PRACTICAL WORK AND PERFORMANCE OF LEARNERS IN PHYSICS: A STUDY OF SECONDARY SCHOOLS IN MERU CENTRAL DISTRICT, MERU COUNTY, KENYA.

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(E55/CE/13925/2009)

A Thesis Submitted in Partial Fulfillment for the Award of the Degree of Master of Education in the School of Education

Kenyatta University.

November, 2012
DECLARATION

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

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DEDICATION

This thesis is dedicated to my parents and friends for their moral support and encouragement towards the accomplishment of the work.
ACKNOWLEDGEMENTS

I greatly thank the almighty God for enabling me to research on this topic of study. I sincerely appreciate the contributions made directly or indirectly by all those people who helped me in the preparation of this research project. I am particularly indebted to my supervisors Dr. Nicholus Twoli and Mr. Michael Waititu for their guidance and advice at every stage of my preparation of this work. I also warmly thank my colleagues David Ndung’u and Ephraim Gitonga principal Mariene Secondary School for their assistance in editing this work. The assistance offered by the Master of Education students in Educational Communication and Technology of year 2010 for going through the work and criticizing where necessary to improve its quality cannot go unnoticed. I most sincerely thank the physics teachers and students from the sampled schools who participated directly by providing data that was used in this document.
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ABBREVIATIONS AND ACRONYMS

AS .......... Attitude Scale.

ASEI ........ Activity, Student, Experimentation, Improvisation.

CRO .......... Cathode Ray Oscilloscope

Exam ........ Examination

KCSE .......... Kenya Certificate of Secondary Education

KIE .......... Kenya Institute of Education.

KNEC .......... Kenya National Examinations Council

Lab .......... Laboratory

PDSI .......... Plan, Do, See, Improvise

PTQ .......... Physics Teachers Questionnaire
This study investigated the relationship between practical work in physics and the performance of students in secondary schools. The study was guided by the following objectives: to establish the relationship between the performance in the theoretical and practical aspects of physics, to find out the factors that can improve the quality of practical work in physics, to investigate the attitude of students and physics teachers towards theoretical and practical aspects of physics and to find out the effects of gender differences in practical work in physics. The study comprised of ten public secondary schools in Meru Central District (three boys, three girls and four mixed day secondary schools). In carrying out this study a questionnaire was used for both physics teachers and the students. Spaces were left for students and teachers to fill as to whether they strongly agree, agree, not sure, disagree, and strongly disagree. The Observation schedule was used to identify how physics practical work was carried out by students. Physics teachers and students were interviewed concerning practical work in physics. A list of topics from Form one, two and three physics syllabus were highlighted and the experiments to be carried out in each topic. Their responses were coded and analyzed using Statistical Package for Social Sciences (SPSS) which was used to compute descriptive statistics such as percentages, standard deviation and mean. The study used descriptive survey that employed correlation methods to investigate the effectiveness of the use of hands on activities in teaching and learning of physics. The findings of the study revealed that both teachers and students have a positive attitude towards practical work in physics and that practical work in physics affect the performance in final examination. The study came up with recommendations for action and further research.
CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter deals with background to the problem, statement of the problem, objectives of the study, significance of the study, scope and limitations of the study, assumptions of the study, theoretical framework, conceptual framework and definitions of terms.

1.1 Background to the problem

Physics in secondary schools is taught using two modes, classroom teaching and laboratory practical. These two modes of teaching are important in imparting knowledge to learners. Physics like any other science subject is a practical oriented discipline that is destined to solve some problems in the society (Tamera, 1974). Use of experiments enhances understanding of scientific concepts and principles. Students are more likely to remember what they do than what they see or are told. UNESCO, (1980) indicates that we learn and remember 10% of what we hear, 15% of what we see, 20% of what we see and hear, 40% of what we discuss with others and 80% of what we experience through practical activities.

There is a need to shift from traditional science to process based science that emphasizes on process skills such observation, investigation, recording and communication. The practical work in physics ensures that these process skills are acquired. One cannot put meanings into students’ heads but can only present ideas from which students construct their own meanings (Hutchings, 1973). The introduction of 8-4-4 physics course in secondary schools greatly shows a shift from traditional science to process-based science (K.C.S.E syllabus 2007)
Experiments are not limited to laboratory work in sciences; it includes any activity that leads the learner to discover/reinforce new concepts/ideas for themselves. According to Strengthening of Mathematics and Sciences in Secondary Education (SMASSE) a body that trains teachers on how to teach mathematics and sciences using practical approach emphasizes on the use of Activity, Student, Experimentation and Improvisation. These scaled-down experiments are also safer and environmental friendly (Lewis, 1976). For adequate teaching of physics, learners need to be provided with an opportunity to have a feel of practical lessons that helps them develop their psychomotor skills (Woolnough, 1985).

Given that students learn a lot more when they are active participants rather than passive recipients of information, it is important that student activities should constitute the main focus of every lesson. The choice of activities should therefore be guided by lesson objectives, key concepts to be learnt and skills to be developed by the learner who should always be the centre of focus. Psychologists Brunner (1962) and Gagne (1970) criticized rote learning as opposed to practical work which emphasizes on the acquisition of knowledge and skill. Tamir (1985) outlines the goals of practical in physics work as:

(i) To promote scientific thinking and scientific ways of solving the problems.
(ii) To develop a range of process skills (John, 1987)
(iii) To arouse interest, attitude, open mindedness and curiosity in science.
(iv) To develop conceptual and intellectual ability and understanding of concepts.

Performance of students in physics in K.C.S.E is of great concern as it has been declining since the year 2006 as shown in table 1.1.

The performance of students in physics has been declining from the year 2006 – 2010.
Table 1.1  Number of candidates achieving each of the K.C.S.E grades in Meru Central District year (2006- 2010)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ENTRY IN PHYSICS.</th>
<th>A</th>
<th>A-</th>
<th>B+</th>
<th>B</th>
<th>B-</th>
<th>C+</th>
<th>C-</th>
<th>D+</th>
<th>D</th>
<th>D-</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td></td>
<td>1487</td>
<td>7</td>
<td>9</td>
<td>19</td>
<td>38</td>
<td>40</td>
<td>87</td>
<td>66</td>
<td>87</td>
<td>111</td>
<td>343</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>0.471</td>
<td>0.605</td>
<td>1.278</td>
<td>2.555</td>
<td>2.690</td>
<td>5.851</td>
<td>4.439</td>
<td>5.851</td>
<td>7.465</td>
<td>23.067</td>
</tr>
</tbody>
</table>

| 2007 |                  | 1244 | 17 | 14 | 40 | 65 | 38 | 78 | 52 | 72 | 76 | 210 | 359 | 223 |

Mean score year 2006 3.8251, mean score year 2007 4.4241

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ENTRY IN PHYSICS.</th>
<th>A</th>
<th>A-</th>
<th>B+</th>
<th>B</th>
<th>B-</th>
<th>C+</th>
<th>C-</th>
<th>D+</th>
<th>D</th>
<th>D-</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td></td>
<td>1120</td>
<td>2</td>
<td>3</td>
<td>13</td>
<td>20</td>
<td>28</td>
<td>44</td>
<td>23</td>
<td>20</td>
<td>30</td>
<td>353</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>0.179</td>
<td>0.268</td>
<td>1.161</td>
<td>1.786</td>
<td>2.500</td>
<td>3.929</td>
<td>2.054</td>
<td>1.786</td>
<td>2.679</td>
<td>31.518</td>
</tr>
</tbody>
</table>

| 2009 |                  | 1080 | 4  | 7  | 15 | 30 | 33 | 41 | 67 | 48 | 110 | 231 | 397 | 97 |
|      |                  | %   | 0.370 | 0.648 | 1.389 | 2.778 | 3.056 | 3.796 | 6.204 | 4.444 | 10.185 | 21.389 | 36.759 | 8.981 |

| 2010 |                  | 960  | 3  | 5  | 12 | 25 | 42 | 53 | 50 | 81 | 93 | 124 | 407 | 65 |
|      |                  | %   | 0.313 | 0.521 | 1.250 | 2.604 | 4.375 | 5.521 | 5.208 | 8.438 | 9.688 | 12.917 | 42.396 | 6.771 |

Mean score year 2008 3.021, Year 2009 3.483, Year 2010 3.616

Source D.E.O Meru Central District (2013)

It is evident from the above table that the mean grade in physics in K.C.S.E has been deteriorating since the year 2006 as many students have been acquiring grades D and E. The poor performance has led to many students consider physics as a subject for the selected few. The performance of physics for the last few years is as shown in table 1.1. The poor performance has led to many students opt for the other sciences at the expense of physics. This implies that the performance of students in physics is directly proportional to the
enrolment. This performance and enrolment of students in physics can be improved by encouraging the use of practical (KIE, 2002).

Physics is an important subject though it has been facing two great threats namely, low enrollment, and poor performance as shown in table 1.2

The enrolment just like the performance has been declining since the year 2006. This is unlike the other science subjects (biology and chemistry).

Table 1.2 Enrolment and Performance of students in physics (2006 to 2010)

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics entry</td>
<td>1487</td>
<td>1244</td>
<td>1120</td>
<td>1080</td>
<td>960</td>
</tr>
<tr>
<td>%</td>
<td>18.3761</td>
<td>14.4531</td>
<td>11.0448</td>
<td>9.6243</td>
<td>8.0208</td>
</tr>
</tbody>
</table>

Source DEO’s office Meru Central District

The enrolment just like performance of students in physics has been declining since the year 2006. The worst was evident in 2009 and 2010 (20%) of the total entry of students.
1.2 Statement of the problem

In spite of the value and contribution of physics to our society, there has been a declining trend in performance in the subject in the national examinations. The low grades E and D characterize national results in physics (KNEC, 1998). The performance of physics is caused by among other factors; availability of resources in the laboratory, theoretical work in physics, and quality of physics practical being carried out, teacher and student characteristics and gender differences. This study sought to establish the possible interrelatedness between the variables and performance.

Practical work in physics was considered because it equips the learners with abilities and skills such as designing and carrying out investigations, observations, measurement, recording data, analyzing and interpreting results. Practical work in physics is important because it provides skills that are useful in supporting theory in schools and later in professions such as engineering, survey architecture radiography and space science (Levinson, 1994).

