DECLARATION

I Anastasia Wanjiru Maina declare that this thesis report is my original work and has not been presented for the award of the degree in any other university.

Signature........................................... Date...........................................

Anastasia Wanjiru Maina

SUPERVISORS

We confirm that the work reported in this thesis was carried out by the candidate under our supervision and has been submitted with our approval as University Supervisors.

Signature........................................... Date...........................................

Prof. Samson. M. Muthwii

Department of Educational Communication and Technology

Southern Eastern University College (SEUCO)

Signature........................................... Date...........................................

Dr. David. O. Oludhe

Department of Educational Communication and Technology

Kenyatta University
DEDICATION

I dedicate this work to my adorable parents Bedan Kahuthia and Lilian Muthoni Kahuthia for creating in me the curiosity in science by practically handling organisms both plants and animals.
I would like to thank various individuals who have been actively involved in the research process and various stages that have culminated in the development of this thesis report. I am greatly indebted to my supervisors, Prof. Samson. M. Muthwii and Dr. David O. Oludhe for their tireless effort in reading through the work and providing professional advice and guidance which culminated in the writing of the thesis towards completion of the Master’s degree requirements.

Secondly, I acknowledge my husband Edward Maina, and my children, James Kamau, Rachel Waithera and Diana Muthoni for their support during the long hours of intense devotion to my study and research. My sincere gratitude to Mr. James Kiarie who assisted me in the data analysis, Mr. David Wanjiru who took the videos, my sisters and brothers for the moral support during my studies and especially Dr. Ruth Kahuthia for spending time to review the final draft.

I acknowledge the many students that I have had privilege to teach and who often express ineptitude in their skill in Biology practical’s more so in the light of the weight borne by the practical paper at Kenya Certificate of Secondary Education (KCSE) got me concerned hence the research. By extension, I acknowledge the many KCSE candidates whose performance reported in KCSE marking report annually got me intrigued on the level of competence developed in schools that accounts for the performance in Biology practical paper 231/3 and subsequently in Biology.

Last but not least, I acknowledge God’s favor and blessings that saw me through the rigorous work that culminated in the development of this thesis.
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# ABBREVIATIONS AND ACRONYMS

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<th>Description</th>
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<tr>
<td>APV</td>
<td>Assessment of Performance Unit</td>
</tr>
<tr>
<td>ASEI</td>
<td>Activity, Students, Experiment and Improvisation</td>
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<tr>
<td>CLT</td>
<td>Constructivist Learning Theory</td>
</tr>
<tr>
<td>ICT</td>
<td>Information Communication Technology</td>
</tr>
<tr>
<td>INSET</td>
<td>In-Service Education and Training</td>
</tr>
<tr>
<td>JICA</td>
<td>Japan International Corporation Agency</td>
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<tr>
<td>KALRO</td>
<td>Kenya Agricultural and Livestock Research organization</td>
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<tr>
<td>KCSE</td>
<td>Kenya Certificate of Secondary Education</td>
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<tr>
<td>KICD</td>
<td>Kenya Institute of Curriculum Development</td>
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<td>KICD</td>
<td>Kenya Institute of Curriculum Development</td>
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<tr>
<td>KINSET</td>
<td>Kenya Institute of Curriculum Development</td>
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<tr>
<td>KNEC</td>
<td>Kenya National Examinations Council</td>
</tr>
<tr>
<td>KUCCPS</td>
<td>Kenya Universities and Colleges Central Placement Service</td>
</tr>
<tr>
<td>KSh</td>
<td>Kenya Shilling, Kenya’s national currency</td>
</tr>
<tr>
<td>MoE</td>
<td>Ministry of Education</td>
</tr>
<tr>
<td>NACOSTI</td>
<td>National Commission for Science, Technology and Innovation</td>
</tr>
<tr>
<td>OB</td>
<td>Orange Book</td>
</tr>
<tr>
<td>QASO</td>
<td>Quality Assurance and Standards Office</td>
</tr>
<tr>
<td>SDT</td>
<td>Social Development Theory</td>
</tr>
<tr>
<td>SEPU</td>
<td>Science Equipment Product Unit</td>
</tr>
<tr>
<td>SMASSE</td>
<td>Strengthening Mathematics and Science in Secondary School</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>SSP</td>
<td>School Science Project</td>
</tr>
<tr>
<td>TSC</td>
<td>Teachers Service Commission</td>
</tr>
<tr>
<td>TWSC</td>
<td>Thika West Sub-County</td>
</tr>
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<td>USA</td>
<td>United States of America</td>
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ABSTRACT

The overall performance in Biology practicals at Kenya Certificate of Secondary Education (KCSE) has been below average. Research on competence of students in specific skills utilized in the practical paper can explain the trend of performance. The study aimed at determining influence of competence in procedure, execution, observation and interpretation skills on performance in practical Biology and subsequently performance in Form Three students in Kiambu County as represented by sample drawn from Thika West Sub-County (TWSC). The Central Limit Theorem was applied to select a sample of 6 secondary schools; 37.5% of the targeted schools. Based on the same theorem, 10 Biology teachers; 25% of Biology teachers and 14% of the Biology students in TWSC were sampled. The sample sizes are within the acceptable 10% minimum limit. Stratified random sampling was used to create three strata of secondary schools that are national, county and sub-county schools. From each stratum, simple random sampling was applied to select national, county and sub-county schools. Purposive sampling was then applied to nominate Biology teachers from national, county and from sub-county schools. The study applied simple random sampling to select the class to be involved in the study in case of school that was multi-streamed. The study involved 49 students from national schools, 47 from county schools and 114 from sub-county schools. Frequency counts of the responses were obtained to generate information about the respondents and to illustrate the general trend of findings on the various variables that were under investigation. The separately, but concurrently, collected data was analyzed quantitatively and qualitatively and merged into one overall interpretation which related the quantitative results to the qualitative findings. Quantitative data was analyzed using Pearson’s product-Moment; Chi-square and Independent sample t-test using Statistical Package for Social Sciences (SPSS). The findings of the study unearthed a significant relationship between students’ competence in practical skills and performance that is ultimately reflected in KCSE results. The findings indicate that competence is highest in observation skills and low in execution, and interpretation skills. This study recommends teachers to use methodology that facilitates competence in these skills. From the findings procedure skill is rote learned.
CHAPTER 1
INTRODUCTION

1.0 Background

Learning science involves investigation and measuring testable concepts. Laboratory work is the hallmark of science education. It requires skills in carrying out practical investigations regarding concepts like types of foods, or tissues and organs amongst others.

A skill is a developed proficiency acquired through specialized training. The training is imparted to the students through practice over time. The Biology practical skills as well as coverage of the content ascribed in the curriculum are influenced by the teaching and learning undertaken in class. Teaching and learning incorporates the ability to improvise some of the resources as per the tenets of Strengthening Mathematics and Science in Secondary School Education (SMASSE)’s clarion call to base teaching on: Activity, Students, Experiment and Improvisation (ASEI). ASEI as a competence is important and ultimately influences performance. Students should be able to use the various skills in conducting specific investigations. Winfield (1988) viewed practical approach in learning concepts as a non-content aspect of learning however; Biology examinations test theory and practical aspects of the discipline.

Globally, practical work has become a well-established part of secondary school science (Poppe and Markis, 2011). In fact, since 1988, the National Curriculum of England placed emphasis on practical’s (Wellington, 2002) and current science teaching involves students carrying out practical work as an entity of biology, chemistry and physics lessons. Since the 19th century practicals have been part of the science classes in the United States of
America and European secondary schools. Practicals are of great significance in curriculum of any practical science such as Biology (Singer et al., 2005). Students claim to find practical work as an enjoyable and effective way of learning science (Hodson, 1993) and this has also been reported in many other studies (Osborne and Collins, 2001; Jenkins and Nelson, 2005).

In Kenya, since 1963, the Biology curriculum has gone through various revisions with each revision maintaining the emphasis on practical skills at both class and examination levels. In the School Science Project (SSP) syllabus, Biology was taught through heuristic approach consequently the students’ text books were more of work-books with brief explanations of concepts (Namuddu, 1989).

The various Biology curriculums inclusive of Biological Sciences syllabus implemented between 1987 and 2000 in Kenya despite it being deemed suitable for schools which had limited science resources tested scientific investigations replicated in practical work in the laboratory. More emphasis and competence in practical skills consequently may result in higher achievement in KCSE. This observation suggests that practical skills are a crucial aspect of learning that determines performance.

During the release of 2010 KCSE results, the Minister of Education Prof. Ongeri wondered why:

“…the persistent drop (in performance) continues despite many strategies laid out by the government including the starting of a center for Mathematics and Sciences, and the provision of laboratories and equipment” (Daily nation).
Perhaps lack of exposure to practical skills might be one of the reasons for the state of affairs in Biology. Competence in practical skills develops through learning of practical skills in Biology. The KCSE Biology paper three (231/3) tests practical skills and the marks scored forms an integral component and determine the overall grade (Kenya National Examination Report, KNEC Report, 2003).

Competence in practical skills enhances the aggregated grade scored by a candidate at KCSE hence to improve performance in Biology. It is worth noting that for science teaching/learning including Biology to be meaningful and relevant, there are procedures that ought to be followed (Kenya Institute of Curriculum Development, 2003). The scientific inquiry and understanding on how science works should be carried out during class practicals. The process prepares students for the steps to be followed in search for scientific solutions. For students to acquire competence the instruction on the practical procedures by the teacher is vital.

Failure in effective training in practical skills may lead to poor performance (KNEC report, 2003; Kisangi 2006 and Hayward, 2003). The necessary skills are learned and built up gradually in the course of repeated experiences. A student’s performance in practicals should reflect the internalized practice. Of concern is how can, and how do, teachers encourage students to acquire the skills. Students can reproduce example diagrams in practical examinations from text books despite guidelines given to draw from specimen. Making biological drawings distinguishes the competent from the not gifted in drawing but may be good in memory hence capable of drawing from memory. Through memorizing expected results in scientific investigations students may give and explain expected results but not the actual. The teacher needs to observe students as they work practically as it
enhances competence. When a student acquires the skills in practicals, a scientist in waiting is born. Evidently poor skills in practical paper contribute to the low performance and this can ultimately lower a student’s the overall grade.

In 2010, the Biology national mean grade was D+ (plus), at a mean score of 3.785 (KNEC, 2010). The table 1.1 below shows the mean scores of the practical performance at the Form Four level KCSE nationally for years from 2006-2009.

**Table 0.1: KCSE Biology paper231/3 Mean score; 2006-2009**

<table>
<thead>
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<th>Year</th>
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<tr>
<td>2006</td>
<td>11.63</td>
</tr>
<tr>
<td>2007</td>
<td>21.81</td>
</tr>
<tr>
<td>2008</td>
<td>17.30</td>
</tr>
<tr>
<td>2009</td>
<td>15.86</td>
</tr>
</tbody>
</table>

Source: KNEC (2010)

Performance in the KCSE practical paper has frequently been below 50% despite the fact that the ministry of education in corporation of other bodies has come up with stringent strategies to improve the teaching and learning of sciences, performance in Biology remains poor. To this end a notable intervention has been the Strengthening of Mathematics and Sciences in Secondary School Education (SMASSE) project. SMASSE was conceived in 1998 by the Ministry of Education (MOE) in conjunction with Japan Corporation agencies (JICA). The project went through piloting in a few Sub-Counties and was eventually rolled out to all sub-counties in the country in 2004. During the years 2003-
2006 two-week long in-service training sessions were held during breaks in the school calendar to address challenges in teaching and learning sciences and mathematics. Nationally, curriculum comprising four year cycle in-service trainings from 2003 to 2006 were held in the entire country. Currently training is at Sub-County levels. A review of progress made this far is urgently needed.

The objectives of SMASSE include training with a view to improving teachers’ capabilities in terms of teaching methods, content level and management of experimental equipment so that the teachers are able to shift classroom practice from expository to heuristic learning. There is also a shift from experiment approach with scaled down experiments incorporating improvisation where necessary (Oyoo, 2009). However, even with interventions such as SMASSE, according to Sifuna and Kaime (2007) teachers are still constrained when it comes to conducting practicals as a way of teaching sciences. It is against this background that the study set out to investigate students’ competence in practical skills Biology in Secondary Schools in Thika West Sub-County (TWSC), Kiambu County, Kenya.

1.1 Statement of the problem

Students’ performance in Biology in TWSC has been wanting and this has generated great concerns amongst education stakeholders. In 2011 the subject mean in eleven (11) schools was below the school mean score. Albert et al. (2011), in their study about place of experiments in sciences, report that most students taking Biology and other sciences manifest poor competence skills in following practical procedures, performance of actual practicals, poor observation skills and poor reporting and interpretation of results. Thika West Sub-County whose performance is below average points to possible lack of
competence in Biology practicals similar to Albert et al. (2011) findings. There have been numerous concerted efforts to address the problem without much success. The drop by a 6.5% in 2008 KCSE Biology performance compared to the previous years (SMASSE Gatundu Report, 2009) is evidence of performance that can improve if competence in practical skills can rise to desired level.

Research has been carried out extensively on factors that influence performances in KCSE Biology, such factors include practicals, Information Communication Technology (ICT) and learning resources, amongst other. This research investigated students’ competence in practical biological skills broken down into procedures, performance of actual experiments, making observations and interpretation of results and effect on performance as research in the area is minimal. The scope of this study has not been undertaken in TWSC hence the desire to fill this research gap.

1.2 Purpose of the study
The purpose of the study was to determine the influence that competence in practical biological skills has on achievement in Biology amongst Form Three students in Thika West Sub-County.

1.3 Objectives of the study
The study sought to fulfil the following objectives,
1. To determine the relationship between competence in procedure skills and performance in Biology practicals amongst Form Three students in Thika West Sub-County;
2. To establish the relationship between competence in practical execution and performance in Biology practicals amongst Form Three students in Thika West Sub-County;

3. To find out the relationship between competence in observation skills and performance in Biology practicals amongst Form Three students in Thika West Sub-County;

4. To find out the relationship between competences in results interpretation skills and performance in Biology practicals amongst Form Three students in Thika West Sub-County.

5. To determine the relationship between competence in skills and performance in Biology practicals.

1.4 Research questions

The study sought to answer the following questions;

1. What is the relationship between competence in procedure skills and performance in Biology?

2. How is competence in practical execution of Biology practicals related to performance in Biology?

3. To what extent is competence in observation skills related to performance in Biology?

4. How is competence in interpretation skills related performance in Biology?

5. What is the relationship between competence in practical skills and performance in Biology?
1.5 Significance of the study

The study sought to explore the effect of competence of students in Biology practical skills on performance in Biology practicals among Form Three students in TWSC. This study can enlighten the learners; empower them to identify aspects of practicals that go towards perfecting their competence. This study will assist the teachers to determine appropriate pedagogical tools and methodology so as to impart procedure, execution, observation and interpretation skills which are learned and make a marked impact on performance in practicals and subsequently on KCSE grades in Biology. The Kenya National Examinations Council (KNEC), which examines the curriculum for the Ministry of Education (MoE), could come up with a novel testing modality to enable testing of all skills employed in a Biology practical test. The Kenya Institute of Curriculum Development (KICD) that develops the curriculum can come up with different instructional methods and pedagogical tools to ensure students competence in practical biological skills.

