentally. Discovery or inquiry method should be used by the biology teachers to improve students' levels of science process skills acquisition. Teachers should incorporate various methods in testing, increase the frequency of practical tests in all the classes and incorporate all methods of scoring achievements in biology practical. The schools should improve in their quest to provide adequate facilities the required for administration of biology test. Biology teachers and students should utilize the facilities in such a way that could lead to the development of practical science process skills.

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