The resources in secondary schools such as the laboratory determine the extent to which the students participate in carrying out the practical in physics. Few resources in secondary schools contribute to the teachers not conducting the lesson using practical work.

During practical laboratory work, students are given an opportunity to manipulate concrete objects, specimens, equipments and chemicals under the direction of the teacher (Twoli, 2006). If the students are involved more in the practical work the overall performance in physics in K. C.S.E will improve (K.N.E.C 2007).
Table 1.3. Performance of students in physics paper 1, 2, & 3 in District common assessment Meru Central District Year 2010/2011

<table>
<thead>
<tr>
<th>YEAR</th>
<th>P1/80</th>
<th>P2/80</th>
<th>P3/40</th>
<th>P3%</th>
<th>AVERAGE</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>Student</td>
<td>06</td>
<td>05</td>
<td>16</td>
<td>40</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td>60</td>
<td>53</td>
<td>30</td>
<td>75</td>
<td>73</td>
</tr>
<tr>
<td>2011</td>
<td>Student</td>
<td>50</td>
<td>60</td>
<td>10</td>
<td>25</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Student</td>
<td>11</td>
<td>09</td>
<td>14</td>
<td>35</td>
<td>23</td>
</tr>
</tbody>
</table>

The importance of practical work in physics is manifested in table 1.3 in a district assessment in year 2010/2011. Four physics students of different abilities in theoretical work and practical work were used. For student A: \((5 + 6/160) \times 100 = 6.88\%\)  \(P3 = (16/40) \times 100 = 40\%\)

Average = \((6.88 + 40)/2 = 24\%\)

Student B: \((60 + 53/160) \times 100 = 70.63\%\)  \(P3 = (30/40) \times 100 = 75\%\)

Average = \((70.63 + 75)/2 = 73\%\)

Student C: \((50 + 60/160) \times 100 = 68.75\%\)  \(P3 = (10/40) \times 100 = 25\%\)

Average = \((68.75 + 25)/2 = 47\%\)

Student D: \((11 + 9/160) \times 100 = 12.5\%\)  \(P3 = (14/35) \times 100 = 35\%\)

Average = \((12.5 + 35)/2 = 23\%\)
Student A scored poorly in theory papers (P1&P2) and slightly below average in the practical paper (P3). This resulted to a poor grade D. Student B performed well in both theory and practical paper. This resulted to a higher grade B. Student C performed better in P1 and P2 but poorly in paper P3. This resulted to an average grade C. Student D performed poorly in both papers P1, P2 and P3 resulting to a poor grade D. The student who performed well in both papers ended up with a higher grade. The student who performed poorly in theoretical papers but performed well in the practical paper acquired an average grade.

In light of the poor performance in physics subject in Meru Central District, it was therefore the interest of this study is to look at how practical work is imparting on performance of learners in physics in secondary schools in Meru Central District.

1.3 Objectives of the study

The study was guided by the following objectives;

a) To establish the relationship between performance in theoretical and practical aspects of physics.

b) To find out the factors that can improve the quality of the practical work in physics.

c) To investigate the attitude of physics students and teachers towards theoretical and practical aspects of physics.

d) To find out the effects of gender in practical work in physics.
1.4 Research Questions

The study attempted to answer the following questions;

a) What is the relationship between the performance in theoretical and practical aspects in physics?

b) What are the key factors that can improve the quality of the practical work in physics?

c) What are the attitudes of physics students and teachers towards theoretical and practical aspects of physics?

d) What are the effects of gender to practical work in physics?

1.5 Significance of the study

The findings of this study are of great importance to the following;

Physics teachers

Teachers are the implementers of the curriculum and the findings of this study will help them on improving the quality of the experiments that teachers carry out with physics students. The teacher can adjust his/her teaching methods in order to meet the needs of the students.

Physics students

The findings of this study will help the students in having a positive attitude towards physics. Negative attitude towards physics contributes to the poor performance in physics. The students can use the findings of this study to give equal importance to the physics practical as in the theoretical work.
Physics Teacher Trainers

The results of these findings can be used to sensitize the teachers on modern trends on teaching of physics. The trainers can use the findings to update the teachers on measures to improve practical work in physics.

Physics Text book authors

The findings of this study will enable book authors to include more materials that are relevant to the physics students and the physics teachers. The findings of this study will facilitate the revising of the curriculum to make it more relevant to the expectations of the students, teachers and society.

The authors of physics text books can use the findings to include information that is student participatory. Various student activities can be included in the physics text books for secondary schools

1.6 Basic assumptions of the study

- The study assumed that all the physics teachers teaching in the sample schools were professionally trained.

- All the sample schools identified had laboratories and these laboratories are functional with basic laboratory tools and equipment.

- All the schools in the study use the National Physics Syllabus. This helped in ensuring that the information gathered from physics students and teachers is aligned to what is contained in the syllabus.

- The physics teachers in the schools in the study conduct practical work with students and were conversant with practical work.
1.7 **Scope and limitations**

1.7.1 **Scope**

The study covered the physics teachers and form four physics students of secondary schools in Meru Central District. The study covered only secondary school physics teachers and their students and focused on physics practical work only.

1.7.2 **Limitations of the study**

The main problems of the study were as follows;

Long distances between one school and the other posed a problem as a lot of time was used in moving from one school to the other.

Inadequate time and insufficient resources posed a limitation as one year for research was not enough.

A sample of ten schools was randomly selected in the district which may not have given a true representation of the schools in the whole district.

1.8 **Theoretical framework**

Constructivism theory was used to show the relationship between the various variables. Constructivism is based on participatory learning starting from real life experience to construct and knowledge. It is problem based, adaptive learning strategy that challenges faulty schema, integrates new knowledge with existing knowledge, and allows for creation of original work or innovative procedures. The focus of constructivist approach in learning is to help learners become creative and innovative through analysis, conceptualizations, and synthesis of prior experience to create knowledge.
A person’s prior knowledge comes from the past experience, culture, and their environment. Generally prior knowledge is good but sometimes misconceptions and wrong information can be a hindrance. Sometimes time must be spent correcting prior knowledge before new learning can occur.

Scientific observation has established that education is not what the teacher gives, but a natural process spontaneously carried out by the human individual, and is acquired not by listening to words but by experiences upon the environment (Woolnough, 1985). The task of the teacher becomes that of preparing a series of motives of activities spread over a specially prepared environment.

Active learning conditionalizes knowledge through experimental learning. The method of instruction used to learners must provide for exploration, thinking, and reflection; and that interaction with the environment is necessary for learning.

Constructivism does not dismiss the active role of the teacher or the value of expert knowledge. Constructivism modifies that role, so that teachers help the students to construct knowledge rather than to reproduce a series of facts. The constructivist teacher provides tools such as problem solving and inquiry based learning activities with which students formulate and test their ideas, draw conclusions and inferences and pool and convey their knowledge in a collaborative environment. Constructivism transforms the students from a passive recipient of information to an active participant in the learning process. Always guided by the teacher, students construct their own knowledge actively rather than just mechanically ingesting knowledge from the teacher or the textbook.

For example groups of students in a science class are discussing a problem in physics. Though the teacher knows the “answer” to the problem he/she focuses on helping the
students restate their questions in useful ways. He/she prompt each student to reflect on and examine his/her current knowledge. When one student comes up with the relevant concept, the teacher seizes upon it, and indicates to the group that this might be a fruitful avenue for them to explore. They design and perform relevant experiments. Afterward, the students and teacher talk about what they have learned, and how their observations and experiments helped (or did not help) them to better understand the concept.

Figure 1.1: Constructivism Theory of Learning

Adapted from Dewey (1987)
1.9 Conceptual framework

The conceptual framework for this study considers the practical work and the performance of physics. The performance in physics was influenced by factors such as teacher and student characteristics, attitudes and aspirations of students towards physics.

In physics, content is exposed to learners through various instructional methods such as lecture method, group discussion and individual or group experiments. Availability of resources such as laboratory equipments plays a key role in the performance of physics.

Figure 1.2 Relationships between variables influencing performance in practical Physics.

Source: Adapted from Twoli N. (2006)
1.10 Definition of terms

In this study, the following words were emphasized with the following meanings.

**Attitude:** Someone’s opinions or feelings about something, especially as shown by their behavior.

**Curriculum:** Are the subjects that students study at a particular school.

**Innovation:** It is the invention or use of new ideas, methods or equipments.

**Laboratory:** A building or room where scientific experiments are carried out.

**Physics:** It is a branch of science that deals with matter in relation to motion.

**Practical work:** It's any work that is carried out using pre designed apparatus and relevant theories by students and teachers.

**Process science:** An approach in the study of science which emphasize on how scientific knowledge is acquired.

**8:4:4:** A system of education introduced in Kenya in 1985 geared towards making students more practical oriented and self reliant.
CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This study is concerned in establishing the relationship between practical work in physics and the overall performance. The study sought to establish whether there exists a link between practical work in physics and performance.

This is structured to include aspects relating to conduct of physics practical in secondary schools such as the contributions of the laboratory in carrying out the practical, problems encountered in acquiring laboratory facilities, role played by the teacher in carrying out the practical, role played by students in carrying out the practical, content of practical work and gender differences in physics learning.

The objectives of 8:4:4 physics course at secondary schools show the shift from traditional science to process based science (K.C.S.E Syllabus, 1987). At the end of every experiment there is an objective(s) to be achieved.

. Physics slowly by slowly unfolds to the learner the treasures of the environment. By manipulating his/her environment, through the guidance of the teacher, the learner understands in a better way. This is done using simple looking experiments within the learner’s cognitive level. Practical work is seen as a subservient to theory (Solomon, 1980).
2.1 Theoretical and practical work in physics

Physics in secondary schools is taught using two modes, classroom teaching and laboratory practical. These two modes of teaching are important in imparting knowledge to learners. Physics like any other science subject is a practical oriented discipline that is destined to solve some problems in the society (Tomera, 1974). During the Kenya Certificate of Secondary Education, the theory is contained in paper 1 and paper 2 each of the papers carrying 80 marks while paper 3 is the practical paper and carries 40 marks. In order to get grade A in physics in K.C.S.E one has to get at least grade D+ in the practical paper (KNEC, 2007).