1.6 Scope of the study

The study was done under the following scope:

1. The study was carried out amongst public secondary schools as rigid monitoring and following of syllabus is more likely to be routine unlike in private schools.

2. Thika West Sub-County (TWSC) has many schools in each category of schools. The sub county has many colleges frequently advertised and not out of reach if students attain satisfactory performance at KCSE. The accessibility to training may act as
motivation to acquiring competence in practical skills that apply in various occupations. The research and educational institutions induce students to embrace the value of practical skills more so in the era of entrepreneurship. TWSC is a rich in agriculture, industries and commerce that exploit practical skills.

3. The study focused exclusively on the relationship between competences in practical biological skills namely procedure, practical execution, observations and results interpretation skills as independent variables indicated in syllabus; Appendix II, page 89 and performance. Despite Paper 231/3 examining the applied forenamed skills, the content learned is tested in theory paper and determines achievement in Biology at KCSE.

4. Data was collected solely from the Form Three Biology students and teachers.

1.7 Limitations of the study

Visually challenged students were not engaged in this study as they cannot carry out some activities such as microscopy, visual observation and drawing, consequently results of this study may not be generalized to students with visual disability.

1.8 Assumptions of the study

This study was dependent on the following assumptions:

1. That the teachers have post qualifications experience and comparable training in skills. The research assumed that relevant records and data on students’ past performance in Biology would be available and accessible in the Biology Departments of the sampled schools.
2. That the teachers follow the suggested guideline in materials and procedure of practicals on variety of topics as per the Biology syllabus.

3. That the respondents would be competent to answer the research questions.

1.9 Theoretical framework:

The study was guided by the Constructivist Learning Theory (CLT). The theory is advanced from Russian psychologist Lev Vygotsky (1896-1934) who also came up with Social Development Theory (SDT) which is applied in education (Bruner, 1996). Constructivism is an active process whereby teacher collaborates with the learners who create their own new information from prior knowledge during learning. The constructed knowledge in this study is procedure, observation, execution and interpretation skills used in selected tasks that constitute the independent variables while achievement or performance in the skills tested constitutes the dependent variable.

Vygotsky proposed learning is a reciprocal experience for the teacher and the students. It emphasizes the affective domain, makes instruction relevant to the learner, help learners develop attitudes and beliefs that support both present and lifelong learning, and balance teacher-control with personal autonomy in the learning environment. According to this theory, people in this context student, construct their own knowledge, from textbook, personal experience, the teacher explanation or any other mode of knowing. In trying to solve novel problems, perceptual or conceptual similarities between existing knowledge a new problem can remind people of what they already know prior, knowledge impacts the learning process. Information not connected with a learner's prior experiences is quickly
forgotten. In short, the learner must actively enrich the existing information by construct new additional knowledge for meaningful learning to occur. This is due to the fact constructivism views learning as a process in which the student actively constructs or builds new ideas or concepts based upon current or past knowledge (Jones, Reeds and Weyers, 2003).

According to Kisangi (2006), the most important single factor influencing learning is what the student already knows. The teacher's role in a constructivist classroom is not so much to lecture at students but to act as an expert learner who can guide students into adopting cognitive strategies such as self-testing, articulating understanding, asking probing questions, and reflection. Thus the success with which a student is able to construct their own knowledge will depend on their prior knowledge, skills and attitudes.

One of the principles of Piaget’s Theory of cognitive development, a variant of constructivist theory proposes students go through certain sensorimotor stages characteristic of age spans. The students in this study were between 16 and 18 years old, a narrow age span hence age was ignored in the factors addressed in the study. Piaget cognitive development theory in respect to learning is similar to theories of other constructivists’ as it supposes that students depending on their circumstances make constant effort to interpret and adapt to the current environment and thereby ultimately making sense of the environment. Making sense of their environment includes striving to perform highly in examinations that test what they learn.

Carrel et al. (2010) argue that constructivism in schools is usually reduced to project based learning, whereas Jones et al. (2003) claims that constructivism advocates very inefficient
learning and assessment procedures. Despite these conflicting views a constructivist approach to education is widely accepted by most scholars. The constructivist theory recognizes the essence of acquisition of learning skills through practice and ultimately affecting performance which rationalizes the study.

1.10 The Conceptual Framework

In this study, students’ performance in practical Biology in scores constituted the dependent variable whereas practical procedures, practical execution, observations and interpretation of results constituted the independent variables as shown in figure 1.1.

Figure 01: The Conceptual framework

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Dependent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competence in Procedure skills</td>
<td>Student performance in practical Biology in scores</td>
</tr>
<tr>
<td>Competence in Observation skills</td>
<td></td>
</tr>
<tr>
<td>Competence in practical execution skills</td>
<td></td>
</tr>
<tr>
<td>Competence in results interpretation skills</td>
<td></td>
</tr>
</tbody>
</table>

Source: Researcher’s Conceptualization (2012)
1.11 Definition of terms

In the context of this study the listed terms will be defined as suggested;

**Achievement** is the feedback expected after learning. The mark awarded in the test is viewed as achievement in the study. At KCSE, achievement is graded using grades A to E, where A is the best and E is the worst achievement grade.

**Biology syllabus** refers to the recommended program of learning Biology as outlined by KICD.

**Competence** is the ability to do Biology practical tasks so as to show expected mastery of skills under review.

**Skill** is a developed proficiency acquired through specific training.

**Practical skill** is activity that involves operations and manipulations, through which one replicates or demonstrates a scientific process or theory.

**Practical Procedure** is the knowing of the items and manipulations required in carrying out a particular practical task.

**Practical Execution** is the carrying out of the manipulations in a task.

**Practical Observation** is the noticing and paying attention to results got in a task.

**Practical Interpretation** is the explanation of observations made in a particular task.
8-4-4 system of education is a practical oriented education in Kenya comprises of 8 years in primary school, 4 years of secondary schooling and 4 at the basic tertiary level (university). The system of education was initiated by the Government of Kenya in 1981.

Form Three is a phase of learning that coincides with the third year of secondary school education.
CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter highlights the literature of the previous studies covered related to the area of study. The literature provides divergent views that are critical to different authors who raised various versions related to the issues being investigated. The review was based on teaching and learning practical skills in Kenya as well as competence in practical procedure, execution, observation and interpretation skills. It also provides a summary of the literature showing the research gaps identified during the literature review.

2.1 Definition and concept of practical skills

Practical work is the scientific instruction which results in learning activities in science. There are student-centered methods of doing school work but laboratory work is the flagship for learning in science and by extension Biology (Singer et al., 2005; Lowman, 1995). Giddings et al. (2000) and Woolnough (1994) on the other hand claim that assessment of students’ behaviors in the laboratory should include planning and designing, implementing, analyzing and interpretation of data and application of laboratory techniques to new problems.

According to The Macmillan Dictionary (2007), practicals are defined as an examination or lesson in which a student makes things or does experiments. The term refers to what appertains to practice or action “doing”. The “doing” depends on acquisition of the required skills. Skill is an expertise in doing something. The terms practical and skills go hand in hand for effective learning of Biology as spelt out in the Biology syllabus.
Practical skills are tested exclusively in the practical paper however findings of practicals may be tested in a theory paper. The level of competence in practical skills may determine performances in a class and ultimately at the national level. Going through the materials needed for a practical for example those required for testing for types of food and doing the stipulated practical using the provided materials is expected of a student (Roberts, 2004). Practical work is any learning in which students handle and observe the materials they are studying. The students can do the practical work individually or in groups (Namuddu, 1989). Most practical work is done in the laboratory. According to Emmett (2003) and Twoli et al. (2006) noted that laboratory work is a subset of practical work. Laboratory and practical work are however terms which are used almost interchangeably in natural science. The investigational work rests partly on its semblance to the real thing, creativity in research, and the hope that in effect it stimulates and fosters the right kind of abilities and ways of thought (Roberts, 2004; Lunetta et al., 2007).

Researchers and educationists have not conclusively agreed on the best approach to laboratory teaching and learning for best achievable performance. It is important to ponder how well practical work can be used in teaching and learning (Jones et al., 2003; Millar, 2004). Roberts (2004) reported from research findings that, “doing” has been found to be the easiest skill attainable by student respondents, many professed to like the “doing” aspect of science practical learning skills but the liking may not translate into performance. Hodson (1993), contended that practical focus on the doing skills and abilities. Mavhungu (2004) confirmed that practical skills are major teaching and learning strategy that may influence greatly the achievement of learners in Biology. Oyoo (2009) conducted a study and noted that practical nature of science, results in solving problems scientifically.
2.2 Teaching and learning of practical skills in science in Kenya

The laboratory sessions in Kenya commonly comprise of one or two experiments often with an assessment thereafter covered frequently in an 80 minutes lesson fondly referred to as “the double lesson”. The syllabus gives schedule of practicals recommended in various topics complementary to what is taught in class. Students’ text books give the procedure followed in most investigations, handling materials or processing secondary data. Woolnough et al. (1995) alleged exercises, experiences and investigations aid discussion about practical work. It was observed that new teachers are accosted with challenges of understanding instructions, content and methods of subject delivery (Davis et al., 2006). The student’s text books recommended by KICD give the outline of the recommended practicals, the procedure, execution, and student reports the observation and makes conclusions. The complementary teacher’s guide’s outlines the materials and conditions under which the experiment ought to be carried and account of the findings that student who is competent ought to come up with. The Biology student’s text books and teacher’s guide after evaluation by KICD subject specialists are listed in the Orange Book (OB) which teachers refer to when sourcing teaching/learning materials. The Quality Assurance and Standards Office (QASO) supervise subject objectives actualization. Kenya National Examinations Council (KNEC) examines the curriculum and consequent performance (KCSE) evaluates the achievement of the objectives.

Objectives of investigative and exploration tasks are open ended and are verified through testing by both the teacher and students. Practices in sciences comprise procedure, execution, observation, and result interpretation skills. Observation may result in experiential science, viewing the real world at most have the chance to make desirable
discoveries. In the Kenyan situation usefulness of some of the practical biological skill include testing for foods like reducing sugar a test that can establish glucose in urine of a diabetes mellitus patient. Identifying a tooth and its parts in dentistry, and microscopy provides prerequisite knowledge in medical career.

Researchers Hayward (2003), and Wambugu and Changeiyo (2008) established that participating in a range of practicals may enhance students understanding of empirical research and scientific theories. Students may learn from scaffolds that add up to the final rich repertoire required in teaching. The teacher determines the approach, flow and manipulations of information (Woolnough and Allsop, 1985; KNEC syllabus, 2003). Mathematics and Chemistry are sciences and have a lot in common with Biology in terms of teaching and learning methodology. Thus, mathematical and chemistry skills may go a long way in making learners better in Biology (Wachanga and Mwangi, 2004).

The School Equipment Production Unit (SEPU) set by the government of Kenya in 1975 produces quality materials reliable for teaching and learning. SEPU assures standardized and quality material. Micro scale kits are advantageous (Musar, 1993) in economizing on finances, time and waste disposal. SEPU can be mandated to make micro-scale kits. SMASSE findings in practical approaches proof that using micro scale kits are better for teaching and in examination of the students than the traditional scales. The KNEC confidential list of requirements guides the teacher on what to avail to the candidates in KCSE Biology paper 231/3.
2.3 Students’ competence in acquisition of procedure skills

Procedure skills form a phase of Biology practical sessions which signals the start of a practical session. Study conducted in Nigeria amongst 111 student respondents about Biology and procedures as observed by Yara (2010), a record 79% of the respondents believed performance of practical procedures and the collection of data determines success in any practical session. Similar views were reported by Ling and Towndrow (2005) in study about Essence of Biology practicals in 45 college students. Ling and Towndrow (2005) reported that an effective mastery of demanding manipulative and procedure skills enable students to understand why an experimental procedure is carried out in a particular way. Such students can recognize sources of error or limitations which could affect the reliability of their results. The study further revealed that procedure is critical with an impressive majority (69%) responding in favor of the fact that instructions, procedures dictates manipulations and the eventual success of practical sessions. This affirms the fact that Biology syllabus should build on practical aspects of Biology skills to improve performance in examinations and lay emphasis on higher level skills of planning, analysis and evaluating. In order to plan effectively, students need to be able to evaluate procedures, to develop competence in practical biological skills; however, though this has not been the case in most secondary schools (Owiti, 2009).

Teaching has not always given students opportunities to perform appropriate manipulations and obtain suitable data due to inadequacy of resources, MoE (2009). Despite this scenario, research studies to establish the influence of competence in practical biological skills on performance in practicals in TWSC has not been undertaken a gap that the study sought to fill.
2.4 Students’ competence in execution skills in practical

Preston and Roberts (2003) ascertained that actual performance of practical forms an important aspect of a practical process. It is more or less the phase where instructions and learned procedures are put into practice to produce results. Yara (2010), investigations revealed that teaching of Biology should be based on developing an understanding as well as execution of practical. Practical activities in Biology provide opportunities for students to actually do science as opposed to learning about science a view that Lunetta et al. (2007) supported. According to Lunetta et al. (2007) practical activities can be regarded as a strategy that could be adopted to make the task of teaching more real as opposed to abstract or theoretical presentation of knowledge. It is worth noting that theory papers in Biology test data obtained from practicals.

Written laboratory work does not provide information about student’s prowess in manipulating equipment, observing, organizing and performing an investigation creatively and efficiently as observed by Twoli et al. (2006), hence the video tapping.

In study done in the United States of America (USA) amongst 121 college interns about practicals without implementations by Smith et al. (2009) indicated that without actual engagement in actual performance of a practical and carrying out the final analysis and interpretations of observed data, the process of experimentation is incomplete and is meaningless and is thus; rendered useless. The study suggested further that student interns who manifested high level abilities in conducting their laboratory assignment were viewed as the best performers. Similar views were expressed by Birenbaum (2003), who observed that actual implementation of all the procedures and manipulations is what counts in a practical session. Execution of practicals despite mastery of procedures has still been a
challenge to many students possible due to focus that has primarily been on the effectiveness of teacher demonstration. It is in light of this background that the study sought to examine the relationship between students’ competences in execution of Biology practical and performance in TWSC.