Physics practical work besides equipping learners with knowledge for specialized courses also develops students' science abilities. This leads to technological advancement which is so much needed by a developing country like Kenya (Parkinson, 1994). Promoting practical work in physics therefore produce young people who can manage the technology and improve the economy and living standards of the people.

Experimentation is one important process that aids in acquiring knowledge. However, although many see it as trial and error, precisely speaking the hope to promote understanding may not be achieved otherwise except through experimental work in the laboratory and critical discussion guided by the teacher (UNESCO, 1980).

New teaching methods of physics for example experimentation and demonstration may be required to teach new curricula. There has been a strong recommendation by educators for a shift from a teacher –centered approach to student centered approach to teaching. (SMASSE).
Physics being a practical subject targets development of manipulative skills in the learner besides acquisition of knowledge in general that is provided equally by other subjects (Boullind, 1957). Physics encourages learning by doing activities that adds more value to learning than any other method. Practical work in physics emphasizes the process skills which include experimentation, measurement, observation, inference, communication, prediction (Schofield, 1980). There has been a shift from traditional science which emphasize on practical work (Woolnough & Alsopp, 1985).

2.2 Factors to consider in improving the quality of practical work in physics.

2.2.1 Contributions of the laboratory in carrying out the practical

A laboratory is a room where scientific experiments are carried out. The laboratory gives the student appreciation of the spirit and method of science, promotes problem solving, analytic and generalization ability and provides students with some understanding of the nature of science (Walberg, 1991). Laboratory designs are progressive and, therefore, shifting to suit the changing material circumstances. These circumstances might be due to new technology, curriculum change or increased demand in terms of the number of students a laboratory is supposed to accommodate (Twoli, 2006). A laboratory consists of various rooms such as;

Main laboratory room- This is the room in the laboratory where the students carry out their practical. Teacher demonstrations are also carried out in this room. In this room there are various systems such as electricity and water system.

Preparation room –This is a room in the laboratory where the teacher prepares the experiment for the students. This is also a room where the teacher rehearses the experiment
before presenting it to the students. The preparation room can also be used for other purposes such as planning and keeping laboratory records such as catalogues.

**Storage room**- This is a room where the materials and equipments are stored. Substances such as the prepared solutions and apparatus are stored in this room. Labeling of solutions is very essential for easier identification.

A laboratory is designed in such a way that in case of a practical that poses a safety threat to the students’ safety precautions must be adhered to. These threats may be as a result of disconnection of wires or scalds from hot water.

Students and teachers need to see beyond the four walls of the laboratory by taking into consideration the context in which physics is learnt and taught (Woolnough & Alsopp, 1985).

Practical work enhances learning by allowing students together in groups hence discussing among themselves in a language familiar to all (Lewis, 1976).

**Basic Equipments in a Functional Laboratory**

There are various laboratory instruments; Instruments for measuring length- a good example of an instrument for measuring length is a meter rule. A meter rule can give accurate measurement of length of objects such as desk and tables.

a) Instruments for measuring mass- These include instruments such as weighing balance, electronic balance and beam balance. These instruments give measurement of mass of various objects.

b) Instruments for measuring the volume- These includes measuring cylinders, burette, pipette and volumetric flasks.
c) Instruments for measuring density- The commonly used instruments include the density bottles.

Problems encountered in acquiring laboratory facilities

The facilities that are found in a laboratory entirely depend on the type of the school. Twoli, (2006) categorizes these types of schools into national, county, district and private schools. The national, County and private secondary schools have most of the required facilities including the advanced ones such as the cathode ray oscilloscope. The district secondary schools lack most of the common laboratory facilities such as Veneer calipers, meter rules and thermometers (Twoli, 2006). Most of the district schools do not have the laboratory itself (Twoli, 2006). Teachers of some of these district schools are only left to improvise in order to carry out the experiments.

2.2.2 Role played by the teacher in carrying out the practical

Preparation of the practical in physics is done by the teacher. This involves assembling of the relevant apparatus. The physics teacher should introduce the apparatus to the learners before the experiment is done by the students (UNESCO, 1983).

The physics teacher plays a key role in imparting knowledge to students during the physics practical. The teacher should consider a practical that enables him to achieve the national goals of education. These include:

a) Acquisition of knowledge, skills and attitudes- physics being a science subject targets development of manipulative skills in the learner besides acquisition of knowledge (Twoli, 2006). This is why learning by doing adds more value to learning than any other method.
b) Discover and understand the order of the physical environment—By manipulating his/her environment, through the guidance of the teacher, the learner understands the environment in a better way. This is done using simple looking experiments within the learner's cognitive level. (SMASSE, 2002)

c) Ability to reason critically in any given situation—Physics practical should equip the learner with abilities to pose a problem, solve it, and draw general conclusions (Watts, 1991). The teacher is supposed to rehearse the practical before that same practical is done by the students. This enables the teacher to identify whether the practical works or not (UNESCO, 1980).

The teacher also should guide the students during the practical on how to draw the graphs, interpret graphs and drawing conclusions. The extent to which physics teachers facilitates the practical is key in this study.

In most of the practical work in physics the practical skills are tested (Riding & Butterfield 1990). The practical skills are categorized into manipulative and process skills. Manipulative and process skills are assessed during routine laboratory practical lessons and the records of each student are kept for every practical (Twoli, 2006). The study investigated the role of the teacher in improving the quality of the practical.

2.2.3 Role played by students in carrying out physics practical

The students assemble the materials/apparatus with the guidance of the teacher. Incase the materials are not enough then the students can participate in improvisation.

There are certain basic skills that are essential in order for students to carry out the practical effectively;
a. Ability to read the instruments (measuring cylinders, thermometers, burettes pipettes accurately.

b. Correct use of instruments and apparatus (microscope, veneer calipers, ammeter, and voltmeter)

Students are actively involved during a physics teacher demonstration. When the materials and apparatus are set on the demonstration table the teacher invites the students in order for them to observe and record the observations. (Twoli, 2006)

The students are also involved in data collection when carrying out the practical. The teacher provides the students with materials either singly or in groups. The data can therefore be collected singly or in groups (Lewis, 1976). After carrying out the practical the students are involved in analyzing the data and making deductions. This is through the guidance and supervision of the teacher. The extent to which the students participate during practical work is important in this study. The data is analyzed through use of graph, pie charts, and tables. Students share ideas particularly when involved in group discussions (Lewis, 1976.) The learners should be given opportunity to work/discuss in groups followed by writing the group reports. (Lewis, 1976)

The students can seek for guidance from the teacher during or after the physics practical. The questions asked by the students are generally meant to clarify a given concept (Parkinson, 1994). When students are actively involved in seeking for guidance from the teacher for example in making conclusions this increases their level of understanding (UNESCO, 1980)
2.2.4 **The content contained in physics practical work.**

Any physics practical that is done by the students should be geared towards equipping them with skills such as manipulation. The teacher should identify the skills the students will acquire at the end of the experiment. (Iraki, 1994). Any hands on activities given to the students measure a given degree of knowledge and skills acquired by the learners. The student carrying out the experiment ought to understand, practice and see the sense in studying physics.

The experiment carried out in physics helps a student to apply the knowledge acquired during the theory lessons (Keeves, 1991). The applicability of such knowledge once comprehended leads to understanding and subsequently wisdom to student. The modern approach puts a lot of emphasis on the process science skills such as observation experimenting, interpretation; inferring and prediction. Understanding does not take away the wonder—the more you know about what is going on, the more respect you give it. It’s not that people should know how to use a computer, but appreciate the amazing things it can do (Keeves, 1991). In assessing of physics practical emphasis is put on the processes of sciences (Schofield, 1980). The materials used during experimentation should meet the objectives stated by the teacher. The materials and apparatus used should be to the level and ability of students. In case of materials that are complex the teacher should guide the students. (Twoli, 2006).

The information contained in a given practical should be to the level of learners. This is to ensure that the practical does not threaten the students in terms of difficulty. In case of complicated experiments the teacher should explain the procedure to the students. (Iraki, 1994)
During experiments the teacher should cater for safety precautions. The teacher should not allow the students to carry out an experiment that poses a threat to them.

The apparatus in the laboratory are becoming expensive such as computers. Improvisation can be the key solution by both students and teachers. Use of mobile laboratories to visit far away schools is important where there are no apparatus (Iraki, 1994).

2.3 Attitude of students and teachers towards theoretical and practical work in physics.

A study carried out by Hutchings, (1973) revealed that the performance in physics practical is greatly improved if positive attitudes are encouraged in terms of relatedness of topics in physics syllabus and inculcating the needs of the society. Negative attitudes in students occur when the teacher concentrates on teaching the theory work in classroom only while ignoring the practical work. Twoli, (2006) supports this by pointing out that in an ideal situation lecture method should be used very sparingly while emphasizing on practical work for wider learning experience and in order to inculcate positive attitudes towards students.

Monk & Osborne, (2002) point out that the attitude of a teacher towards a given subject mostly depends on the motivation of that teacher towards that subject. If the attitude of a teacher towards a given subject is low, then the same will be passed on to the students.

Attitude is very important in acquisition of skills and knowledge in practical in physics (Donovan, 1973). It is the attitudes that our students develop which are likely to stimulate or stop further studies. It is attitudes which we develop that are highly involved in learning and retention of our subjects. (Homas, 1970) points out that attitude involves tendency to act towards or against something in the environment which becomes thereby a positive or
negative value. The attitude or preparation in advance of the actual response constitute important determinant of ensuing academic and social behavior. Tamir, (1985) points out that we form and develop attitudes in order to understand the world around us to protect our self esteem, and to adjust in a complex world or environment around us.

2.4 Gender differences in physics learning

The enrolment of girls in physics in high school has been wanting for a long time. This is most commonly found in mixed secondary schools where few girls enroll for physics leaving it to be dominated by boys (Mwangi, 1983). This has mostly been attributed to the mathematics factor where physics is associated with mathematics and mostly girls have a negative attitude towards mathematics (Eshiwani, 1982). Gender is one of the leading problems in the teaching and learning of science and mathematics (Eshiwani, 1982). Girls are underrepresented in sciences particularly in physics and mathematics (Mwangi, 1983). There is a big gap between boys and girls in enrolment of science subjects particularly mathematics and physics (Twoli, 1986). The society and home background favors boys in practically oriented subjects such as physics (Mwangi, 1983). This study sought to establish the attitude of girls towards practical work in physics in secondary schools.

Whyte, (1986) when researching for Girls in Science and Technology (GIST) found out that boys persistently intimidated girls in the science laboratory and refused them access to equipments. This explains why boys are more advantaged than girls in that they will take risks and ‘hog’ materials and apparatus incase of shortage.

Mwangi, (1983) suggests that by removing the group that dominates and excludes the experience of women, single sex schools can allow women to express and validate their own
experiences to develop some autonomy, to build some confidence. This study sought to find out the effects of gender in practical work in physics.
CHAPTER THREE

RESEARCH METHODOLOGY

3.0  Introduction

This chapter describes the methodology that was followed in carrying out the study. The chapter includes sections on study design, research sample, data collection instruments sampling and sample size, sampling description, sample selection techniques, research instruments.

3.1  The study design

A descriptive survey study design was used. Descriptive survey gathers data at a particular point in time with the intention of describing the nature of existing conditions, identifying standards against which existing conditions can be compared and determining the relationships that exist between specific events. This is because it involves collecting data that guided in answering questions from teachers and students concerning the role of practical work in physics performance. The descriptive survey was also used to assess the effectiveness, attitude and procedures that are used, gather a lot of information within a short time and describing the nature of the existing conditions.

This study has four stage processes. Phase one include preparation of proposal and the development of research instruments. Phase two involves piloting of the research instruments in order to make them more valid and to refine them. Phase three is concerned with data collection from the samples sampled. Phase four is concerned with analysis of data collected. Conclusions and recommendations are also made after analyzing the data. The design of study process is summarized as shown in figure 3.1.
The problem

Research target
population: secondary schools.

Sample

Instruments, AS and PTQ

Randomly selected Physics teachers

Piloting

Revised Instrument

Data

Data analysis and presentation of results

Conclusion and recommendations

Figure 3.1 The process of the study

Adapted from Cohen and Mohen (1994)
3.2 Target population of the schools

Meru Central District has 30 public secondary schools. The district has both day and boarding schools.

Table 3.2: Distribution of schools in terms of being day or boarding criteria

<table>
<thead>
<tr>
<th>Criteria for schools</th>
<th>Type school</th>
<th>Boys</th>
<th>Girls</th>
<th>Mixed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boarding school</td>
<td></td>
<td>3</td>
<td>9</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Day schools</td>
<td></td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4</td>
<td>10</td>
<td>16</td>
<td>30</td>
</tr>
</tbody>
</table>

Boarding schools are the majority (16) with the day schools being left with 14 schools. Most of the day schools are mixed schools leaving only one boy’s and girls’ mixed day schools.
3.3 Sampling procedure

This section tries to explain how the sample used was obtained. The criterion below was used:

Meru Central District was selected because it has schools both day and boarding thus not inclined to one type of school which may lead to biased results. The three categories of secondary schools in Meru Central District (boys, girls and mixed) were taken care of.

18 physics teachers from the sampled schools teaching form four classes were used. This also applied in case the schools with more than a single stream.

The names of the students who do physics were written on papers which were picked randomly. The required number of students was picked randomly.

The schools were grouped into boarding and day schools. These schools were further subdivided into boys, girls and mixed schools. In each group two schools were randomly selected.

Form four students in the selected schools in Meru Central district were the most ideal for using because they have already selected the subjects and have considered physics as one of those subjects. Form one and two have not selected the subjects yet. Form three students are also not the best because they have not completed the syllabus. Some physics teachers from the stratified randomly selected schools were used.

3.3.1 The sample size

Meru Central District was identified because it gave useful sample for collecting data. The researcher was familiar with the area which facilitated the administration and collection of
data efficiently and on time. This section deals with the total population of physics students and teachers that were used in this study.

**Number of schools:** Meru Central District has a total of 30 secondary schools. Out of these 30 schools, 10 schools were considered for this study. This comprised 33.3\% of the total schools.

**Table 3.3: Distribution of teachers and students to be used in the study.**

<table>
<thead>
<tr>
<th>Type of school</th>
<th>Boys</th>
<th>Girls</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target of students</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Sample students</td>
<td>80</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong> 160</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample teachers</td>
<td>10</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total</strong> 40</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source: D.E.O Meru Central District**

Meru Central district had 600 form four physics students by the year 2010. Out of this number 160 students were used from the sampled schools (26.67\%).

Three boys’ schools were sampled with a target population of 80 students. There were few girls used from the three sampled girls’ schools since the girls who had selected physics were fewer as compared to boys. Table 3.3 above shows that there are a smaller number of teachers in the sampled schools.
3.4 Research instruments

Three sets of instruments were used to collect data.

3.4.1 Physics teacher’s questionnaire (PTQ)

This instrument documented the academic qualification of teachers, their attitude towards practical work in physics and their teaching experience. The instrument also identified the attitude of physics teachers towards practical work and the factors that can be used to improve the quality of physics practical (Appendix A).

3.4.2 Attitude for physics students

This document sought information from students concerning their attitude towards practical work in physics and their opinions concerning theoretical work and practical aspects of physics (Appendix B).

3.4.3 Observation schedule

This document helped in establishing how the students carry out the physics practical. The main focus was on the process skills, manipulation skills, safety and procedure. (Appendix C). This document helped in identifying the quality of the practical that is carried out by students.

3.4.4 Interview schedule for physics teachers and students

The researcher conducted interviews with 6 form 4 physics students and 8 physics teachers of the sampled schools. The purpose of the interview was to supplement the information
obtained from the questionnaires. The oral interviews were in form of discussions between the researcher and the physics teachers and students.

This document was useful in obtaining views from students and physics teachers concerning their attitudes towards practical work.

3.5 Piloting the instruments

The instruments of the study were piloted in a girl’s high school in Meru Central District. The refined instrument was administered to the sample respondents in the main study. The piloting was important because

a) It improved the validity and reliability of the items used.

b) It helped in determining the difficulty level of the items in the instruments.

c) Was useful in estimating the time allocation for each item.

There were responses to every question. The results were analyzed after piloting.

3.5.1 Reliability and validity of instruments

The reliability and validity of the instruments was improved by piloting the instruments in a High School that was from a nearby district. The data obtained was coded. To improve the reliability the split half method was used to determine the correlation (r). Two sets of students of similar abilities were used. A mixed secondary school different from the schools sampled was used. The instrument was administered to 10 students; 5 boys and 5 girls that were selected randomly. The analysis of the data was done by grouping it into two halves for both boys and girls. Then the two halves were correlated. The correlation was 0.6 which meant the instrument was fine. The instrument is considered to be fine if it is above 0.5. The four instruments used in this study were correlated. The validity of the instruments was
improved by use of verified data such as that from the Kenya National Examination Council through the D.E.O'S office. After the release of KCSE results KNEC analyses the results and produces a report that is issued to school Validity was also be improved by use of experienced teachers and supervisors who read through the work.

3.6 Data collection procedure

This involved administering of the research instrument to the sampled schools. In order to minimize the Hawthorne effect, there were preliminary visits of the sampled schools. These visits were useful in creating a good rapport with the teachers and the students. Authority was sought from the principals of the various schools that were involved. The instruments were administered by the researcher during break times through the assistance of the physics teachers. The observation schedule was administered by the researcher during practical lessons with the guidance of the subject teacher.

3.7 Ethical issues in the study.

The information obtained from the physics teachers and students from the sampled schools was only meant to be used in this study. It was made clear to teachers and students that their identity would be kept confidential. Before any instrument was administered to the teachers and students, permission was sought from the principal. It was made clear to the principal by the researcher that the identity of the school will not be made open to the public who happens to come across this document.
3.8 Analysis of the data

The analysis was done section by section looking at each aspect of practical work separately. The data was analyzed using the frequency distribution tables and the percentages in analyzing the sample, ratio of boys and girls, physics teachers in terms of gender, scores of physics teachers and students towards physics practical, the resources that support physics practical, the various topics in physics syllabus that were covered or not, facilitation of physics practical work, utilization of practical skills and the skills used in physics practical lessons. The data was also analyzed using the coefficient correlation (r).
CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.0 Introduction

This chapter deals with data analysis, Presentation, interpretation and discussion of the findings. The findings are presented in the form of percentages, mean, pie charts and frequencies and organized into four themes derived from the research objectives.

The themes derived from research objectives are;

a) Relationship between performance in theoretical and practical aspects of physics.

b) Factors that can improve the quality of the practical work in physics.

c) Attitude of students and teachers to theoretical and practical aspects of physics.

d) The expectations of students on physics with respect to gender.

4.1 General information on schools in Meru Central District

Meru Central district comprises of three sex-categories of schools; boys schools, girls school, and mixed secondary schools. Since Meru Central is a new district most schools are day schools. Most of the schools in the district offer physics as one of the examinable subjects. Unlike other examinable subjects in the district physics has the lowest enrolment compared to other science subjects.
Table 4.1 Sample for the study

<table>
<thead>
<tr>
<th>Type of the school</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boys</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>C</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td><strong>Girls</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>E</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>F</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Mixed schools</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>H</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>I</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>J</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>104</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 4.1 shows the population of the physics students in the schools under this study. The boys' secondary schools recorded the highest number with the girls' schools recording the lowest number. A higher number of the respondents were from school A 17%, B 14%, H 14%, D 10%, F 10%, G 10%, I 10%, E 8% and C 7% respectively. School J did not return the scripts thus they recorded zero. This shows that except school C most of the boys' secondary schools had the highest respondents. The population of the students doing physics in this district is low as only 150 students in 10 secondary schools were doing physics. Some schools recorded as low as 7 students for example at school C out of a population of 145 students in form four.
4.2 Gender (population) among form four students

Physics as a science subject is expected to be done by both girls and boys. This study was interested in finding out the effect of gender to practical work in physics. The results are as indicated in table 4.2

**Table 4.2 (a) The ratio of boys and girls taking physics in study schools**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>76</td>
<td>73.33</td>
</tr>
<tr>
<td>Female</td>
<td>28</td>
<td>26.67</td>
</tr>
<tr>
<td>Total</td>
<td>104</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Out of 104 respondents 76 boys were taking physics (73.3%) against only 28 girls which is (26.67%). This means that physics is still a male domain.