2.5 Students’ competence in acquisition of observation skills

Whilst competence in manipulating the apparatus is crucial, students ought to able to make observations with clarity and discrimination, and take measurements with accuracy (Yara, 2010). Franklin et al. (2002) believe that accurate readings of meters or burettes and precise descriptions of color changes and precipitates make it much easier for students to draw valid conclusions and ultimately score highly in a test. In an experimental study done amongst 33 secondary school students in Hong Kong about School-based Assessment of Chemistry Practical Work: Exploring some directions for improvements, Chieung and Yip (2003) noted students who were able to make sound and accurate observations out of a practical session registered better performance, an impressive 78% in Biology practicals. These findings lend credence to the fact that to be able to make simple decisions on a range of practical tasks adequate time is of essence and students are instructed appropriately (paper 231/3). Students need to be able to make informed decisions regarding making measurements and identify when repeated measurements or observations are appropriate especially when results which appear anomalous Orado (2009). Similarly the layout and contents of a results table for recording numerical data or observations should be decided before the experiment is performed. Orado (2009) further revealed that students who record their experimental data with highest degree of precision, display high level
competence in skills in practical Biology and perform highly. According to Onamu (2011), secondary school students face difficulties when drawing tables, they fail to give adequate space for recording data or observations. Onamu’s (2011) finding concurs with SMASSE (2007), findings; that most secondary school students in TWSC exhibit low degrees of precision.

There are many findings that suggest shortage leads to poor observation as students don’t have adequate interaction with the resources, Owino O. A. et al. (2014), Akpan, B. B. (2006) but need to research on influence of competence to performance when resources are provided in TWSC.

### 2.6 Students’ competence in results interpretation skills

According to Caribbean Examination Council (2010), results interpretation skill requires students to apply their understanding of underlying theory to an experimental situation. In a study conducted in France amongst 111 college students about success of a practical session, Rodriguez (2010) asserted that interpretation of results is a high-level skill and so makes a greater demand on a student’s basic understanding of the Biology involved. The study revealed that students who were able to make effective interpretation of practical results registered 69.5% success in their Biology practicals. This attests to the fact that to conclude a practical session, students should be able to make effective interpretations of the observed data or results, consequently good and proper inferences. Contrary to the Rodriguez (2010), a finding made by Millar (2004) was that explanations and ideas do not automatically arise from data obtained. From the findings of Thika Gatundu (2009) commissioned by Ministry of Education, interpretation of results is a high order skill and
has proved daunting for secondary school students in TWSC. SMASSE (2007) report further indicated that most of the students fail their practical sessions and perform poorly in the subject because they lack the pre-requisite skills to do practical evaluations. An assessment of the data obtained and taking an informed judgment depends on competence of the student. This study undertakes to establish the extent of the competence in interpretation skill in the TWSC public secondary schools.

2.7 Chapter summary

The major areas of research are on pedagogy and practice in science practicals. Such research has been done on resources adequacy, and student participation in Biology experiments. Researches include enhancement of understanding of science, learning Biology through practical work to achieve student’s competence in specified practical skills and performance, Tamir et al., (1992). A gap however exists in research on influence of competence in practical biology skills on students’ performance in Biology practicals in public schools in TWSC (Appendix IV, page 92) a gap that the study sought to fill.
CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

This chapter presents the research design and methodology used in this study. It explains the design of the study, locale of study, target population, sample size, sampling techniques and procedure, data collection instruments, methods of testing the validity and reliability of instruments, the research procedure adopted and the data management and analysis techniques used in the study are explained.

3.1 Locale of the study

Kiambu County has 11 sub counties one of which is Thika west Sub-County (TWSC). TWSC is cosmopolitan with many tertiary education institutions and science based research organizations such as Kenya Agricultural and Livestock Research organization (KALRO) that students may wish to join after completing their KCSE examination and train in science based courses. The sub-county also offers many chances in farming in the rural areas and business in urban areas, the major economic activities providing employment. The history of the region as industrial center with Thika town christened “the Birmingham” offers many chances for self and formal employment more so those that involve practical skills. Infrastructure such as means of communication is good with extensive road network hence movement of the human and non human resources inclusive of education material is not hampered. The sub-county at the time of the study had 16 public secondary schools and many colleges and universities that psych students towards mastery of practical skills hence choice of TWSC as locale of the study.
TWSC is one of the sub-counties in Kiambu County, it borders the other sub-counties of Kiambu, see figure 3.1(Thika Sub-County Strategic Plan, 2005-2010), Maragwa Sub-County to the North and Machakos Sub-County in what was formerly Eastern province to the east. TWSC covers an area of 1,960.2 sq. Km² comprises Thika Municipality and Juja Divisions.

Figure 3.1 Thika West Sub-County

One of the stated goals of studying Biology in the syllabus is to demonstrate resourcefulness, relevance, technical skills and scientific thinking necessary for economic development; hence study in the TWSC, an economic hub, is very appropriate. Applicability of some concepts taught in Biology such as biological control of pests is of
immediate assistance to farmers. Biology practical skills may therefore stimulate the learner positively as it facilitates students’ contribution towards economic activities of in the community to eradicate poverty.

The realization of the importance of Biology may ultimately improve performance at KCSE as the students perfect the practical skills and keenly learn theoretical concepts. The performance means score in Biology in Thika district in 2006 stood at 3.8198. The lowest grades; D plus to grade E comprised 56% of the candidates. Majority of the secondary schools, 55% in TWSC recorded lower mean scores in Biology than the school mean (Appendix V, page 93) District mean score (MOE, Sub County Director of Education; KCSE 2011 Analysis). This performance acted as a pointer to the aspects of the subject that require to be addressed urgently despite secondary schools in Thika West Sub-County registering 37% achievement in Biology, higher than the national aggregate; 29.23%, (KNEC 2010).

3.2 Research Design

The study which is a descriptive survey adopted a blend of qualitative and quantitative approaches of research methodology. These approaches were relevant to the study since it involved collection and analysis of quantitative and qualitative data from the teachers and students. In this study, questionnaires for both teachers and students, observation schedules inclusive of video taken as well as a test practical paper were used to collect data from Biology teachers and Form Three students. Assessment of Performance Unit (APV) 1978, Tamir et al. (1992) outlines some issues on performance of practicals students. Scoring practical as students have hands on not practical since classes are large hence use of taking video clips.
Competence was assessed through a portfolio that comprised standard methodology in carrying out procedure, actual execution of specified tasks, observations and result interpretation of specific tasks in a practical test (Appendix VII, page 96). The performance assessment score sheet (Appendix XI, page 103) was used to measure level of competence in terms of achievement. Testing gives a dynamic picture of student’s competence. The marking scheme (Appendix XII page 105) was drawn from the performance assessment score sheet but comprise of the items that can be awarded a maximum of 15 marks. Student’s competence therefore was comprised of the marks attained plus a maximum of 24 marks score in manipulation skills. The total for the paper therefore is 39. Level of competence as a percentage for students: is score divided by maximum marks times 100.

Formula: Competence = \( \frac{\text{score}}{39} \times 100 \)

3.3 Variables

According to Saunders (2007), a variable is a statistical trait which changes from case to case. The independent variable was practical biological skills reflected through practical procedure, practical execution, observation and results interpretation skills. The dependent variable is the performance in Biology skills in tasks involving drawing making, food testing and microscopy. The skills that the performance was assessed in includes identifying specimens, drawing specimens, writing procedure, making measurements, making observations, making conclusions, making sections, recording of experiment data, using microscope, and manipulation of apparatus.
3.4 Target population

Thika West Sub-county has 16 public secondary schools with national and county schools constituting 12.5% and 18.75%, respectively whereas sub-county schools constituting 68.75% (MoE, 2013). The target population for the study comprised 40 Biology teachers and 1320 Form Three students. The percentage figures meet the minimum 10% qualification sample size as in Mugenda and Mugenda (2005) is shown in Table 3.1.

A letter of introduction on intention to carry out the study in the sampled school was delivered to the respective principals (Appendix III, page 91).

<table>
<thead>
<tr>
<th>School category</th>
<th>No of schools</th>
<th>Percent (%)</th>
<th>No. Form Three students</th>
<th>Percent (%)</th>
<th>No. Biology teachers</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>2</td>
<td>12.5</td>
<td>548</td>
<td>41.5</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>County</td>
<td>3</td>
<td>18.75</td>
<td>328</td>
<td>24.9</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>Sub county</td>
<td>11</td>
<td>68.7</td>
<td>444</td>
<td>33.6</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>100</td>
<td>1320</td>
<td>100</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Thika West Sub-county Education Office (2013)

3.5 Sample size determination and sampling techniques

A sample is defined as a subset of the population (Kothari, 2005). Stratified random sampling was applied to sample six secondary schools from the target sixteen (16) public secondary schools in TWSC. The six sampled schools comprised of, one school from the two national schools accounting for 50%, two schools from the three county schools
accounted 66.7% and four schools sampled from the eleven (11) sub-county schools accounting 36.4%. Ten Biology teachers teaching Form Three students, accounting 40% of the total teachers (25) selected were sampled purposively. The percentages meet the 30% minimum sample size according to the Central Limit Theorem. The Central Limit Theorem states for any sample size, \( N \geq 30 \) sampling distribution of means is approximately a normal distribution irrespective of the parent population.

The criterion for selection of the teachers was a teacher of Biology in the Form Three. Six teachers were sampled purposively one from national and from county schools and two from sub-county schools that were sampled. Four additional teachers were sampled purposively; one from a national and a county school and two from sub-county schools to make a total of ten teachers. Two hundred and ten (210) Form Three students (15.9% of 1320) were sampled. To select students, the study applied purposive sampling to ensure equal representation of male and female students in co-education schools. Sampling drew forty nine (49) Form Three students from a national school, forty seven (47) from county school and one hundred and fourteen (114) from sub-county schools. Sample grid Table 3.2 represents schools, students and teachers in the study. The percentage figures meet the minimum 10% qualification sample size (Mugenda and Mugenda 2005).
Table 0.2: Sample grid of schools, students and teachers in TWSC

<table>
<thead>
<tr>
<th>School category</th>
<th>No of schools</th>
<th>Percent (%)</th>
<th>No of students</th>
<th>Percent (%)</th>
<th>No of teachers</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>1</td>
<td>12.50</td>
<td>49</td>
<td>23.33</td>
<td>2</td>
<td>12.50</td>
</tr>
<tr>
<td>County</td>
<td>1</td>
<td>18.75</td>
<td>47</td>
<td>22.38</td>
<td>2</td>
<td>18.75</td>
</tr>
<tr>
<td>Sub county</td>
<td>4</td>
<td>68.75</td>
<td>114</td>
<td>54.28</td>
<td>6</td>
<td>68.75</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>100</td>
<td>210</td>
<td>100</td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

3.6 Research instruments

The following tools namely questionnaire, interview schedule and observation schedule were used to gather information to achieve the research objectives of the study.

3.6.1 Construction of instruments

The instruments for this study were developed along the set objectives with each objective forming a sub-topic with relevant questions. The syllabi practical tasks that are carried out in various topics are outlined (*Appendix II*, page 89). A few of the practical tasks under which practical skills were assessed were selected based on the fact they have been covered in all the schools as stipulated in the syllabus.

3.6.2 The students questionnaire

A self-designed questionnaire was used to get information from Form Three students. The students’ questionnaire had response items covering competence in procedure, execution of practicals, observation and interpretation skills (*Appendix VII*, page 96). The respondents were assured of confidentiality because of the sensitive nature of the study.
3.6.3 Observation schedule

Observation schedule took the form of a Biology practical test (appendix IX, page 100) for the sampled students as respondents. The test was set based on objectives spelt out in the syllabus (Appendix I, page 88) and weighted in level of difficulty to KCSE paper 231/3 sat in the past. The tasks test some activities outlined in (Appendix II, page 89). The test covered drawing, testing for food and microscopy tasks. The teacher was provided with a list of all the items required in the practical test a week before the students were scheduled to sit the test (Appendix X, page 102). A research assistant was guided on overall goal of the research. The assistant captured students’ manipulative activities (Appendix XI, page 103). The student’s manipulation of apparatus when carrying out various practical skills on tasks was captured on video and analyzed to provide insight on competence of the students in general. Competence is marked by student’s management of tasks outlined (Appendix IX, page 100). The practical test provided a baseline from which individual student’s competence in practical biological skills were exhibited in form of scored marks. A marking scheme (Appendix XII page 105) was used to award marks out of 15 maximum.

Competence in procedure skills assessed in following achievements;

**Question 1**

Correct drawing of the tooth

**Question 2**

Indicating; add drop of iodine to the food substance testing for starch
Indicating; add Benedict’s solution to the food substance and boil contents for reducing sugar.

**Question 3**

Identifying longitudinal aspect of stem

Knowing that the beans should be arranged lengthwise on the petridish

**Competence in Observation Skills assessed;**

**Question 1**

Making accurate drawing

**Question 2**

Seeing the blue/black color of iodine in presence of starch

Seeing the orange/brown color of Benedict’s solution

**Question 3**

Selecting the medium objective lens so as to place it in position

Looking through the microscope for field of view

Identifying the beans along the diameter

Noting the length of diameter of petridish

Counting the number of beans
Competence in execution skill assessed in the following achievements;

Question 1

Making fine pencil lines; continuous outline in pencil;

Label of the crown; label line touches the crown and no arrow head on the label line;

Label of the neck; label line touches the neck and no arrow head on the label line;

Label of the root; label line touches the root and no arrow head on the label line;

Question 2

Carrying out testing for starch correctly;

Carrying testing out for reducing sugar correctly;

Question 3

Mounting slide on the microscope;

Focusing on the specimen under the microscope;

Competence in interpretation skill assessed in the following achievements;

Question 1

Coming up with a proportional drawing of the tooth;

Distinguishing the crown; neck; and root;
Question 2

Knowing which food substances to test for using the reagent provided starch; and reducing sugars;

Writing the correct names- starch; and reducing sugars;

Concluding the presence of starch; and reducing sugars;

Question 3

Calculating the diameter of the petridish;

Identifying the beans lengthwise as representing cells in a cross sectioned stem;

Interpreting length of a cell as being equivalent of length of a cell;

Noting the size of cells is very small hence units of measurements ought to be in micrometer units;

The data on each student performance in tasks under investigation in the practical test was scored on performance assessment score sheet; see Appendix XI on page 103. Appendix XII page 105 allocates 39 as the highest possible score which is inclusive of maximum 15 marks in the test scores and 24 marks for manipulation of the materials and equipment. Manipulation of the equipment does not score marks independently, the correct answers does. Corelationships between the marks in various skills and competence whereby student would score as per responses outlined in Appendix XI on page 103 were established.
3.6.4 Questionnaire for the teachers

The teachers were subjected to a written questionnaire (Appendix VI, page 94). The teacher’s views of the students’ ability to handle the various Biology skills were captured.