The enrolment of girls in physics in secondary schools has been wanting for a long time (Mwangi, 1983). According to Hutching, (1973 girls are underrepresented in sciences particularly in physics and mathematics. Twoli, (1986) points out that there is a big gap between boys and girls in enrolment of science subjects mostly in physics and mathematics. The main reason has been related to the attitude of learners (Dekkers, 1991).

In order to find out if physics is meant for both boys and girls, the results in figure 4.1 were obtained;
Majority of the respondents 73.6% indicated that physics is meant for both girls and boys; however 26.4% of the respondents indicated that physics was supposed to be taken by boys. Some girls still believed that physics is a preserve for boys particularly those that are bright in class work. When the following question was put to students whether physics is meant for both boys and girls, a female student had this to say;

*Physics is meant for boys only as they perform well in mathematics. How can you separate mathematics from physics? The two are brothers. For the last five years the highest number of girls that has enrolled in physics is five against forty boys. Let the boys continue in physics and the girls shall opt for softer sciences. If there were no calculations in physics then majority of us would be very much in it.*

(From a form four female student in a mixed secondary school)
Though physics is meant for both boys and girls it is mostly dominated by boys. Girls have been adversely affected when it comes to opting for physics with the trend being that very few girls do physics and those few perform relatively poorer than their male counterparts (KNEC, 2007). Most of the girls associated physics with mathematics and argue that the two subjects are inseparable. The main calculations involved in physics make girls fear the subject. Kimura, (1992) carried out a study and found out that learning of physics requires a certain level of mathematical and spatial abilities. These mathematical and spatial abilities according to Kimura are limited in girls compared to boys. Twoli, (1986) while supporting this view points out that these differences in spatial abilities manifest after adolescence. Clark, (1972) carried out a study and found out that gender differences are particularly related to science interests. Boys are more interested in physical sciences while girls are more interested with biological sciences.

### 4.2.1 Teachers of physics distribution according to gender

The physics teachers were required to indicate the gender in physics teacher questionnaire. The study was interested in the distribution of physics teachers according to gender (Table 4.2(b) Table 4.2(b) Physics teachers by gender

<table>
<thead>
<tr>
<th>Teachers' sex</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>21</td>
<td>65.63</td>
</tr>
<tr>
<td>Females</td>
<td>11</td>
<td>34.38</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>100.0</td>
</tr>
</tbody>
</table>
The results revealed that majority were males, frequency 21 (65.63%) while females were 11 (34.38%). Role modeling has been found to have some impact on learning a subject. Female teachers play a great role in modeling girls in physics in secondary schools as they set a good example to them. Dekker’s, (1991) carried out a study and found out that there are relatively few female teachers teaching physics in secondary schools and hence girls and society at large lack what would be the most immediate female role models in physics education. One male physics teacher in form three in a girl’s secondary school when asked why there were few students enrolled in physics said;

_In this school there are four physics male teachers against one female teacher, who will these girls use as the role model? Girls in this school are only used to seeing male teachers teach physics. This has made these girls associate physics with men. How will I convince any of these girls that female students can equally do better as the male student counterparts? This is impossible. More female teachers should be willing to teach physics for the sake of these girls in order for them to emulate these teachers. Failure to do this will make physics remain a male dominated subject._

(From H.O.D. Physics department in a girl’s secondary school.)

4.3 Attitude of students and teachers towards physics practical

This study sought information from physics students and teachers about their attitude towards practical work in physics. Practical work is important in imparting skills such as psychomotor and process skills. The attitude of the students doing physics in the sampled schools was obtained using a five point Likert scale on items in the questionnaire (Appendix B). The results were first coded with the positive statements being coded as SA=5 and SD=1 the negative statements were coded as SD=1 and SA= 5. The mean obtained from students
was 3.8. This mean is above 3 which implied that the attitude of students towards physics practical was positive.

The mean for teachers was 3.12. This is above the mean which is 3 implying that the attitude of teachers towards physics practical is positive as shown in table 4.3

Table 4.3 Mean scale scores of Physics teachers' and students' attitude towards practical work in physics.

<table>
<thead>
<tr>
<th></th>
<th>Mean (maximum = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics teachers</td>
<td>3.12</td>
</tr>
<tr>
<td>Physics students</td>
<td>3.8</td>
</tr>
</tbody>
</table>

The mean scale score for the attitude of teachers towards physics practical was 3.12 which were positive but lower than that of students. A physics student in form four in a boy’s school had this to say concerning their attitude towards physics practical;

*We usually carry out a practical depending on the teacher’s mood at that particular time. If the teacher is not in good mood then he will keep on postponing the practical. Many a times we ask for a practical at the end of a topic but this entirely depends on the teacher. I wish the students can be allowed to carry out any physics practical without necessarily in the presence of the teacher. The practical helps in understanding some difficult topics.*

(From a male student in a boy’s secondary school)

From the observation physics teachers used practical work in teaching but lecture method was the most preferred method to them. Many physics teachers argued that the inadequate
facilities demotivated them from carrying out most of the experiments in physics. When the facilities are provided the teacher carries out the practical effectively.

### 4.4 Resources that support practical work in physics

Practical work in physics is supported by resources such as laboratory facilities, improvised materials, projects charts and diagrams. The physics students in form four were expected to indicate whether these facilities support practical work in physics and to what extent.

<table>
<thead>
<tr>
<th>Resources</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory facilities</td>
<td>39</td>
<td>34.8</td>
</tr>
<tr>
<td>Charts</td>
<td>10</td>
<td>8.9</td>
</tr>
<tr>
<td>Projects in physics</td>
<td>31</td>
<td>27.7</td>
</tr>
<tr>
<td>Diagrams used in physics</td>
<td>30</td>
<td>26.7</td>
</tr>
<tr>
<td>Improvised materials</td>
<td>2</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>112</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

The table above shows the various resources that support physics practical in secondary schools. It is evident from the table 4.4 that the students view laboratory facilities as playing the greatest role in supporting physics practical (34.8%), charts (8.9%), projects in physics (27.7%), diagrams used in physics practical (26.7%) and improvised materials (1.8%). This shows that the practical work in physics is generally supported by the laboratory facilities.
Most of the practical work in physics is carried out in the laboratory therefore making the laboratory one of the most important facilities in a secondary school. It is in the laboratory where the physics apparatus are stored in a store room while the practical work is carried in the common room.

Through practical work in physics many discoveries have come up that have led students to participate in science congress. One girl in a girl’s school when interviewed had this to say:

*This year in history I was able to take to National Science Congress Competitions at Nakuru High School physics presentation on ‘Electrical stimulation of a bull to ejaculate.’ This came as a result of the various practical that I carried out in the laboratory that this kind of a discovery was born. Surely through practical work in physics one can become a true scientist through various discoveries. This to me means the more a student is exposed to experiments in the laboratory the more one understands nature and the more the scientific discoveries.*

(From a physics female student in school B)

Walberg, (1991) supports this by pointing out that a laboratory gives students appreciation of the spirit and method of science, promotes problem solving, analytic and generalization ability and provides students with some understanding of the nature of science. This shows that in the absence of a laboratory the students may fail to understand the nature as they may not be able to analyze and understand various concepts in physics.

Since not all the schools can afford to establish a modern laboratory in schools, Twoli, (2006) gives a solution by emphasizing on the use of mini-labs. Many physics practical are not done by most of the schools in Kenya due to lack of enough resources such as the laboratories (Twoli, 1986). As one way of overcoming this problem science kits have been
developed and promoted for use in secondary schools. Science kits are quite small but very powerful in terms of performance. They can accommodate many experiments which a conventional laboratory cannot accommodate.

Most schools seem to have fewer charts (8.9%). Some concepts can be well explained when charts and diagrams are used particularly when the concept is abstract. A physics teacher in a secondary school that lacks sufficient equipments in the laboratory can easily utilize the charts in order to transfer information to learners. A male physics teacher who was interviewed had this to say concerning the utilization of charts:

*When teaching on the topic of force on a current carrying conductor, a chart becomes very useful as the school cannot afford to buy some devises such as magnetic relay. A chart that is elaborate, clear and visible usually makes teaching easy for me as I can explain concepts while at the same time showing the students the same in a diagram. I have a good number of charts in each class that are hang on the walls of the classroom in order for them to refer to even in the absence of the teacher. In the presence of these charts in the classroom, every time is learning time.*

(From a physics teacher in physics department)

This is supported by Twoli, (2006) who said that with visual aids the words acquire a more concrete meaning which makes it easy for the learner to visualize the words which could be a description. The visualization process involves observation and internalization of the visual aid, thus making the idea or description concrete. A model can be used as a visual aid which makes the learners to internalize and visualize the concept.

The use of improvised materials recorded the lowest percentage. This means that both teachers and students do not improvise incase of scarcity of the conventional materials. This
has contributed to low performance in physics as most teachers mostly rely on theory knowledge at the expense of practical work. A female physics student in girl’s secondary school who was interviewed on improvisation said;

*What is improvisation? We usually carry out any physics practical depending on the availability of the apparatus in the laboratory. If there are no apparatus for a particular practical then the teacher uses lecture method waiting for the apparatus to be bought. If for any reason the apparatus are not bought, then that experiment is done away with. I have never seen our physics teacher trying to use locally available resources to supplement the conventional materials. Our physics teacher has not involved us in utilization of locally available resources in case of scarcity of conventional materials.*

(From a female physics student in form 4)

This is supported by Iraki, (1994) who says that improvisation can be a key solution by both teachers and students to participating in physics practical. Improvisation helps the students in ensuring that students perform as many practical as possible in physics which boosts the performance in physics.

Participation of students in physics projects is utilized at 27.7% in supporting physics practical work. This means that physics teachers use projects as a method of teaching. Compared with others in the table the projects are mostly utilized. The projects give both physics students and teachers a good exposure to the society and the immediate environment. Projects enable teachers and students to link the concepts learnt during theory work with the environment. This is supported by Twoli, (2006) who says that project work has been linked to many useful learning experiences and efforts should be made to encourage teachers to arrange some project work for their students. Due to the importance of
Project work in physics the syllabus encourage the undertaking of project work at the end of any main topic. Teachers are encouraged to sample and engage their students in as many projects as possible.

A female physics teacher who was interviewed said;

\[\text{At the end of every topic in physics I have to engage students in carrying out a project. This has greatly resulted to improved results in physics. When students participate in project work they can easily link the information acquired during the theory lesson with the project. The form fours physics students are working on a project of making a simple d.c. electric mortar using a bicycle dynamo and used dry cells. This is after completing the topic on electromagnetic induction in form four physics syllabus. Projects are very important in physics and should not be ignored.}\]

(From a form 4 physics female teacher)

Project work is a measure of how capable and responsible a student can work with minimum supervision. Students should regard project work as an opportunity to show their ability in dealing with an independent piece of work. Project work trains the students in designing a practical investigation or problem solving strategy with suitable controls, sampling procedures and presentation.

4.5 Various experiments in physics curriculum that are a priority

The respondents were required to indicate whether the various physics experiments were covered or not, they were expected to use a tick for done and cross (x) for not done. The results were presented as in table 4.5.
Table 4.5 Indication of whether various experiments in physics curriculum were covered or not

<table>
<thead>
<tr>
<th>Experiments done</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>90</td>
<td>86.00</td>
</tr>
<tr>
<td>NO</td>
<td>14</td>
<td>14.0</td>
</tr>
<tr>
<td>Total</td>
<td>104</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Majority of the students supported that most of the physics experiments that were supposed to be done (86%) while another 14% of the respondents indicated that the physics practical were not covered. In total 104 students participated in the study with the respondents from the boy's schools having (60), girls (9) and mixed schools (35). This shows that the highest respondents were from the boy's schools.

The findings evidently showed that most of the experiments in physics syllabus were done. Particularly the experiments and projects that are found at the end of every topic in physics syllabus were covered. This does not reflect the performance of learners in physics in K.C.S.E. This means that the physics experiments done did not serve as a solution to the deteriorating physics performance. The quality of the experiments being done could be the problem. The importance of practical work in physics is greatly emphasized by the K.N.E.C
(2007) who points that in order for a candidate to acquire grade B minus and above in overall physics examination the candidate should have acquired grade D+ and above in physics practical.

A form four student in a girl’s school when asked how often they carry out experiments replied;

Most of the experiments in physics are done through demonstration. This means that we do not have a direct touch with the apparatus as the teacher does the experiment alone or involves only few students. At other times when there is physics practical the students are left either alone or with the laboratory technician. We usually lack the guidance from our teacher. We usually make so many mistakes in the process of carrying out the experiments. How can I be able to draw the graphs in physics if I am not guided by the teacher? Worse is the answering of the questions after every practical. For quality work in physics practical the teacher must be involved.

(From a form 4 physics female student)

This is quite a concern and might be one of the causes of poor performance among students in physics even with the many practical work that is covered in class.

During the practical both the teacher and the students play a key role in order to ensure there is high efficiency of the practical. The teacher can use a variety of methods during the physics practical such as laboratory experiments, demonstration and project work in order to ensure that the set objectives for the practical are achieved. Over utilization of one method such as demonstration may result to students not being well involved.
4.6 Facilitation of practical work in physics

Physics practical cannot be complete if physical facilities, teacher’s guidance, equipments and contact time between the teacher and the learner are not put into consideration. The respondents (teachers and students) were required to record the factors that hinder the facilitation of physics practical. The results are as recorded in table 4.6

Table 4.6 Factors that hinder facilitation of practical work in physics.

<table>
<thead>
<tr>
<th>Facilitation of practical of practical work in physics</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate physical facilities e.g. labs.</td>
<td>31</td>
<td>41</td>
</tr>
<tr>
<td>Inadequate teaching and learning materials.</td>
<td>30</td>
<td>40.5</td>
</tr>
<tr>
<td>Guidance by the teacher.</td>
<td>6</td>
<td>8.1</td>
</tr>
<tr>
<td>Use of unfamiliar physics equipments and apparatus.</td>
<td>2</td>
<td>2.7</td>
</tr>
<tr>
<td>Contact time with the teacher.</td>
<td>5</td>
<td>6.8</td>
</tr>
<tr>
<td>Total</td>
<td>74</td>
<td>100.0</td>
</tr>
</tbody>
</table>
The results show that the most restricting factor for physics practical from being done was inadequate physical facilities like the laboratory (41%). This means that lack of laboratories in schools is one of the main reasons as to why many students do not do the physics practical which lead to poor performance in physics. A laboratory is very important in physics as most of the practical work is carried out there. Twoli, (2006) refers to the laboratory as a place where logical and accurate observation is of great importance, where precise measurement or recording aids observation, where controlled conditions make it possible to conduct experiments from which clear conclusion can be drawn. Only by experience in the laboratory it is possible to understand the nature.

When students participate in a series of experiments they acquire knowledge in process skills such as observation, communication, recording and prediction of data. Most experiments in physics involve observation and recording of data. For instance in form four physics syllabus the students are involved in determining the focal length of concave and convex lenses. Students observe what happens to the image distance when object distance is varied. The image length and object length are recorded in a table. Interpretation of the results is done by drawing the graph using the data obtained. Conclusions are drawn from the graph. In this particular experiment for determining the focal length of a lens a conclusion like this can be made, \( \frac{1}{f} = \frac{1}{v} + \frac{1}{u} \) where \( f \) is the focal length, \( v \) is the image distance and \( u \) is the object distance.

Monk and Osborn, (2002) support the idea that a laboratory is a very important resource in understanding of sciences since it links the theoretical work and the practical work. The
emphasis on the use of a laboratory has been associated with so much significance such as
development of practical skills, development of scientific way of thinking, developing a
positive attitude to learning and natural environment. Many schools do not have laboratories
and others have converted classrooms to laboratories. One male physics teacher in a mixed
secondary school when asked how a laboratory is useful in his school said;

_In this school we do not have a laboratory we only have classrooms. He further said that in case of a practical he
usually organizes it in a classroom. The equipments and apparatus needed are usually carried by students and taken to
the classroom for a practical. The space is limited and facilities such as water and electricity systems are nowhere to
be found. My students only hear of a laboratory but they have not seen one yet. If a laboratory was available the many
experiments that I do not carry out with students would be done. Schools with laboratories have a great advantage as far
as sciences are concerned._

(From a physics male teacher in science department)

Twoli, (2006) points out that the situation regarding science laboratories is in a worse
situation in smaller schools than in big schools. In some day schools there is only one
laboratory which is used for the three sciences that is physics, chemistry and biology. This
brings about confusion and competition for the usage of the laboratory among the three
sciences. Some disadvantaged schools have a room with bits and pieces of equipment for
physics, chemistry and biology that is referred to as a science room. These rooms are
improvised from classrooms churches and dormitories. A good and well designed
laboratory should contain a common room, preparation room, storage room gas supply,
water supply and the fume cupboard (Twoli, 2006). These make the laboratory to be
complete.
Another group of respondents (40.5%) pointed out that the other restricting factor was inadequate teaching and learning materials. Most of the teaching and learning materials that are used in physics practical can be categorized as measuring instruments such as those meant for measuring time, temperature, volume density, mass and electricity. Inadequate learning materials even in the presence of a good laboratory may not fully help in physics practical. In most of the schools there was a scarcity of some materials that are needed in a given experiment. In one of the boy’s provincial secondary school in the district, one physics teacher interviewed said;

*Our school is lucky to have five laboratories each science subject having its own. The only hindrance to carrying as many experiments as possible is that most of the materials needed during a particular practical are the lack of enough materials needed. For example measuring instruments such as potentiometer have never been found in this school. Incase of a practical requiring such kind of an instrument the teacher might be forced to teach only theoretically. There is a long process that requires to be followed in order to order for some materials. Whenever the department asks for more science equipments to be bought the only answer received is that the department should wait a little longer.*

(From the H.O.D. physics department)

Materials when used in learning provide learners with an opportunity to find solutions to the many questions they might be having. These questions can be useful in clarifying otherwise concrete concepts. When the materials are available the learners can easily use discovery approach as a method of teaching. Kyallo, (1984) observes that lack of adequate apparatus makes science teaching and learning ineffective and uninteresting and the teaching becomes too involving if one has to make apparatus. This shows that practical work cannot continue well without the availability of the necessary materials.
One solution to the lack of the conventional materials in the laboratory is the use of improvised materials. Improvisation can be exercised by the physics teacher, students or the technician. Improvised materials are usually made from locally materials or using those of low cost. When improvisation is well utilized the students are able to do a variety of experiments. Leonard, (1989) supports the use of improvised materials because as the teacher makes a resource it gives him/her an opportunity to review the concepts that will be emphasized when using the resource. A modified resource can be used by the teacher to revise the work that has already been taught theoretically.

Charts are also important materials that are used in practical work in physics. Charts can either be teacher made or commercial. Either of the two serves the same purpose. During practical time the teacher can write the procedure on a chart that is visible to all the students in a given lesson. The charts are very useful particularly if the procedure involves a diagram. The chart used should be big enough in order to improve on the visibility.

A physics teacher is very instrumental in any form of experiment that is carried out in the laboratory. In the presence of the teacher the student gains confidence and any form of guidance that the student may require will come from the teacher (Twoli, 2006). The student can easily refer to what he/she was taught during the theoretical lesson. SMASSE, (2002) supports the importance of a teacher during the physics practical. According to SMASSE a physics teacher should consider the following when determining the type of practical that should be done by the student; acquisition of knowledge, skills and attitudes. This is because physics is a practical oriented subject and should target the development of manipulative skills in the learner besides acquisition of knowledge (Leonard, 1989). The physics teacher should also consider the cognitive level of the learners in determining the kind of practical
he/she should carry out with the learners. This can be achieved if the teacher uses simple looking experiments that capture the attention of the learners.

In order for the physics teacher to achieve the objectives set, one must rehearse the same practical before it is done by the students. SMASSE, (2002) points out that rehearsing the practical by the physics teacher is very important as it enables him/her to establish whether the practical works or not and identifies the safety threats in case of any. A male physics teacher who is the H.O.D. when interviewed on the importance of the presence of teacher during physics practical said;

The presence of a teacher during physics practical is very necessary as the teacher is expected to assemble the apparatus and ensure that they are enough for a given number of students. The teacher should be moving round the groups guiding them in case of any difficulty. Some instruments such as ammeters might be faulty and the teacher has to replace them. There might arise some safety threats in the process of carrying out the practical. For example in practical involving electricity safety threats such as fire and electrocution may arise. The teacher is expected to offer a solution. Some instruments are very delicate and can easily be damaged in case of wrong connections or using excessive current, such instruments are like the galvanometer, ammeter, voltmeter, Milliammeter and potentiometer.