3.6.5 Interview schedules for the teachers

Oral interview schedule; (Appendix VIII, page 98) had two parts. The first part consisted of information on teachers’ demography while the second part was made of sections B, C, D, E, F, and G capturing: the status of practical skills in the class taught, views on competence in procedure skills, execution skills, observation skills, interpretations skills and competence in skills and performance respectively. The interview guide comprises questions on the research objectives. Interview was important in this study since it allowed collection of information from Biology teachers. It also enabled asking of probing and supplementary questions as well as establishing a good rapport to obtain reliable and valid measures in the form of verbal responses from interviewees.

3.7 Pilot study on the teachers and students questionnaire

Pilot study was carried out in Thika West Sub-County. Only one Biology teacher and four Form Three students were involved. The teacher’s questionnaire (Appendix VI, page 94) was pretested on one teacher in a national school; 10% of the sample population (Mugenda and Mugenda, 2005) in TWSC. The student’s questionnaire (Appendix VII, page 96) was piloted on 4 students from a national school in TWSC. Time allocated to the respondents to answer the questionnaires was open. Eighty minutes was allocated to practical test, determined by the longest time taken to complete the test in the pilot study.
3.7.1 Reliability of the research instruments

The teacher respondents affirmed having taught the skills under investigation as outlined in recommended text books in OB hence test was standard for all respondents. The questions in the achievement test took the format of KCSE practical paper but were set to capture the skills under research based on the formulated objectives. Standard answers were arrived at from several repetitions of the test. Test was carried out during the test session using the same materials used by the students in each sample to validate the marking scheme used for the student’s scripts. Set scores were awarded for clearly defined answers to serve as norms achieve test results with same level of accuracy for all the students (Kasomo, 2015).

The teeth were of the same type to subject students to same level of skill exhibition. The type of foods tested for were the same ensures test for similar skills. The microscopes were inspected and serviced to ensure they are in working condition. Beans and likewise petridishes provided to the students were of the same type and size in all the sample schools. The same materials other than the microscope were used in this study, requirement dispensed in each school from a common source. The final marking scheme was written during the marking to capture the unanticipated respondent experience. Some of the teachers and laboratory assistants failed to prepare adequately for the practical test despite timely availing of the list of required materials; this led to students working under working under stressful conditions.

Kothari (2005) defines reliability as the extent to which studies or findings can be replicated, that is, the accuracy or consistency of the research instrument in measuring whatever it measures. The reliability of the teacher student questionnaire and the practical test was established using the test retest reliability. The language used was revised and
repetitive items removed where applicable. Based on the responses modifications were made on items that were vague or didn’t capture the practical skills. The practical Biology test was administered to the four (4) students; 10.67% met the threshold of the sample population as per Mugenda and Mugenda (2005). The test items were administered to the same persons after one week to test stability of instrument over time, Kasomo (2015). The Cronbach’s Alpha correlation was used to analyze the data on the reliability of the instrument. The pilot data on competency, the reliability statistics is represented in Table 3.3.

<table>
<thead>
<tr>
<th>Table 0.3: Determination of reliability coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cronbach's Alpha</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
<tr>
<td>0.732</td>
</tr>
</tbody>
</table>

These results indicate that the reliability coefficient obtained from the pilot study was $\alpha=0.732$ which indicated that the instruments were reliable and showed high internal consistency. The piloting of teacher questionnaire indicates moderate reliability as depicted by Cronbach’s Alpha $\alpha=0.516$ (Table 3.4)

<table>
<thead>
<tr>
<th>Table 0.4: Reliability of Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cronbach's Alpha</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>0.516</td>
</tr>
</tbody>
</table>
3.7.2 Validity of the research instruments

Validity is an indication of how sound a research is and in this study applies to research instruments that include questionnaires and content in the questionnaires and practical test.

Validity of questionnaires and practical test as research instruments was addressed through following the outline of practical skills expected to be taught and learned by the end of the third year of secondary Biology. The use of the practical activities outlined in the syllabus made the instrument valid. The test papers were sent out to experts to seek opinion on whether the tests measured what it was intended to. The language, structure and scope of the questions were modelled along the standardized KCSE (231/3: 2003, 2009, 2014). Pre-testing the survey was a good way to increase the likelihood of face validity. Expert opinions from my supervisors were sought in order to help improve content validity of the instrument leading to adequate coverage of the objectives.

All the sampled teachers are trained and can interpret the syllabus. The teachers use the recommended text books that guide the teaching/learning activities. The Orange Book produced by KICD has recommended text books, teachers guides and reference books that have been vetted for both content and sequence of topics hence all students are taken through the same learning experiences hence validity of the instruments.

3.8 Data Collection Procedure

An introduction letter from Kenyatta University (Appendix XIII page 107) was obtained and thereafter an authorization letter from the National Commission for Science, Technology and Innovation (NACOSTI) sought (Appendix XIV page 108) for the award of a research permit to carry out the study Appendix XV and XVI front and back on pages
109 and 110 respectively. These documents led to the authorization from The County Commissioner, Kiambu (Appendix XVII, page 111). Authority was given to carry out the research in selected public secondary schools in the county. The significance of the study was clarified to the Sub-County Director of Education Officer in Thika West who granted permission to carry out research in some schools in TWSC. Through the same letter, (Appendix II page 89) self introduction to the principal and Biology teachers of the sampled secondary schools was done enabling the research. The researcher through the class teacher specified to the sampled students the aim of the research and need to answer a questionnaire and sit a practical test.

Data collection in the field was done with aid of a research assistant. The research assistant has academic training in science and has photography skills. For efficiency he was taken through the structure of the study.

Data collected was in descriptive, qualitative, and quantitative form. Respondents were assured the information they gave would be confidential and would be used for academic purposes only.

3.9 Data Analysis

Data analysis was conducted through identifying common themes from the respondents’ description of their experiences. The separately, but concurrently, collected data was analyzed quantitatively and qualitatively and then merged into one overall interpretation in which the quantitative results were related to the qualitative findings. The relevant information was broken into phrases or sentences, which reflected a single, specific thought. The responses to the close-ended items were assigned codes and labels. Frequency
counts of the responses were then obtained to generate information about the respondents who participated in the study and to illustrate the general trend of findings on the various variables that were under investigation. The collected data was, finally, analyzed qualitatively along the competence in procedure, execution of practical, observation, result interpretation skills and performance of the students.

The basic quantitative data was analyzed using Pearson’s Product Moment Correlation, regression analysis, Chi-square and Independent Sample T-Test in Statistical Package for Social Sciences (SPSS) and presented in form of percentages, tables and charts.

3.10 Logistical and ethical considerations

Mugenda and Mugenda (2005) observed that ethical considerations in research involve outlining the content of research and what would be required of participants, how informed consent would be obtained and confidentiality ensured. It is concerned with protection of respondents’ autonomy, maximizing good outcomes while minimizing unnecessary risk to research assistants. In conducting the study, explanations about its aims were made to the respondents to obtain their informed consent. Anonymity of the respondents was assured and the data they provided was treated with utmost confidentiality.
CHAPTER 4

RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents the findings of the study. For clarity and chronology, it is arranged by the five research questions that the study sought to answer. In the first section, background information about the respondents is presented, because it might be pertinent in interpreting the data that they provided. The chapter is divided into four subsections namely introduction, the respondents’ general and demographic information and the research questions that the study sought to answer and discussion of the findings.

4.1 General and demographic information

4.1.1 Questionnaire return rate

The questionnaires were administered to two hundred and eleven (211) students, where two hundred and ten (210) were successfully filled and returned. This accounted for 99.5% returned forms against 0.5% unreturned forms (Table 4.1). The information shows that majority of the respondents returned their questionnaires affirming the fact that the response rate was sufficient to enable generalizing the results to the target population.

Table 0.1: Mean Questionnaire return rate by Form Three students

<table>
<thead>
<tr>
<th>Test items</th>
<th>No of respondents</th>
<th>Achieved return rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Returned forms</td>
<td>210</td>
<td>99.5</td>
</tr>
<tr>
<td>Not returned</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>211</td>
<td>100</td>
</tr>
</tbody>
</table>
4.1.2 Respondents demographic information

Information on Biology teachers’ level of education and teaching experience was collected and the results indicated in Table 4.2. The findings show that 90% of the respondents were degree holders. All the Biology teachers had at least fifteen (15) years of teaching experience. Majority of the teachers has an average 15-20 years which accounted for 60% of the total respondents.

Table 0.2: Distribution of Biology teachers by level of education and teaching experience

<table>
<thead>
<tr>
<th>Variable</th>
<th>Categories</th>
<th>Frequency</th>
<th>Percent %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of Education</td>
<td>Diploma</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Bachelor’s Degree</td>
<td>9</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Teaching Experience</td>
<td>15-20 years</td>
<td>6</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>21-25 years</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>26-30 years</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10</td>
<td>100</td>
</tr>
</tbody>
</table>

These results show that all the Biology teachers who were involved in the study were qualified and had teaching experience. Davis et al. (2006) observed that some of the challenges that accost new teachers included understanding instructions, content and methods of delivery. This is contrary to the findings in this study since most of the teachers (respondents) had a long teaching experience ranging from fifteen (15) to thirty (30) years.
The teachers have skills necessary for teaching practical biological skills as all are professionals and have undertaken SMASSE training whose curriculum includes hands on approach to teaching that lays an emphasis on practicals. These findings therefore concretize the expectation that information they provided is authoritative and plausible.

The questionnaire also yielded information on ages of Biology teachers. The results are represented in the figure 4.1;

![Mean number of Biology teachers by age in years](image)

**Figure 0.1:** Mean number of Biology teachers by age in years

These findings reveal that the Biology teachers were mature age wise and in conjunction with professional maturity this implies that the information that they provided is reliable. The sampled teachers can teach the skills adequately hence teacher is not an intervening variable. The implication of maturity in age on teaching is supported by the findings that young science teachers are not adequately prepared in skills such as inquiry (Woolnaugh and Allsop, 1985).
4.2 Students competence in procedure skills

The research question addressed to the teachers intended to find out their views on the extent to which competence amongst students is related to their grasp or understanding of practical procedures of Biology experiment. This study recognized the immense contributions of Biology teachers in acquisition of competence in procedure skills amongst students. This is due to the fact that during a practical lesson, is expected to plan, organize, implement and assess practical skills during the laboratory session. KCSE Biology syllabus calls for teaching and learning of practical skills which involves a number of steps, starting at the point when the teacher goes through the relevant section of a syllabus being covered, and picking out the objectives suitable for a practical. The subsequent steps are acquisition of the appropriate material and deciding on whether the practical will be a demonstration or group work based thereafter the teacher goes through the pre-laboratory session. The teachers responses on questionnaire appertaining to their views on competence of their students in procedure skills were analyzed, data was collected was as indicated in Table 4.3.
Table 0.3: Teachers’ views on students’ competence in procedure skills

<table>
<thead>
<tr>
<th>Test Item</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students challenged in identifying apparatus during Biology practicals</td>
<td>Agree: 9, Disagree: 1, Total: 10</td>
</tr>
<tr>
<td>Students understanding of instructions and procedures before undertaking any Biology practical lesson</td>
<td>Agree: 8, Disagree: 2, Total: 10</td>
</tr>
<tr>
<td>Students competence level has a direct relationship with their acquisition of procedure skills</td>
<td>Agree: 9, Disagree: 1, Total: 10</td>
</tr>
</tbody>
</table>

The results in Table 4.3 indicate that nine, 90% of Biology teachers indicated that students frequently face challenges in identifying apparatus during Biology practical. Eight teachers, 80% revealed that students understand instructions and procedures before undertaking Biology practical. Nine Biology teachers, 90% indicated that students’ competence is directly related to their acquisition of procedure skills. These findings indicate that competence is an important dynamic and attribute that students should have to understand instructions or procedures of any practical lesson in biology. To verify the teachers’ views on relationship between the student’s competence in procedure skills and performance in practical Biology was established in a Biology practical test.

The research questions addressed to the students intended to find out their views on their competence in procedure skills in Biology experiments and performance in Biology practicals. Competence amongst students is related to their grasp or understanding of practical procedures of Biology experiments.
The Students indicated that majority 91% frequently face challenges in identifying apparatus during practical while a small proportion, 9% of the students responded in favor of the fact that they understand instructions and procedures before undertaking any Biology practical lesson. A paltry 8% indicated that they understand procedures and instructions before undertaking any Biology practical. Majority of the sampled students, 91% however indicated that their competence has a direct relationship with their understanding of procedure skills. Only a small proportion, 9% indicated that there is no relationship between students’ competence and procedure skills. These findings attest to the fact that students are aware that mastery and understanding of instructions and procedures is the first step in Biology practical lesson. The students were subjected to a practical test with tasks that involved use of procedure skills. The test was marked and data on scored marks obtained in tasks involving procedure skills captured. The reliability statistics on the data collected on procedures of the various test items are represented in the table 4.4.

**Table 0.4: Reliability statistics on procedure skills**

<table>
<thead>
<tr>
<th>Cronbach’s Alpha</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.531</td>
<td>5</td>
</tr>
</tbody>
</table>

The reliability statistics shows fair relationship between procedure skills and marks scored in practical tests, Cronbach’s Alpha $\alpha=0.531$ at N=5. The scored marks in the 5 items capturing the procedure skills were analyzed through SPSS and Mean, Variance and Standard Deviation calculated, the results are represented in table 4.5.
Table 0.5: Scale statistics

<table>
<thead>
<tr>
<th>Mean</th>
<th>Variance</th>
<th>Std. Deviation</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.41</td>
<td>0.954</td>
<td>0.977</td>
<td>5</td>
</tr>
</tbody>
</table>

Mean 2.41, Variance=0.954 and $SD=0.977$ reveals that the population is almost homogeneous in the ability to recall the procedures of various biological practical tasks taught and tested in Biology at Form Three.

4.4 Students’ competence in execution skills in Biology practicals

The research question addressed to the teachers intended to find out their views on the extent to which competence amongst students is related to execution skills in practical Biology practicals. This study recognized the immense contributions of Biology teachers in acquisition of competence in execution skills amongst students. This is due to the fact that during a practical lesson the teacher is expected to take the students through how to carry out hands on execution of practical and assess practical skills during the laboratory sessions. Table 4.6 captures the views of teachers on competence in execution skills of their students in Biology practicals.
Table 0.6: Teachers’ views on competence in execution skills in Biology practical

<table>
<thead>
<tr>
<th>Test Items</th>
<th>No of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agree</td>
</tr>
<tr>
<td>Students complete their practicals on time</td>
<td>3</td>
</tr>
<tr>
<td>Students face challenges when conducting Biology practicals</td>
<td>8</td>
</tr>
<tr>
<td>Poor competency skills is the cause of challenges students face during Biology practicals</td>
<td>9</td>
</tr>
</tbody>
</table>

From the results 3 (30%) of Biology teachers indicated that students complete their practicals in scheduled time whereas 7 (70%) teachers were not in agreement. Eight teachers accounting for 80% indicated that students face challenges when conducting Biology practicals. Most of the Biology teachers sampled, 9 (90%) however indicated that challenges students face during practical Biology session are consequences of poor competence skills amongst the students. To verify the teachers’ views on the relationship between the student’s competence in execution skills in practical Biology and performance was established in Biology practical test. The findings were subjected to analysis Cronbach’s Alpha analysis.