(From H.O.D. physics department)

The teacher should guide the students after the practical on how to draw the graphs since most of the experiments in physics are analyzed using graphs. One female physics student when asked why she needs the teacher during the physics practical said,

How can I be able to draw the graph after collecting the data, sometimes we have straight line graph and at other times we have graphs that are curves? The practical may fail to work and the results are expected from you. Incase of damages of
the instrument the presence of a teacher is very necessary. Sometimes one does not understand the procedure due to the terms that are used such as swirling the test tube.

(From a physics female student)

Other than the graph drawing, students also required the guidance of the teacher in making conclusions. After drawing the graph there is a conclusion that is derived from the interpretation of that graph. For example in experiments involving electricity using an ammeter, voltmeter, rheostat, battery, switch, nichrome wire and connecting wires, a graph of potential difference against the current gives a straight line graph. A conclusion can be drawn from this graph by determining the gradient of this graph and be stated as; the current passing through a conductor is directly proportional to the potential difference applied across it provided that physical conditions such as temperature are kept constant. A student needs the teacher’s guidance in order to come up with such kind of a conclusion.

A smaller percentage (2.7%) of the respondents pointed out that the use of unfamiliar physics equipments and apparatus posed a problem in the facilitation of physics practical. Most of the instruments that were not in adequate supply in many schools are those involving electricity such as potentiometers and galvanometers. Galvanometers are used in form three in the topic of “Current electricity 2” while potentiometers are mostly used in form four in the topic of electromagnetic induction. Another field in physics where there is scarcity of apparatus is in heat and mechanics. For example micrometer screw gauge is one of the instruments used in determining the diameter of small substances such as a wire. Length is a basic physical quantity that is supposed to be taught in form one physics syllabus.
K.N.E.C, (2001) pointed out that many of the students did not read correctly the current that was recorded by the galvanometer in K.C.S.E. A survey carried out by K.N.E.C, (2007) revealed that some students only happen to find some instruments during the final examination. This means that most of the physics teachers do not introduce the basic instruments to students when introducing physics syllabus in form one. Due to the great use of unfamiliar instruments during the final examinations K.N.E.C, (2007) during the physics practical, the students have been performing dismally in K.C.S.E. Panic and lack of confidence among students during the final physics examination is contributed by use of unfamiliar instruments during examinations.

Some respondents (6.8%) said that lack of enough contact time between the teacher and the students during physics practical was one of the greatest problems in the facilitation of physics practical. The presence of the physics teacher during the practical is very important to the students. The role of the teacher during the practical has been taken over by the science technicians. Twoli, (2006) supports the work of a technician by saying that a laboratory assistant should understand the lab- management, experiments and be familiar with the equipment and procedures if they are to help the teacher and students well enough. The science teacher should work closely with the lab- assistant in order to help the students during the practical.

The findings discussed in this section imply that, despite the increased number of high school physics teachers in Kenya, derisory facilitation for curriculum implementation and need for more resources remain a challenge in schools, compromising effective teaching.
4.7 Contribution of physics practical to the performance in final examination

The respondents were further required to explain if they were aware that physics practical affect the performance in final examinations. The students were requested to record whether the physics practical contributes in any way to the final grade that one acquires in physics examination. The results are as indicated in figure 4.2 below.

![Pie chart](image)

**Figure 4.2 Contribution of the physics practical's to performance in final examinations**

Majority of the respondents, 68% strongly disagreed that physics practical contribute to performance of the main grade, 15.33% disagreed, 3.33% not sure, 3.33% agreed, 10.01% strongly agreed. Majority of the students interviewed did not know that physics practical was important in determining the final physics grade in K.C.S.E. Physics practical is ignored because it is only assigned 40 marks while theoretical papers are assigned 160 marks (KNEC, 2007). This makes the learners to concentrate more on theoretical papers at the expense of the practical paper. This misconception of the students concerning the practical
because it is only assigned 40 marks while theoretical papers are assigned 160 marks (KNEC, 2007). This makes the learners to concentrate more on theoretical papers at the expense of the practical paper. This misconception of the students concerning the practical has led to students performing poorly in their final examinations. One male student interviewed on the importance of physics practical said;

*Physics practical is important but not as important as the theory papers. Why should I put more effort in practical paper which constitutes only 40 marks while paper 1 and paper 2 have a total of 160 marks? This means that the physics practical paper is only \( \frac{1}{4} \) of the theory papers. The practical paper covers only 2 topics while the theory papers covers across the entire physics syllabus.*

(From a physics student in a boy’s school)

K.N.E.C, (2006) released a report to the secondary school heads showing the analysis of the results of the year 2005. In this report the K.N.E.C recorded clearly that science subjects are boosted by the practical paper. This is because sciences such as physics are practical oriented subjects and emphasis should be put in the practical paper. In order for a student to acquire grade B- in the overall grade in physics in K.C.S.E one ought to have acquired grade D+ in the practical work (KNEC, 2007). This shows that one can easily fail in the overall physics paper having passed very well in theoretical papers but failed in the practical paper. The importance of the practical paper is also reflected in the 2 1/2 hours’ time allocated for the practical paper while paper 1 and paper 2 theory papers are each allocated 2 hours in K.C.S.E.

One of the female physics teachers who were interviewed further explained how theoretical and practical aspects affect performance in school physics. This is what she said;
4.7 Contribution of physics practical to the performance in final examination

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![Figure 4.2 Contribution of the physics practical's to performance in final examinations](image)

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Physics teachers should be increased per stream in every school so that one teacher may be assigned the practical lessons and the other teacher the theory lessons. This will ensure that one teacher is not overburdened with lessons. The teacher should create more time with students during the physics practical, and the teacher should encourage the students to do the practical. The practical should be done after every theory session, and more physics apparatus should be increased.

(From a female physics teacher)

Leonard (1989) and Padilla (1983) also observed that the use of the laboratory investigation to teach formal reasoning improves significantly the ability of students to use formal operational thought. Consequently the teacher’s teaching objectives are not effectively achieved if learning through laboratory work is not applied. The results indicated that students fear practical work in physics and they don’t like performing experiments.

Most students have a problem in writing a report after practical work. This is because report writing is associated with a series of procedures and requires the guidance from the teacher. The presentation of data requires that it be organized systematically in order to achieve reasonable results.

One category of the experiments done in physics involves use of electricity and heat. Students associate the experiments involving electricity with safety threats such as burns and electrocution.

4.8 Significance of the use of a laboratory in development of practical skills

The respondents were required to state how the use of laboratory in teaching of physics is beneficial to the development of practical skills and scientific way of solving problems. The respondents were expected to record whether the skills acquired during physics practical are utilized or not. The results are as shown in table 4.8
Table 4.7 utilization of practical scales from the laboratory during experiments

<table>
<thead>
<tr>
<th>Skills used or not used</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skills are utilized</td>
<td>23</td>
<td>76.66</td>
</tr>
<tr>
<td>Skills are not utilized</td>
<td>8</td>
<td>26.34</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>31</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

The findings of the study indicated that three quarter (76.66%) of the respondents were aware that skills were utilized and had effect in performance in practical. The other quarter (26.34%), indicated that the skills were not utilized which resulted to negative attitude to the students, hence had most effect on theory and practical examination.

4.9 Skills acquired during physics practical

A number of skills were observed by the researcher during physics practical such as observation, measurement, recording, analyzing and making conclusions.
Table 4.8 Skills used in practical physics lessons

<table>
<thead>
<tr>
<th>Skills</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement of basic quantities.</td>
<td>48</td>
<td>45.7</td>
</tr>
<tr>
<td>Handling of apparatus during physics practical.</td>
<td>12</td>
<td>11.4</td>
</tr>
<tr>
<td>Observation</td>
<td>11</td>
<td>11.3</td>
</tr>
<tr>
<td>Recording of data obtained from the experiment.</td>
<td>9</td>
<td>8.6</td>
</tr>
<tr>
<td>Analyzing of data from the experiment.</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Making conclusions from data obtained.</td>
<td>14</td>
<td>13</td>
</tr>
</tbody>
</table>

Measurement is one of the key skills that are acquired during the physics practical. Measurement of basic quantities such as length, time and current is key during the physics practical. These concepts are taught as early as in form one and continues up to form four. Inaccurate measurements implicated an error which leads to low grade hence poor performance. This was brought up by 45.7% of the students from the sampled schools. Poor measurements during physics practical lead to poor conclusions and interpretation of the
data. The nature of the graph drawn from the data obtained greatly depends on the measurements recorded.

Breakages of apparatus during the physics practical are due to poor handling of apparatus. This was brought forth by 11.4% of the students used in the study. This leads to incompleteness of the practical because there are few apparatus and with no replacement.

When the apparatus are not stored in the right way they can easily be lost and the time spent in looking for those apparatus results to wasting of time that would otherwise been used for the practical. Equipments can well be stored in a cupboard in the store room in order to minimize the breakages and to facilitate the physics practical.

Another 11.3% of the respondents explained that poor observation during experiments should be guided on how to make correct observations during physics practical. One student in a boy's school said that he usually performs poorly in physics practical due to poor observations made particularly in the area involving electricity. This can be corrected by involving students with as many experiments as possible.

When the data obtained is wrongly recorded, the interpretation of the graph becomes incorrect. A small percentage of the respondents (8.6%) pointed out that recording of data during physics practical poses a problem. This is because the data is supposed to be recorded in a systematic way. For instance practical work in the area of mechanics has their data being recorded using different units. For example in a micrometer screw gauge the units used are in millimeters (mm) for example 30mm and not in any other units. In Vermeer calipers the measurements are recorded in centimeters (cm) and not in any other unit. A girl in form 4 class had this to say concerning recording of data;
When carrying out a practical in physics the assembling of the instruments is not difficult as there is always a diagram to guide you. Everything else requires following the instructions given and the whole process will be easy. Recording the data poses the greatest problem. For example in a practical that requires the use of an ammeter and a voltmeter, the data needs to be recorded in a given manner. For instance if one observed the reading of a voltmeter as 3volts the measurements should be recorded as 3.0 V and not 3V. In case of a stopwatch for instance the readings observed are 00.45.56 if recorded exactly as observed then the data would be wrong. The correct way of recording this time from a stopwatch would be 45.56 seconds. This requires one to be knowledgeable on recording of data during a practical.