The student’s question also captured views of Form Three Biology students on their in execution skills in Biology practicals. The data reveals that 28% of the students complete their practicals in time while approximately 91% of the students face challenges when executing practicals. Majority of the students 91% indicated poor competence skills is the cause of challenges they face during execution of Biology practicals. To verify the
students’ views on their competence in execution skills in practical Biology and performance was established in Biology practical test. The questions in the practical paper that tested the execution skills were marked and marks scored and used to establish the reliability statistics. Cronbach’s Alpha 0.828 shows high reliability in the N=12 items that test the skills involving execution of practicals (Table 4.7).

**Table 0.7: Reliability statistics**

<table>
<thead>
<tr>
<th>Cronbach's Alpha</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.828</td>
<td>12</td>
</tr>
</tbody>
</table>

The dispersion of the scores was analyzed in Mean, Variance and Standard Deviation. The M= 6.36 at SD=3.308 and Variance 10.944 in N=12 test items indicates high Variance. The students ability in execution varied widely so did the Mean scores and a wide Standard Deviation (Table 4.7).

**Table 0.8: Scale statistics**

<table>
<thead>
<tr>
<th>Mean</th>
<th>Variance</th>
<th>Std. Deviation</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.36</td>
<td>10.944</td>
<td>3.308</td>
<td>12</td>
</tr>
</tbody>
</table>

**4.3 Students’ Competence in observation skills**

The research questionnaire to the teachers intended to establish their views on competence in observation skills in relationship to students’ performance in Biology practicals yielded the data presented in table 4.9.
Table 0.9: Teachers’ views on competence in observation skills

<table>
<thead>
<tr>
<th>Test Items</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students do not make accurate observations during Biology practical</td>
<td>Agree: 8  Disagree: 2  Total: 10</td>
</tr>
<tr>
<td>Students face challenges when drawing</td>
<td>Agree: 9  Disagree: 1  Total: 10</td>
</tr>
<tr>
<td>Competent students make accurate observations</td>
<td>Agree: 9  Disagree: 1  Total: 10</td>
</tr>
</tbody>
</table>

The results indicate that eight Biology teachers, 80% indicated that students do not make accurate observations during Biology practical sessions. Majority of the teachers nine, 90% indicated that student face challenges when drawing during Biology practicals a similar number revealed that competent students make accurate observations. These findings indicate that competence is an important attribute that students should have to understand instructions or procedures of any practical lesson in biology. To verify the teachers’ views on relationship between the student’s competence in observation skills in practical Biology and performance was established in Biology practical test. The findings were subjected to Cronbach’s Alpha analysis.

The data obtained from the student’s questionnaire indicate that approximately 91% of the students sampled do not make accurate observations during Biology practical sessions and similar percentage face challenges when drawing during Biology practicals. Majority of the students 91% also revealed that when they are competent they make accurate observations this supports Chieung and Yip (2003). Chieung and Yip (2003) found that
students who made accurate observation registered 78% in examination. These findings further reveal that making accurate observations forms an integral part of Biology practical skills and competency is the key factor in acquiring such skills. To verify the students’ views on relationship between their competence in observation skills in practical Biology and performance was established by administering of a Biology practical test. Data was collected on performance in observation skills in particular tasks. The marks scored in the Biology test in the observation skills was analyzed through Cronbach’s Alpha, results were as shown in (Table 4.10)

**Table 0.10: Reliability statistics**

<table>
<thead>
<tr>
<th>Cronbach's Alpha</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.743</td>
<td>8</td>
</tr>
</tbody>
</table>

The reliability statistics show strong reliability between the observation skills and the marks scored in test items. The inference is that the results were statistically significant, which implies that students’ competence has significant relationship with observations skills. Table 4.11 shows scale statistics on Mean, Variance, and Standard Deviation in the scored marks in observation skill.

The Mean is high supporting the reliability whilst Standard Deviation $SD= 2.207$ indicated close to masterly of the skills by majority of the students. In secondary schools in Thika West Sub-county, students who make good observations in a practical session register higher scores, this concurs with the findings of Orodho (2005).
Table 0.11: Scale statistics

<table>
<thead>
<tr>
<th>Mean</th>
<th>Variance</th>
<th>Std. Deviation</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.37</td>
<td>4.870</td>
<td>2.207</td>
<td>8</td>
</tr>
</tbody>
</table>

4.4 Students’ competence in interpretation skills

The research questionnaire responded to by the teachers was intended to find out their views on the extent to which competence amongst students is related to interpretation skills in practical Biology practicals. This study recognized the immense contributions Biology teachers have in tutoring the students on acquisition of competence in interpretation skills in practicals.

Table 0.12: Teachers’ views on competence in interpretation skills

<table>
<thead>
<tr>
<th>Test Items</th>
<th>Number of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students find it challenging to interpret the results from a Biology practical</td>
<td>8 2 10</td>
</tr>
<tr>
<td>Students are able to make meaning of observed results</td>
<td>3 7 10</td>
</tr>
<tr>
<td>The level of competence determines students’ ability to make interpretations of results from a Biology practical</td>
<td>9 1 10</td>
</tr>
<tr>
<td>Competence is effective in making students have the ability to summarize the key points of a set of observations</td>
<td>8 2 10</td>
</tr>
</tbody>
</table>
The results in Table 4.12, eight Biology teachers, 80% indicated that students find it challenging to interpret results from Biology practicals this supports findings of Ling and Tawndrow (2005). Three teachers, 30% indicated that students are able to make meaning of observed results from Biology practical. Despite the challenges the teachers think students face, nine teachers, 90% were in agreement that the level of competence determines students’ ability to make interpretations of results from Biology practical. Eight teachers, 80% also indicated that competence is effective in making students have the ability to summarize the key points of a set of observations. Only two, 20% of the sampled teachers did not respond in favor. These findings suggest that, interpretation of results is a skill which determines students’ success in practical Biology skills. To verify the teachers’ views on relationship between the student’s competence in interpretation skills in practical Biology and performance was established in Biology practical test. The findings were subjected to Cronbach’s Alpha analysis.

The questionnaire administered to the students yielded results that reveal that 93% of the students find it challenging to interpret results from Biology practical. 37% of the students indicated that they are able to make meaning of results observed in Biology practicals. Despite these findings 91% of the students indicated that the level of competence determines students’ ability to make interpretations of results from Biology practical. Majority of the students 91% also indicated that competence is effective in making students have the ability to summarize the key points of a set of observations. These findings also reveal that, as the last step in practical Biology skills, interpretation of results is an important skill which determines students’ success in practical Biology skills.
The test items intended to establish competence in interpretation skills were marked and students’ performance in marks scored in practical test. Data was collected from Biology students and results were as indicated in Table 4.13;

**Table 0.13 Reliability statistics**

<table>
<thead>
<tr>
<th>Cronbach's Alpha</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.688</td>
<td>14</td>
</tr>
</tbody>
</table>

The reliability statistics analyzed through Cronbach’s Alpha shows a strong relationship between the interpretation skill and performance in practical Biology.

The finding agrees with Rodriguez (2010), interpretation is a high level skill with greater demand on the student. The Mean score at $M= 8.67$ is high with a Standard Deviation $SD= 2.740$. The scale statistics from interpretation skills are represented in table 4.14;

**Table 0.14: Scale Statistics**

<table>
<thead>
<tr>
<th>Mean</th>
<th>Variance</th>
<th>Std. Deviation</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.67</td>
<td>7.506</td>
<td>2.740</td>
<td>14</td>
</tr>
</tbody>
</table>

Reliability final data shows high correlation between skills and performance in all the four skills. (Table 4.15).The Cronbach's Alpha for procedure skill at $\alpha=0.531$ is lowest likewise Mean score is lowest $M= 2.41$, its lowest for Variance $\sigma= 0.954$ and Standard Deviation $SD= 0.977$. Practical execution skills has the highest Cronbach's Alpha, $\alpha= .828$, Variance
σ=10.944 and Standard Deviation SD= 3.308. The interpretation of skills has the highest Mean, M= 8.67.

Table 0.15: Cronbach's Alpha, Variance, Mean and Standard Deviation of skills applied in practical Biology.

<table>
<thead>
<tr>
<th>Skill</th>
<th>Cronbach's Alpha</th>
<th>No of Items</th>
<th>Mean</th>
<th>Variance</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure skills</td>
<td>0.531</td>
<td>5</td>
<td>2.41</td>
<td>0.954</td>
<td>0.977</td>
</tr>
<tr>
<td>Execution skills</td>
<td>0.828</td>
<td>12</td>
<td>6.36</td>
<td>10.944</td>
<td>3.308</td>
</tr>
<tr>
<td>Observation skills</td>
<td>0.743</td>
<td>8</td>
<td>4.37</td>
<td>4.87</td>
<td>2.207</td>
</tr>
<tr>
<td>Interpretation skills</td>
<td>0.688</td>
<td>14</td>
<td>8.67</td>
<td>7.506</td>
<td>2.740</td>
</tr>
</tbody>
</table>

The Pearson Correlation for all the four procedures was analyzed and differed significantly. The observations had greatest correlation with interpretation, p=0.477 while observation and execution is at p=0.353. The procedure has a high correlation with execution, p=0.437, while procedure and Interpretation is at p=0.306. Execution and interpretation has the lowest correlation at p=0.297 (Table 4.16)
Table 0.16: Pearson’s correlation for relationship between students’ competence in skills and performance in the practical test

<table>
<thead>
<tr>
<th></th>
<th>Procedure</th>
<th>Execution</th>
<th>Observation</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure</td>
<td>1</td>
<td>0.437**</td>
<td>0.279**</td>
<td>0.306**</td>
</tr>
<tr>
<td>Execution</td>
<td>0.437**</td>
<td>1</td>
<td>0.353**</td>
<td>0.297**</td>
</tr>
<tr>
<td>Observation</td>
<td>0.279**</td>
<td>0.353**</td>
<td>1</td>
<td>.477**</td>
</tr>
<tr>
<td>Interpretation</td>
<td>0.306**</td>
<td>0.297**</td>
<td>0.477**</td>
<td>1</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level

Regression analysis was carried out to establish whether prediction can be made on performance based on skills.

The model explains 32.7% of the variance in marks, other than procedure, observation, execution and interpretation there are factors that explain 67.3% of the variance in marks, report as F (4,196) = 23.848, p<0.001 (Table 4.17). This finding supports Millar (2004) who suggested that there is another challenge linked with how students might interpret and explains data; explanations do not just arise from the data obtained.

Table 0.17 Model summary

<table>
<thead>
<tr>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>R Square Change</td>
<td>F Change</td>
<td>df1</td>
<td>df2</td>
<td>Sig. F Change</td>
</tr>
<tr>
<td>0.572a</td>
<td>0.327</td>
<td>0.314</td>
<td>3.049</td>
<td>0.327</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant) Procedure, Observation Execution and Interpretation
b. Dependent Variable: Marks
Coefficients unstandardized and standardized on the four skills and marks were analyzed and presented in Table 4.18. The significance for the procedure variable is \( p=0.406 \) which is bigger than \( p>0.05 \) rejects the assumption. The competence in procedure skills is not statistically significant to marks is 60% lower than the anticipated 95%. Procedure is more theoretical than a practical skill. The execution, observation and interpretation are significant at approximately 98.3% for observation skill and 100% for execution and interpretation skills.

Regression equation:

\[
Y=\beta_0 + \beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+ \varepsilon
\]

\[
Y=13.555+(-1.002)X-.055+(-3.192)X-.237+2.193X.166+(-7.829)X-.509+0.844
\]

\[
Y=19.559613
\]

The data did not have issues with multicollinearity as the VIF value is not greater than 10, nor the Tolerance less than 0.1.

Table 0.18: Coefficients; unstandardized and standardized on the four skills and marks collinearity

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>T</th>
<th>Sig.</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
<td>Tolerance</td>
</tr>
<tr>
<td>Constant</td>
<td>13.555</td>
<td>0.844</td>
<td></td>
<td>16.068</td>
<td>0.000</td>
</tr>
<tr>
<td>Procedure</td>
<td>-1.002</td>
<td>1.204</td>
<td>-.055</td>
<td>-832</td>
<td>0.406</td>
</tr>
<tr>
<td>Execution</td>
<td>-3.192</td>
<td>0.900</td>
<td>-.237</td>
<td>-3.549</td>
<td>0.000</td>
</tr>
<tr>
<td>Observation</td>
<td>2.193</td>
<td>0.911</td>
<td>.166</td>
<td>2.406</td>
<td>0.017</td>
</tr>
<tr>
<td>Interpretation</td>
<td>-7.829</td>
<td>1.048</td>
<td>-.509</td>
<td>-7.473</td>
<td>0.000</td>
</tr>
</tbody>
</table>
The data were subjected to residues statistics to establish whether there were outliners. Data is presented in table 4.21. The Standardized Residual values are within range the data had no outliers as the minimum value is not equal or below -3.29 neither the maximum value equal to or above 3.29.

**Table 0.19: Residues statistics on minimum, Maximum Mean and Standard Deviation**

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted Value</td>
<td>3.44</td>
<td>13.78</td>
<td>8.22</td>
<td>2.106</td>
</tr>
<tr>
<td>Std. Predicted Value</td>
<td>-2.271</td>
<td>2.641</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>SE of Predicted Value</td>
<td>0.234</td>
<td>1.042</td>
<td>0.466</td>
<td>0.121</td>
</tr>
<tr>
<td>Adjusted Predicted Value</td>
<td>3.36</td>
<td>13.82</td>
<td>8.23</td>
<td>2.110</td>
</tr>
<tr>
<td>Residual</td>
<td>-7.195</td>
<td>7.624</td>
<td>0.000</td>
<td>3.018</td>
</tr>
<tr>
<td>Std. Residual</td>
<td>-2.360</td>
<td>2.501</td>
<td>0.000</td>
<td>0.990</td>
</tr>
</tbody>
</table>

Histogram was drawn from the regression standardized residuals statistics showing a normal distribution curve from marks scored in the test. The chart is presented as figure 4.2. Data collected from the scores in the items dealing with scores in practical skills was subjected to multiple regression analysis to find out whether marks can be predicted from the competence in the practical skills in form three students. The data obtained formed a random scatter along a line of best fit. Based on the histogram and the Normal P-P plot the data did not have concerns on Random Normally Distributed Errors and Homoscedasticity. The histogram of standardized residuals indicated that the data contained approximately normally distributed errors, as did the normal P-P plot of standardized residuals, which showed points that were not completely on the line, but close.
Figure 0.2: Random normally distributed errors, homoscedasticity and linearity

The least squares line slope (b) shows was used to plot a graph on normal P-P Plot Regression Standardized Residual Dependent variable as represented in figure 4.3

Figure 0.3: Normal P-P Plot Regression Standardized Residual
4.5 Analysis of sample practical test

The students were subjected to a sample Biology practical test with questions touching on different topics that have been covered as per the Biology syllabus. All the sampled schools had covered the topics as per the syllabus. The test was in an effort to observe and assess competence in practical skills under investigation. The sample Biology practical test provided a baseline from which students’ individual skills on competence was measured. The questions were drawn from drawing, food tests and microscopy. The students were observed as they performed the practicals and manipulative competence for each student scored, scripts were marked and the student’s performance in the two parameters tabulated in Table 4.20;

Highest frequency was in the marks range 16-20 which corresponds to 46% of competence. Approximately 63% of the students scored below 50% of the marks. The first quartile comprises approximately 14%, second quartile 49%, third quartile approximately 33% while last quartile comprises approximately 4%.
Achievement in form of performance in tasks tested was represented as mean scores, standard deviation, Cronbach’s Alpha correlation and number of items in tested skills. Data on the performance of individual tasks represented in mean score, SD, Cronbach’s Alpha correlation, and number of items scored is presented in Table 4.21.

The Mean score was highest in food test at M=0.5820, medium in tooth drawing at M=0.4956 and lowest in microscopy at M = 0.4360 suggesting greater competence in skills involved in food testing skills and least competence in microscopy. The achievement of the students showed greatest standard deviation in microscopy SD = 0.29742 and lowest in tooth drawing SD = 0.24541 and while food test had medium standard deviation at SD=0.29563. Food test had highest correlation, Cronbach’s Alpha α=0.867, while high correlation in tooth drawing, Cronbach’s Alpha α=0.855, microscopy lowest correlation,
Cronbach’s Alpha $\alpha=0.579$. Two students failed to attempt the microscopy $N=208$, suggesting possibility of lack of competence skills required in the task as adequate time or slowness.

Table 0.21: Achievement in tasks, Mean Scores, Standard Deviation, Cronbach’s Alpha Correlation and Number of Items in Tested Skills

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Cronbach’s Alpha</th>
<th>N of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draw</td>
<td>210</td>
<td>0.496</td>
<td>0.2454</td>
<td>0.855</td>
<td>15</td>
</tr>
<tr>
<td>Food</td>
<td>210</td>
<td>0.582</td>
<td>0.2956</td>
<td>0.867</td>
<td>15</td>
</tr>
<tr>
<td>Micro</td>
<td>208</td>
<td>0.436</td>
<td>0.2974</td>
<td>0.579</td>
<td>12</td>
</tr>
</tbody>
</table>

4.6.1 Performance in the research objectives per school category

Data was also collected on how different schools in the three categories performed in the four practical skills assessed. Data presented in table 4.22, indicates national schools performed very well in the showing highest competence by registering an impressive 71% average mark on all the practical skills though execution skill was least performance and interpretation highest. The county schools registering 60% average mark on all the questions that touched all the four practical skills. The performance of students in the county schools was well above average and observation skill was best performed. The sub-county schools showed low performance in the four practical skills. The average of all of the schools in all categories performed fairly below half mark in all the four practical skills.
Table 0.22: School category performance per practical skill catered for in the four objectives

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Procedure %</th>
<th>Execution %</th>
<th>Observation %</th>
<th>Interpretation %</th>
<th>Average %</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>47</td>
<td>79</td>
<td>47</td>
<td>75</td>
<td>84</td>
<td>71</td>
</tr>
<tr>
<td>County</td>
<td>49</td>
<td>56</td>
<td>58</td>
<td>74</td>
<td>52</td>
<td>60</td>
</tr>
<tr>
<td>Sub-county</td>
<td>114</td>
<td>30</td>
<td>29</td>
<td>32</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>210</td>
<td>42</td>
<td>38</td>
<td>46</td>
<td>41</td>
<td>42</td>
</tr>
</tbody>
</table>

The relationship between competence and performance in terms of marks obtained was analyzed through Pearson’s Correlation and data presented in Table 4.23. The data shows a strong positive correlation, positive significant \( r=0.729 \) at \( p=0.05 \) this signifies as competence increases marks increase. Students who are competent score high marks. It was established that students who exhibited high levels of competence registered impressive marks compared to their counterparts who manifested poor competence skills in practical Biology skills.

Table 0.23: Pearson’s correlation coefficient on competence and marks

<table>
<thead>
<tr>
<th>Competence score</th>
<th>Marks obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competence score</td>
<td>1</td>
</tr>
<tr>
<td>Marks obtained</td>
<td>0.729**</td>
</tr>
</tbody>
</table>
An Independent Sample T-Test was conducted to compare low and high achieving Form Three students in practical biological skills on competence. There was a significant difference in the scores in low achieving schools (M=9.078, SD=0.761) and high achieving schools (M=9.078, SD=0.760); t\(_{(208)}\)=11.929, p=0.000. There was significant difference in the scores in marks for competence (M= - 4.198, SD=0.435) and low marks (M= - 4.198,SD=0.435);t\(_{(199)}\)= -9.799, p=0.000. These results suggest that competence in practical biological skills really does have an effect on marks scored in a practical test. The competent students scored higher marks. Sig.(2tailed) value .000 for both competence and marks shows that there is a statistically significant difference between them and the marks scored are as a result of skills exhibited hence reliability of the results.

**Table 0.24: Independent Sample T-Test on competence and marks scored in upper and lower performing students**

<table>
<thead>
<tr>
<th></th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPETENCE</td>
<td>Equal variances assumed</td>
<td>0.146</td>
</tr>
<tr>
<td></td>
<td>Equal variances not assumed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equal variances assumed</td>
<td>11.943</td>
</tr>
<tr>
<td>MARKS</td>
<td>Equal variances assumed</td>
<td>12.603</td>
</tr>
<tr>
<td></td>
<td>Equal variances not assumed</td>
<td></td>
</tr>
</tbody>
</table>

The data to establish possible relationship between performance and teachers responses from oral interview showed a strong significant correlation between marks and data from
teachers responses in the interview, r=0.529. Teachers teach tasks but do not allow time for adequate practice. The training and long teaching experience means that the teachers are competent in imparting the practical skills hence improvement in performance can possibly be achieved through frequent practice especially the execution and result interpretation.

4.7 Discussion of the findings

4.7.1 Relationship between student’s level of competence in procedure skills and performance

Identification of apparatus is wanting suggesting majority of the students do not handle some of the equipment during the learning process hence non familiarity this supports findings made by SMASSE needs survey (2009) Thika/Gatundu that was commissioned by MoE. Stipulated practical materials usage is expected of a student (Roberts, 2004) hence findings show a contradiction to the expected norm n apparatus and equipment. Procedures need to be explained as only 8% understand despite the teachers rating the students highly on procedure skills. There is a strong correlation between procedure and performance.

4.7.2. Relationship between competence in execution skills and performance

The teachers and students agree strongly that time constraints are the greatest hindrance to completion of practical tasks. The tasks hence ought to be assigned more time during the laboratory sessions. Students seem less sure of themselves though teachers over rate the students skills. Exposing students to frequent practicals will have the teachers get the actual level of the students’ execution skills. Students have poor competence in execution skills and both teachers and students are in agreement on it impeding performance in
Biology practicals, a similar finding was encountered in the field during the Needs survey (2009), Thika/Gatundu.

4.7.3 Relationship between competence in execution skills and performance

Execution skills have high internal reliability to performance as exemplified in the practical test that the students sat supporting both the teachers and students views. Students are more constrained by time despite the two stakeholders concurring on time constraining execution skills. The video tape showed two students boiling test tube contents one walked away reluctantly after contents boiled and no color changed while the other student’s contents changed. This signified some wrong execution in placing contents in the test tube hence procedure skills is paramount in practical skills.

4.7.4 Relationship between competence in observation skills and performance

Findings are that teachers think students’ competence on making accurate observations is lower than what the students think of themselves. Students expect more attention from the teachers in learning observation skills especially in the drawing tasks that students have lowest competence in and that teachers rarely teach. Practical skills are therefore taught and not acquired. The findings reveal that both teachers and students concur on the importance of observation in performance. There is a very high correlation between observation and performance as observation is crucial in further development of the knowledge to be conceived from the task. Majority of the students 91% also revealed that when they are competent they make accurate observations this supports Chieung and Yip (2003). The observation skill was best performed.
4.7.5. Relationship between competence in interpretation skills and performance

Interpretation skill is the concluding aspect of a practical exercise during which inferences are drawn. Interpretation and observations have high correlation as correct interpretation cannot be made from no or wrong observation. Interpretation and procedure have low correlation as the student may not necessarily execute the procedure. Interpretation and execution have low correlation possibly because the interpretation can be based on prior knowledge unrelated to the task on hand. Competence in interpretation skill signifies epitome of competence in practical Biology performance. This is because making lucid interpretations does not come naturally to most students. The students may not be in a position to detect errors in the practicals during their interpretations of results. Some secondary school students might not be used to looking at an experiment, assessing the relative importance of errors and where appropriate, expressing these numerically, this view is supported by an assessment report by SMASSE (2007) on Implementation of Practicals in Science Subjects.

4.7.6. Relationship between competence in practical skills and performance in Biology practicals

It was established that students who exhibited highly levels of competence registered impressive marks. The regression analysis establishes that it is possible to make predictions on performance depending on level of competence in the various practical skills. This supports Ling and Towndrow (2005) on effective mastery of demanding manipulative and procedure skills, students understand why an experimental procedure is carried out in a particular way. With certain levels of competence then students can be assured of certain grades in examinations. Piaget cognitive development and other constructivists’ theories
are supported by findings of this study. Predictability on performance is possible as per the findings. A school that has high performance in Biology practicals will have a history of good performance so long as the level of competence is maintained through strategized methodology ensuring same extent of skill learning. This meets the gap that the study sought to fill on the competence that ultimately yields the performance witnessed in TWSC.

The students and teachers therefore should aim at attaining levels of competence in practical skills that will assure them of performance that will translate to desired grades. The grades ought to enable the students qualify to join tertiary level of education and do courses that they desire. Stakeholders can adopt the findings to make improvements in Biology from teaching and learning perspective in order to perform better in KCSE biology. Ultimately the students can achieve their career choices and occupations thereafter, Bradley (2012). Open and distance learning students could not attain required competencies. The students failed to construct knowledge as expected in the constructivism theory. Students performed better in food test signifying the task is carried out more frequently in most schools; skills are learned and not acquired. Lowest performance was witnessed in microscopy and drawing tasks suggesting they are not frequently taught the syllabus KICD (2003) should be adhered to. The QASO ought to monitor curriculum implementation.
CHAPTER 5

SUMMARY AND RECOMMENDATIONS

5.0 Introduction

The study sought to establish the relationship between competences in practical biological skills and performance of Form Three students in practical Biology tasks. The study is significant in that stakeholders can establish competence they ought to achieve for higher performance. Prediction of performance is possible as indicated by regression analysis. Theoretical framework was made around constructivism theory; with teachers input the students can construct knowledge and skills based on prior knowledge enabling them to master the practical skills.

Research instruments were designed to enable collection of data using questionnaires written for students and teachers and oral interview was given to the teachers, observation schedule. A practical test was administered to give a vivid picture of student’s competence in the practical skills.

This chapter presents summary of the study and conclusions as discussed under the research objectives. The chapter also gives recommendations and suggestion for further research.

5.1 Summary of the Study

The level of competence of practical biological skills affects performance at KCSE more so as the practical paper has a set huddle that a student needs to attain to get a particular
grade. Competence in practical skills and performance in Biology at Form Three in TWSC is below average.

The objectives of the study set to;

1. Examine competence in procedure skills and performance in Biology practicals amongst Form Three Students in Thika West Sub-County;

2. Establish competence in execution of Biology practicals and performance in Biology practicals amongst Form Three Students in Thika West Sub-County;

3. Determine competence in observation skills and performance in Biology practicals amongst Form Three Students in Thika West Sub-County;

4. Establish competence in interpretation skills and performance in Biology practicals amongst Form Three Students in Thika West Sub-County.

5. Establish competences in practical skills and performance in Biology practicals in Thika West Sub-County.

The teachers’ views on various aspects of competence were compared with that of students to arrive at inferential statistical analysis. Woolnough and Allsop, (1985), and KNEC Syllabus (2003) supports that teacher determines the approach, flow and manipulations of information hence teachers are instrumental in establishing competence in practical skills and performance of the students.

5.1.1 Competence in procedure skills

The study has revealed that an understanding of instructions and procedures of Biology practicals is crucial in a Biology practical session and impacts greatly on performance. This view is supported by majority of Biology teachers who were involved in the study and
indicated that for success in practicals, the students should first master the procedure and show a full understanding of the instructions. This fact is further supported by students themselves with majority agreeing that competence in understanding the first step of a practical lesson is significant to the eventual success of the practical. However, a small number of the sampled Biology teachers and students believe that students cannot develop competence in mastery of instructions; despite holding the very view that competence is important in understanding the procedures of a Biology practical session.

The findings support Ling and Towndrow (2005) who wrote that an effective mastery of demanding manipulative and procedure skills enable students to understand tasks they are carrying out. Likewise practical skills are best achieved by starting in development of competence in practical biological skills; however, though this has not been the case in most secondary schools (Owiti, 2009) as attested by the performance in the test items involving procedure in various tasks. Students in national, county and sub-county categories of schools scored 79%, 56%, 30% respectively and an averaging of 42%.

5.1.2 Competence in execution of Biology practical

The study also established that competence is important in the actual practical session. Sampled Biology revealed that this step in a practical session requires more competence development for higher performance. Similar views were expressed by Preston and Roberts (2003), Yara (2010), Birenbaun (2003) in his observation that actual implementation of all manipulations is what counts in a practical session. Written laboratory work does not provide information about student’s prowess in manipulating equipment, observing, organizing and performing an investigation creatively and
efficiently Twoli et al. (2006) hence video tapping such activity overcomes the bottleneck. This fact was supported by majority of the teachers and majority of the sampled students who indicated that successful performance of Biology practical is significantly determined by competence of the students. The views are contrary to Yara (2010), investigations revealed that teaching of Biology should be based on developing an understanding and the execution determined by both student and teacher. The performance in the test in national, county and sub-county categories of schools was 47%, 58%, 29% respectively and average 38%. Biology practicals such as microscopy, food tests and more so drawing require high level keenness, creativity, versatility and problem solving characteristics amongst students. The students who responded on the contrary however maintain that acquisition of competence skills depends on teachers hence teachers should improve their pedagogy and methodology in practical skills. This affirms the fact that from whatever factors that might influence performance, competence is a key attribute to academic success in practicals established to be at 32%.

5.1.3 Competence in observation skills

These are the practical Biology skills that require the student to record the outcomes of an experiment which is the essence of undertaking a Biology practical. It is one of the problematic aspects of practical sessions for students. Students need to be competent to achieve this skill effectively; Yara (2010) made similar findings. Biology teachers support this fact with majority of them indicating that observation forms the most important part of practical skills without which all the practical activities will be futile. Students too hold the same view and a record 94.4% responding in favor of the fact that competence has a significant relationship with acquisition of observation skills in practical biology. Franklin
et al. (2002) suggested accurate readings precise descriptions changes make it much easier for students to draw valid conclusions, as well as scoring more highly in a test. Chieung and Yip (2003) noted students who were able to make accurate observations out of a practical session performed better by registering an impressive 78% in Biology practicals, student in TWSC scored lower suggesting lower competence due to inability to make accurate observations. Performance in the test national, county and sub-county categories of schools scored 75%, 42%, 32% respectively with an average of 46%.

5.1.4 Competence in interpretation of results

The study found out that competence enhances the students’ ability to make logical interpretation of practical results and draw inferences or conclusions from such interpretations. This was supported by most of the sampled Biology teachers and the students. This is a phase of practical session which gives meaning to the recorded observations as well as giving meaning to the essence of the practical and learning sciences. In science scaled down investigations of process involving life and living organisms are carried out. The findings support SMASSE (2007), Thika Gatundu (2009), Rodriguez (2010) who asserted that interpretation of results is a high-level skill and so makes a greater demand on a student’s basic understanding of the biology. The study revealed that students who were able to make effective interpretation of practical results registered 69.5% success in their Biology practicals whereas their colleagues who exhibited poor interpretative skills this is the category students in TWSC fall as exemplified in the following performance in the test national, county and sub-county categories of schools scored 84%, 52%, 29% respectively and an average of 41%. To make appropriate interpretations, the students must be competent enough to make meaning of
practicals. Unfortunately as Millar (2004) supposes proper inferences explanations and ideas do not automatically arise from data obtained out of a practical session as students can use prior knowledge. This then ought to be weeded out by utilizing new methodology of assessing practicals to ensure interpretations are of observations made.

5.1.5 Performance in Biology practical test

The sample practical Biology test given to the students established that most Form Three students in the national, county and sub-county schools have competence challenges. These challenges had a negative impact on their acquisition of practical biological skills. The challenges from least to most severe were; observation skills, procedure skills, interpretation skills and execution of the practical.

The study also established that students in national schools registered impressive achievement in competence in practical Biology skills, though their lowest competence was in procedure skills however they exhibit best performance in the Biology practical test.

5.1.6 Relationship between competence in practical skills and performance in Biology practicals

Students who have high level of competence in biological practical skills perform highly in the practical examinations students in national schools qualified to be said to be competent. Competence in practical skills has very high correlations to performance therefore students ought to develop competence in practical skills to avoid the wastage grades at KCSE.
5.2 Implications of the findings for practice

The study has clearly established that competence in practical biological skills of Form Three students in TWSC are low which explains why the scores in Biology at KCSE are below average as the marks for practicals contribute to the overall grade scored in Biology. The study established that competence in observation skill is highest while execution skill is most challenging hence least competence. Competence in procedure is learned through rote learning as implementing them in carrying out the practical registered lower competence. The practical Biology test 231/3 at KCSE should have the KNEC address the modality of testing achievement of all practical skills the student may have learned.

5.3 Conclusions

From the foregoing, it is evident that students’ competence in practical biological skills is significantly related to performance. These skills are reflected through understanding of instructions and procedures, execution of practical, observation and interpretation of results. Students should construct the knowledge on practical skills for higher performance. Competence in practical skills enables students to become creative and develop ability to solve problems which, in turn, enable them to effectively and competently tackle practicals in Biology. Practice and assessment of practical skills as well as revising methodology of numerically awarding all the scaffolds that go into the practical session could go into improving performance in practical Biology.

5.4 Recommendations

The findings of this study would have numerous educational implications for the principals who should provide materials for practical Biology tasks. The students have measuring and proper inferences out of a practical session. Centrally to the aforementioned Millar (2004)
explanations and ideas do not automatically arise from data obtained. Active participation of the students in the class aids retention and makes learning sciences more meaningful. As the students participate and manipulate equipment/materials, they apply their five senses and other skills to their lessons more than when they would have learned in abstraction.

The teachers can be aware of areas of weakness and strengths in covering of the syllabus. Teachers should encourage students to develop interest in practical activities by engaging them in practicals, accord adequate time to practice and by providing interesting instructional materials.

The curriculum planners can moderate the time allocated to certain tasks and advise learning materials producers accordingly. The teachers should adopt student centered practical activity method of teaching Biology. Students learn better when they are involved in activity-based learning. Since the use of practical activities enhances students acquisition of science process skills, it follows that curriculum planners can enhance the awareness of this methodology of teaching amongst teachers. The curriculum planners can also include within the existing subjects contents of the Biology such as awareness of the equipment and apparatus that students are poor in identifying. For usefulness of the practical skills in Biology some emerging issues and corresponding indigenous knowledge acquired from practical skills should be incorporated in Biology. Biology concepts should be taught with practical activity so that the students will do science instead of learning about science. The government of Kenya (GoK) through Ministry of Education (MoE) and organizations like Japan International Corporation Agency (JICA) that sponsor projects such as Strengthening of Mathematics and Science in Secondary education (SMASSE) to
continue organizing workshops, seminars and conferences for Biology teachers where they learn skills on how to enhance development of academic competence amongst their students. Symposia on developing practical skills can be held to promote the competence in the skills. Sponsorship of science and technology fair can encourage practical skills in biology.

Quality assurance and standards officers (QASO) can monitor through syllabus audit on the practical skills.

The national educational policy on studying Biology stipulates as outlined in the syllabus objectives the designing and carrying out experiments by employing appropriate practical skills be taught to enable the students to understand biological concepts. Evidence from the findings of the research study, reveal that there is little adherence to the policy recommendation hence in some secondary schools in TWSC hence the below average performance. There is evidence that approach to developing competence in practical Biology skills amongst secondary school students is more theory than practical oriented hence performance in such tested skills is below average. Industrialization can be based on Biology a science, (Kibe et al., 2008) in that it provides a firm foundation for further education and training in related scientific fields hence the students need to perform better in Biology at KCSE as a sign of mastery of the skills. The education stakeholders and QASO should monitor implementation of the education policy which lays emphasis on practical approach to teaching and learning of Biology and the achievement of grades C plus and above that do not constitute wastage.
5.5 Areas for further research

There is need for further research on the variables that affect performance in Biology practicals other than the skills researched in this study. The skills studied in this research accounts for only 32.7% of the variables that contribute to performance hence need to carry out further research.
REFERENCES


Donkor, F. (2010). The Comparative Effectiveness of Print-Based and Video-Based Instructional Materials for Teaching Practical skills at a Distance. Winneba: University of Education.


APPENDICES

APPENDIX I: Objectives of studying Biology as outlined in the KICD syllabus

By the end of the course, the learner should be able to;

1. Communicate biological information in a precise, clear and logical manner
2. Develop an understanding of interrelationships between plants and animals and between humans and their environment
3. Apply knowledge gained to improve and maintain the health of the individual, family and the community
4. Relate and apply relevant biological knowledge and understanding to social and economic situations in rural and urban settings
5. Observe and identify features of familiar and unfamiliar organisms
6. Develop positive and interest towards Biology and the relevant practical skills
7. Demonstrate resourcefulness, relevant technical skills and scientific thinking necessary for economic development
8. Design and carryout experiments and projects that will enable them understand biological concepts
9. Create awareness of the value of cooperation in solving problems
10. Acquire a firm foundation of relevant knowledge, skills and attitudes for further education and for training in related scientific fields.
APPENDIX II: Outline of Biology practical activities in the syllabus to be attained by end of Form Three

**Dissections:** of small mammals as a demonstration of digestive system, blood circulatory system, display the respiratory system.

**Investigate:** gas produced when food is burned, during fermentation, factors affecting photosynthesis, food tests

**Analyze:** data on transpiration under different environmental conditions, analyze and interpret data from ecological studies e.g. food chains, food webs, and calculations of ratios of producer to consumer from data provided.

**Construct:** simple dichotomous keys using leaves/parts of common plants/arthropods/common chordates in the local environment, or used prepared keys, models to demonstrate the breathing mechanism in mammals.

Collecting record, specimens comparing animals and plants

**Calculation:** magnification of and making drawings of specimens, of magnification of cells as seen under the microscope

**Demonstrating:** Unidirectional flow of blood

: Diffusion

: The effect of exercises on the rate of breathing

**Experiments:** That affects enzymatic activities

: To compare rates of transpiration between upper and lower surfaces of the leaf.

Experiments with visking tubing and living tissues on water relations

**Examine:** Distribution of spiracles on grasshopper or locust

: Gills of bonny fish

: Preserved specimens or photographs of representatives of major divisions of Plantae and phyla Arthropoda and Chordata.

: Hydrophytes and mesophytes and identify features that adapt them to their habitats

: Roots of legumes and compare number of root nodules based on the type of soil they grew in

: Examine and draw a mammalian kidney

Estimation of populations using sampling method
Drawing specimens

**Investigating:** for presence of enzymes in living tissues

- Effect of catalase enzyme on hydrogen peroxide
- Make vertical sections through the kidney to identify the cortex and medulla
- Measure temperature, pH, wind direction and humidity of habitats

**Observing:** Permanent slides under the microscope or own prepared temporary slides

- Cells and making an estimate of the size of the cells
- Permanent slides of cross sections of aerial and aquatic leaves and stems, terrestrial stems and roots
- Stomata distributed on a leaf
- Different types of mammalian teeth
- Wall charts
- Mammalian skin on a slide

**Recording:** of the features on the specimens, pulse rates and analyzing the results after physical exertion, heat produced during aerobic and anaerobic respiration

**Dissectioning:** Demonstration and display of mammalian heart and associated blood vessels.
APPENDIX III: Letter of introduction

October, 2013

Dear Sir/Madam,

RE: PERMISSION TO CARRY OUT RESEARCH

I am a student undertaking a research towards acquiring a degree in Master of Education in Educational Communication and Technology at Kenyatta University. The title of the research is **Influence of Competence in Practical Skills on Students’ Performance in Biology Practicals in Schools in Kiambu County, Kenya** to achieve this; I have sampled your school for the study. Through you kindly request the sampled Form Three Biology students and teachers to participate fully through the research instruments. The information gathered will be used purely for the academic purpose.

Your assistance and cooperation will be highly appreciated.

Thank you in advance.

Yours faithfully,

Anastasia Wanjiru Maina
## APPENDIX IV: Schools in Thika West Sub-County and their category

<table>
<thead>
<tr>
<th>School</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mangu High School</td>
<td>National School</td>
</tr>
<tr>
<td>2. MaryHill Girls’ High School</td>
<td>National School</td>
</tr>
<tr>
<td>3. Chania Girls’ Secondary</td>
<td>County School</td>
</tr>
<tr>
<td>4. Chania Boys’ Secondary</td>
<td>County School</td>
</tr>
<tr>
<td>5. Thika High School</td>
<td>County School</td>
</tr>
<tr>
<td>6. Juja Secondary School</td>
<td>Sub-County School</td>
</tr>
<tr>
<td>7. Juja Farm Secondary School</td>
<td>Sub-County School</td>
</tr>
<tr>
<td>8. Kenyatta Secondary School</td>
<td>Sub-County School</td>
</tr>
<tr>
<td>9. Karibaribi Secondary School</td>
<td>Sub-County School</td>
</tr>
<tr>
<td>10. Broadway Secondary School</td>
<td>Sub-County School</td>
</tr>
<tr>
<td>11. Gachororo Secondary School</td>
<td>Sub-County School</td>
</tr>
<tr>
<td>12. Kimuchu Secondary School</td>
<td>Sub-County School</td>
</tr>
<tr>
<td>13. Queen of Holy Rosary Secondary School</td>
<td>Sub-County School</td>
</tr>
<tr>
<td>14. Delmonte Secondary School</td>
<td>Sub-County School</td>
</tr>
<tr>
<td>15. Salvation Army Joy Town for Physically Handicapped</td>
<td>Sub-County School</td>
</tr>
<tr>
<td>16. Salvation Army High School For the Blind Thika</td>
<td>Sub-County School</td>
</tr>
</tbody>
</table>
APPENDIX V: KCSE grades in Biology and school Mean scores (2011) for some public schools in Thika West Sub-County

<table>
<thead>
<tr>
<th>School</th>
<th>2011 Biology Mean Scores</th>
<th>2011 School Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mangu High School</td>
<td>10.350</td>
<td>10.860</td>
</tr>
<tr>
<td>Mary Hill girls’ High School</td>
<td>10.150</td>
<td>10.500</td>
</tr>
<tr>
<td>Thika High School</td>
<td>8.392</td>
<td>8.470</td>
</tr>
<tr>
<td>Chania Boys’ High School</td>
<td>7.400</td>
<td>6.770</td>
</tr>
<tr>
<td>Chania Girls’ High School</td>
<td>6.900</td>
<td>7.300</td>
</tr>
<tr>
<td>Broadway Secondary School</td>
<td>4.314</td>
<td>4.850</td>
</tr>
<tr>
<td>Kenyatta Secondary School</td>
<td>2.900</td>
<td>4.180</td>
</tr>
<tr>
<td>Juja Secondary School</td>
<td>2.700</td>
<td>3.180</td>
</tr>
<tr>
<td>Salvation Army Joy Town for Physically Handicapped</td>
<td>3.100</td>
<td>4.348</td>
</tr>
<tr>
<td>Juja Farm Secondary School</td>
<td>2.960</td>
<td>3.710</td>
</tr>
<tr>
<td>Salvation Army High School For the Blind Thika</td>
<td>2.700</td>
<td>4.480</td>
</tr>
<tr>
<td>Gachororo Secondary School</td>
<td>3.100</td>
<td>3.860</td>
</tr>
<tr>
<td>Karibaribi Secondary School</td>
<td>2.500</td>
<td>2.180</td>
</tr>
<tr>
<td>Kimuchu Secondary School</td>
<td>4.980</td>
<td>5.211</td>
</tr>
</tbody>
</table>
APPENDIX VI: Teachers’ questionnaire

Dear Respondent,

I am a student undertaking a course in Master of Education in Kenyatta University, carrying out a thesis research on *Influence of Competence in Practical Skills on Students’ Performance in Biology Practicals in Schools in Kiambu County, Kenya.* Kindly answer the questionnaire to the best of your ability. The information you provide will be treated with utmost confidentiality and used entirely for purpose of this study.

**Answer the questions as honestly as possible in the spaces provided.**

**Section A: Procedure Skills**
1. Do your students understand procedures before undertaking a practical lesson?
   - Yes [ ]
   - No [ ]
2. Do your students frequently face challenges in identifying apparatus during Biology practicals?
   - Yes [ ]
   - No [ ]
3. Does students competence level have a direct relationship with their acquisition of procedure skills?
   - Yes [ ]
   - No [ ]

**Section B: Execution Skills**
1. Do your students complete their practicals in time?
   - Yes ( )
   - No ( )
2. Do your students face challenges when conducting Biology practicals?
   - Yes ( )
   - No ( )
3. Are poor competence skills the cause of challenges students face during Biology practical sessions?
   - Yes ( )
   - No ( )
Section C: Observation Skills
1. Students do not make accurate observations during Biology practical sessions
   Yes [ ] No [ ]
2. Students face challenges when drawing
   Yes [ ] No [ ]
3. Competent students make accurate observations
   Yes ( ) No ( )

Section D: Interpretation Skills
1. Students find it challenging to interpret the results from a Biology practical
   Yes ( ) No ( )
2. Students are able to make meaning of observed results
   Yes ( ) No ( )
3. The level of competence determines students’ ability to make interpretations of results from a Biology practical
   Yes ( ) No ( )
4. Competence is effective in making students have the ability to summarize the key points of a set of observations
   Yes ( ) No ( )

Section E: Relationship between Competence in Skills and Performance in Biology Practical

Is there a relationship between competence in skills and performance in Biology practicals?
   Yes [ ] No [ ]
APPENDIX VII: Students’ questionnaire

Dear Respondent,

I am a student undertaking a course in Master of Education in Educational Communication and Technology at Kenyatta University, carrying out a thesis research Influence of Competence in Practical Skills on Students’ Performance in Biology Practicals in Schools in Kiambu County, Kenya. Kindly answer the questionnaire to the best of your ability. The information you provide will be treated with utmost confidentiality and used entirely for purpose of this study.

*Answer the questions as honestly as possible in the spaces provided.*

**Section A: Procedure Skills**

1. Do you understand procedures before undertaking a practical lesson?
   - Yes [   ]
   - No [   ]

2. Do you frequently face challenges in identifying apparatus during Biology practicals?
   - Yes [   ]
   - No [   ]

3. Does competence level have a direct relationship with their acquisition of procedure skills?
   - Yes [   ]
   - No [   ]

**Section B: Execution Skills**

1. Do you complete their practicals in time?
   - Yes (  )
   - No (  )

2. Do you face challenges when conducting Biology practicals?
   - Yes (  )
   - No (  )
3. Are poor competence skills the cause of challenges you face during Biology practical sessions?
   Yes (     ) No (     )

**Section C: Observation Skills**

1. I do not make accurate observations during Biology practical sessions
   Yes [     ] No [     ]

2. I face challenges when drawing
   Yes [     ] No [     ]

3. Competent students make accurate observations
   Yes (     ) No (     )

**Section D: Interpretation Skills**

1. I find it challenging to interpret the results from a Biology practical
   Yes (     ) No (     )

2. I am not able to make meaning of observed results
   Yes (     ) No (     )

3. The level of competence determines ability to make interpretations of results from a Biology practical
   Yes (     ) No (     )

4. Competence is effective in making students have the ability to summarize the key points of a set of observations
   Yes (     ) No (     )

**Section E: Relationship between competence in skills and performance in Biology practical**

Does your teacher explain the relationship between competence in skills and performance in Biology practicals?
   Yes [     ] No [     ]

Thank you

Anastasia Wanjiru Maina
APPENDIX VIII: Oral interview guide for Biology teachers

Section A: Background Information

1. Gender
   Male ( )   Female ( )

2. Age in years.

3. Highest level of education
   Diploma ( )   Bachelor ( )   Masters ( )   PhD ( )

4. Duration of Teaching Biology in years
   16-20 ( )   21-25 ( )   26-30 ( )

Section B: Status of Practicals in Secondary Schools

1. How much practical work have you covered this far?

2. List challenges your students face in course of learning practical skills.

3. Do you carry out pre laboratory sessions to try out the practicals?

Section C: Procedure Skills Section

4. Do you take the students through the outline of a practical?

5. Do you outline expectations of perfection

6. Do you explain to the students the skills to use in the practical?

Section D: Execution of Practical

7. Do you explain how all the equipment and material in a practical task is used?

8. Did you explain what is expected when drawing specimens in a practical?
9. Do you explain how to carry out procedure steps when testing for foods?

Section E: Observation Skills

10. Do you explain what is expected when recording results?

Section F: Results Interpretation Skills

11. Do you take the students through interpretation of results/data obtained in a practical task?

Section G: Competence in Skills and Performance in Biology Practical

12. What is the relationship between competence in skills and performance in Biology practicals?
Dear Respondent,

I am undertaking a research on **Influence of Competence in Practical Skills on Students’ Performance in Biology Practicals in Schools in Kiambu County, Kenya.** This exercise is to assist in the assessment of performance of students in practical biological skills. The findings will not be used for any other purpose other than for this study. Performance assessment schedule provided here will be used to record your answer. Kindly respond to all the questions to the best of your ability.

1. You are provided with a tooth obtained from a mammal. Observe the tooth to enable you to answer the following questions.
   
   i. Draw the tooth 1 mark
   
   ii. Identify the tooth by writing its name above the drawing 1 mark
   
   iii. Label the parts of the tooth 3 marks

2. Test the solution provided for the various foods using the resources provided. Record your results in the table below.

<table>
<thead>
<tr>
<th>Food substance</th>
<th>Procedure</th>
<th>Observation</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8 marks
3. You are provided with a soft stem of the tradescantia or wandering Jew.

(a) Make thin cross sections of the stem. Prepare a temporary slide of the stem. Place the slide on the microscope and focus under medium power objective lens.

(b) Assume the beans are cells of the stem whose cross-section is represented by the petridish. Arrange the beans within the petridish.

Work out the equivalent length of the cells in the stem represented by beans on a petridish. Assume the stem is 1 centimeter wide.

Show your working.
APPENDIX X: Confidential list of requirements per student

1. Two handfuls of beans seeds
2. One petridish
3. Five drops of iodine solution
4. Two droppers
5. 1cm$^3$ Benedict's solution
6. Means of heating (shared)
7. One test tube
8. Test tube holder
9. Ruler with millimeter markings
10. White tile or petridish placed on a white paper
11. 10 cm$^3$ Measuring cylinder
12. 2cm$^3$ solution extracted from crushed leafy plants
13. Scalpel blade
14. Microscope slide, microscope and cover slip
15. 1cm$^3$ Water
16. Incisor, molar or premolar tooth
17. Stem of tradescantia or wandering jew
### APPENDIX XI: Performance assessment score sheet

<table>
<thead>
<tr>
<th>ITEM</th>
<th>TASK</th>
<th>IMPLEMENTATION / SKILL</th>
<th>ACHIEVED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drawing</td>
<td>i. Drawing made</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii. Fine pencil line made used in drawing either incisor, premolar or molar</td>
<td>NO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iii. Continuous pencil lines - execution</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>iv. Correct identification of tooth</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>v. Width and height of tooth proportional</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>vi. Accurate shape of the tooth</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>vii. Label crown</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>viii. Correct spelling of crown</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ix. Label line touching crown-execution</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>x. Label neck</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>xi. Correct spelling of neck</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>xii. Label line touching neck</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>xiii. Label root</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>xiv. Correct spelling of root</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>xv. Label line(s) touching the root(s)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Food tests</td>
<td>i. Naming of starch</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii. Naming of Reducing sugar</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>iii. Correct spelling of starch</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>iv.</td>
<td>Spelling of reducing sugar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>v.</td>
<td>Correct procedure of testing for starch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi.</td>
<td>Correct procedure of testing for reducing sugar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vii.</td>
<td>Correct volumes of test reagent</td>
<td>Iodine</td>
<td></td>
</tr>
<tr>
<td>viii.</td>
<td>Correct volumes of test regent</td>
<td>Benedict’s solution</td>
<td></td>
</tr>
<tr>
<td>ix.</td>
<td>Correct observation for starch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>x.</td>
<td>Correct observation for reducing sugar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xi.</td>
<td>Conclusion for starch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xii.</td>
<td>Conclusion for reducing sugar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Microscopy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>Cross section of stem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii.</td>
<td>Making a thin section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii.</td>
<td>Placing specimen on slide with cover slip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv.</td>
<td>Slide on stage light passing through</td>
<td></td>
<td></td>
</tr>
<tr>
<td>v.</td>
<td>Medium objective lens in position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi.</td>
<td>Focusing on specimen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vii.</td>
<td>Single layer of beans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>viii.</td>
<td>Beans lengthwise on petridish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ix.</td>
<td>Calculation of diameter of petridish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>x.</td>
<td>Number of beans across diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xi.</td>
<td>Correct working length of ‘cell’ mm/μm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX XII: Marking scheme

No. 1

i. Correct identity of drawing; Proportionality of drawing 1 mark
   Accuracy of drawing 1 mark

ii. Fine pencil lines 1 mark
    Continuous line 1 mark

iii. Label Crown 1 mark

iv. Label root 1 mark

v. Label neck 1 mark

vi Label line touch the crown 1 mark

vii Label line touch the neck 1 mark

vii Label line touch the root 1 mark

Labels 3, Identity 1 total awarded for drawing = 4.

Manipulations 6 marks

Total for question 1= 10

No. 2

<table>
<thead>
<tr>
<th>Food substance</th>
<th>Procedure</th>
<th>Observation</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch</td>
<td>Add drops of iodine</td>
<td>Blue/black colour</td>
<td>Starch present</td>
</tr>
<tr>
<td>Reducing sugar</td>
<td>Add equal volume (x cm³) of Benedict’s solution to</td>
<td>Colour turns to orange/brown</td>
<td>Reducing sugar present</td>
</tr>
<tr>
<td></td>
<td>the food substance, Heat mixture to boiling point</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table Marked out of 8. Marks for spellings and volumes of reagents = 10

Total for question 2= 18
No. 3

a. Making of a cross section
   Making a thin section
   Having a microscope slide with coverslip over the specimen
   Placing slide on the microscope with the specimen on the opening on the stage
   Having the medium objective lens in position
   Medium objective lens clicked in position
   Light passing through the microscope

b. Placing 1 layer of beans on the petridish

c. Lengthwise along the diameter
   Calculation; diameter of petridish in centimeter
   Number of beans along the diameter
   Length of cell
   Worked out in mm OR worked out in micrometers

Marks for question 3 awarded to written answers, 8 for manipulations
Total for question 3 = 11

Maximum marks on script= 15. Maximum marks for Manipulations= 14.

TOTAL marks for the paper 39
APPENDIX XIII; Introductory letter from department of Educational Communication and Technology, Kenyatta University

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: kuhps@yahoo.com
        dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

FROM: Dean, Graduate School
TO: Ms. Maina Anastasia Wanjur
    C/o Educational Communication & Technology Department
    KENYATTA UNIVERSITY

DATE: 18th September 2013
REF: E55/CE/14610/09

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

This is to inform you that the Graduate School Board at its meeting of 11th September 2013 approved your M.Ed Research Proposal entitled, “Competence in Practical Biological Skills: A Study of Form Three Students in Thika West Sub-County, Kenya”

You may now proceed with your Data Collection.

JOSEPHINE KENDI
FOR: DEAN, GRADUATE SCHOOL

cc: Chairman, Educational Communication & Technology Dept.

Supervisors:
1. Prof. Samson M. Muthwii
   South Eastern Univ. College – Univ. of Nairobi
   C/o Educ. Comm. & Technology Department
   KENYATTA UNIVERSITY

2. Dr. David O. Oludhe
   C/o Educ. Comm. & Technology Department
   KENYATTA UNIVERSITY

JK/twk
APPENDIX XIV: Authorization letter from National Commission for Science, Technology and Innovation (NACOSTI)

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Phone: +254-20-2241349, 20-267 3550, 0713 788 787, 0735 403 245
Fax: +254-20-2213215
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke

When replying please quote
Our Ref: NACOSTI/P/13/4203/149

25th October, 2013

Anastasia Wanjiru Maina
Kenyatta University
P.O.Box 43844-00100
Nairobi.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on
“Competence in practical biological skills: A study of form three students in
Thika West Sub-County, Kenya,” I am pleased to inform you that you have
been authorized to undertake research in Kiambu County for a period ending
28th February, 2014.

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

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

DR. M. K. RUGUTT, PhD, HSc.
DEPUTY COMMISSION SECRETARY
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Copy to:
The County Commissioner
The County Director of Education
Kiambu County

APPENDIX XV: Research permit from NACOSTI, front page

THIS IS TO CERTIFY THAT: 
MS. ANASTASIA WANJIRU MAINA of KENYATTA UNIVERSITY, 0-1000 
thika, has been permitted to conduct 
research in Kiambu County on the topic: COMPETENCE IN 
PRACTICAL BIOLOGICAL SKILLS: A 
STUDY OF FORM THREE STUDENTS IN 
THIKA WEST SUB-COUNTY, KENYA. 

For the period ending: 
28th February, 2014

Applicant's Signature: 

National Commission for Science, Technology & Innovation

Secretary

Permit No.: NACOSTI/P/13/4203/109
Date Of Issue: 25th October, 2013
Fee Received: Kshs 1000.00
APPENDIX XVI: Research permit from NACOSTI (back page)

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.
APPENDIX XVII: Authorization letter from the County Commissioner, Kiambu

OFFICE OF THE PRESIDENT
MINISTRY OF INTERIOR AND CO-ORDINATION OF NATIONAL GOVERNMENT
COUNTY COMMISSIONER, KIAMBU

Telegraphic address: "Rais"
Telephone: +254-66-2022709
Fax: +254-66-2022644
E-mail: county.commiss@kiambu.gov

When replying please quote

Ref No. ED.12/1/VOL.4/302

7th November, 2013... 20...

Anastasia Wanjiru Maina
Kenyatta University
P.O Box 43844-00100
NAIROBI

RE: RESEARCH AUTHORIZATION


You have been authorized to conduct research on “Competence in practical biological skills: A study of form three students in Thika West Sub-County” in Kiambu County up to the period ending 28th February 2014.

You are requested to share your findings with the County Education office upon completion of your research.

ESTHER MAINA
COUNTY COMMISSIONER
KIAMBU COUNTY

CC
County Education Officer
KIAMBU COUNTY

National Commission for Science, Technology and Innovation
P.O BOX 30623-00100
NAIROBI-KENYA