(From a female physics student)

Analysis of data poses a big problem to students during physics practical (10%) of the respondents explained that poor analyzing methods lead to wrong conclusions hence poor performance and this was a challenge to physics performance. When the data collected is not well analyzed the conclusions made are usually wrong. Graphs are commonly used in analyzing the data during physics practical. Students need to have knowledge in graph drawing and identifying the best graph that can be used depending on the type of data obtained. Most of the graphs in physics are either in form of a curve or a straight line.
CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the main findings

The theoretical and practical work in physics is equally important in determining the overall grade during the Kenya Certificate of Secondary Education. Therefore both papers should be given equal effort. More awareness campaign about the importance of physics practical need to be done among students. Many of the students lack the awareness of the importance of the practical examination paper during the final examination. The practical paper greatly influences the final grade one gets. This means that as much as theory is important in physics, practical work is not any less important. This is because through practical work in physics one acquires manipulative and process skills which are very important in industrialization.

Physics students encounter a lot of challenges including sharing of few apparatus, few laboratories, few text books, few materials and equipments. Despite these challenges, these students are making great effort in order to improve in their performance in physics. The schools with inadequate education facilities like a laboratory have to put in a lot effort to build self confidence, self esteem, personal understanding, modification of apparatus, and positive self –concept which motivates them to success. The teacher should support physics students to learn and perform the physics practical.

Sometimes students are discouraged by the physics teachers because the teachers also believe that physics is supposed to be done by those students that are good in mathematics.
This has discouraged many students who had interests in physics but do not do very well in mathematics. The result of this is that the careers of these students are greatly affected particularly if those careers require physics subject

Lack of enough contact time of students with teachers affects the performance in practical work in physics. Students are left alone carrying out the practical with no one to guide them. Some Physics teachers lack enough time with students during physics practical which greatly affects the outcome of the practical.

Poor attitudes towards teachers directly contribute to poor attitudes of students in physics. Some teachers discouraged students by failing to guide them during the practical work particularly when the practical is complicated. Monk & Osborne, (2002) points out that the attitude of a teacher towards a given subject mostly depends on the motivation of that teacher towards that subject. Most teachers will fail to carry out the practical incase the facilities are not adequate. If the attitude of a teacher towards a given subject is poor, then the same will be passed on to the students.

The expectation of students on practical work in physics is that it should be for both genders. The physics practical is appreciated by both genders. The findings of this study have revealed that boys participate more in physics practical than girls which is an indication that physics is not gender sensitive.
5.2 Conclusions to the study

Physics teachers are willing to conduct a lot of physics practical but they have a limitation in time and resources. Lack of resources such as the laboratory in schools affect the acquisition of skills and knowledge and hence performance. The findings of this study show that most of the schools lacked laboratories and those that had them lacked the basic equipments. Due to insufficient resources needed in carrying out the practical, it was revealed from this study that both physics teachers and students were not willing to improvise incase of shortage of the conventional resources which led to many practical not being carried out. Through practical work in physics students acquire manipulative and process skills which are important in areas such as vehicle assembling industries and in aviation. This shows that various careers require skills acquired during practical work in physics. Aviation and mechanical engineering require skills acquired in practical work in physics that deal in mechanics. Physics is a practical oriented subject that enables the students to acquire skills during practical work. Psychomotor skills such as manipulation of instruments cannot be acquired by teaching students on how to handle the instruments but through practical work. Students need to be exposed more in practical work in order to understand the nature. Woolnough, (1976) supports this by pointing out that for adequate teaching of physics learners need to be allowed an opportunity to have a feel of practical lessons that helps them develop their psychomotor skills.

Piaget , (1972) carried out a study and found out that the failure of traditional schools in natural sciences was due to systematic negligence in training students in experimentation. This shows that learning of sciences must be accompanied by experimentation.
Attitude is useful to the learners and teachers to invest time in learning physics. The study has shown that the mean attitude of students towards physics was 3.8 while that of physics teachers was 3.12 which were slightly above average. In order for students to perform well in physics their attitude should be boosted by the teachers, B.O.G and the ministry of education. Lack of both physics teachers and students having a positive attitude are caused by lack of enough physics teachers, facilities and unfamiliar apparatus that are used during physics practical examinations. A study carried out by Hutchings, (1973) reveals that the performance in physics practical is greatly improved if positive attitudes are encouraged in terms of relatedness of topics in physics syllabus and inculcating the needs of the society. Negative attitudes in students occur when the teacher concentrates on teaching the theory work in classroom only while ignoring the practical work. Twoli, (2006) supports this by pointing out that in an ideal situation lecture method should be used very sparingly while emphasizing on practical work for wider learning experience and in order to inculcate positive attitudes among students. According to Maritime, (1972) school achievement is a multi-dimensional concept besides being dependent on the child’s social and economic background, school facilities, mental abilities and personality; it is also dependent on student’s attitude.

The role of the physics teacher is important during practical work. There is very little that can take place in practical work without the guidance of the teacher. The teacher supervises the practical and helps in the interpretation of the results in a given practical. The acquisition of the skills and knowledge from a practical depends entirely on the role played by the teacher in that practical. The findings of this study have shown that students are mostly left
alone or with the laboratory technician which makes the students lack the guidance and supervision during the practical work in physics.

Boys have greatly dominated physics in secondary schools with a very small percentage being left to girls. The findings of this study have indicated that girls have opted for other science subjects (biology and chemistry) instead of physics leaving physics to be a boy’s dominion. It is also evident from this study that there are few female teachers that teach physics in secondary schools. This has greatly affected the enrolment of girls in physics particularly in girls’ secondary schools.

5.3 Recommendations:

5.3.1 Recommendations for Action

a) The laboratories in secondary schools greatly help students in acquiring knowledge and skills that are needed in areas such as industries and therefore the principals of secondary schools should ensure that they are equipped. Lack of enough laboratories and equipping of these laboratories is a key challenge in practical work in physics. The physics teachers should utilize the laboratory more in order to develop practical skills such as measurement and recording of data.

b) Sensitization of students on the importance of practical work in physics is necessary. This can be achieved through use of elaborate projects and audio-visual materials.

c) The attitude of the students towards practical work in physics is very important. Positive attitude drives the students towards having a great liking for the practical work in physics which improves the performance. The physics teachers and the principals of
secondary schools should come up with ways of cultivating positive attitude towards practical work in physics.

d) Physics is a practical oriented subject and therefore is supposed to be taught using practical approach rather than the lecture method. The physics teachers should not over emphasize on theory work leaving behind practical work. The physics teachers should therefore come up with measures geared towards revising the curriculum to help in improving practical work in physics.

e) The confidence and courage in students can be cultivated by doing as many experiments as possible. Practical skills such handling of apparatus can be improved if the learners are involved in as many experiments as possible. Physics teachers should ensure that the students do experiments particularly those that are found at the end of every topic in physics syllabus. The students and physics teachers should be sensitized that physics practical is meant for both boys and girls. Practical work in physics and the choice of practical to be done does not depend on gender. Numerous seminars, workshops and induction courses should be organized by the ministry of education to achieve this.

f) Girls have associated physics with boys leaving the girls to opt for other subjects. Through seminars and workshops the stakeholders can take initiatives to create awareness to students on the importance of physics to both genders. This will improve the enrolment of girls in physics.
5.3.2 Recommendations for further research

This study has looked at practical work in physics and how it affects the performance in physics examination.

The study has also pointed that practical work is very important. The geographical coverage of this study was Meru Central District which is one of the districts in Meru County in Kenya. The same research can also be carried in other districts in order to ascertain the validity and the reliability of the findings in this study.

This study has shown that a functional laboratory is very significant in development of practical skills. A further research can be carried out to determine the number of schools that have well equipped laboratories. This will help the government in establishing policies that will be meant to building more laboratories and equipping them.

Many schools do not carry out the experiments due to lack of enough finances to establish laboratories in schools those that have laboratories lack the necessary facilities. More research can be carried out to determine the allocation of funds in secondary schools in order to determine how the schools can be assisted in terms of funding. This will help in eliminating the classes of schools with the haves and the have not.

The study has found out that girls shy away from physics leaving it to boys. An investigation to find out the extent to which the enrolment of girls affects their performance in physics is necessary. This will help in increasing the number of girls that enroll for physics.
According to this study most of the experiments in physics are usually done. This is not reflected in the performance in final examinations. More research needs to be done to establish the factors that can be used to improve the practical work in physics.

The attitude of both teachers and students has been identified as being key in this study towards practical in physics. A further research can be carried out to determine the effect of the attitude of the teachers and the students towards practical work in physics.

At the end of every topic in physics syllabus there is a project that is supposed to be carried out to facilitate the retention of theory work that is taught in the classroom. Further research can be carried out to determine the utilization of the policies that have been set up by the ministry of education and other stake holders concerning practical work in physics.
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APPENDICES

APPENDIX A

PHYSICS TEACHER'S QUESTIONNAIRE ON PHYSICS PRACTICAL.

The performance of students in physics in Kenya National Examination Council has been deteriorating since the year 2002. One of the contributing factors of these results could be attributed to the practical in physics. In K.C.S.E examination the practical plays a key role in determination of the final grade. In order to help in improving the results, you are requested to fill this questionnaire as honestly as possible. Any information you provide will be kept confidentially and will be used only for this study.

SECTION 1: BACKGROUND INFORMATION

(TICK ONE AS APPROPRIATE)

1. Name of school ____________________________

2. Gender (I ) male ☐ female ☐

3. Type of school (i) boys ☐ (ii) girls ☐ (iii) mixed ☐

4. Number of science laboratories in your school (write the number in the provided box) 1

   2 ☐ 3 ☐ 4 other ☐

5. Professional qualifications

   (i) B.E.D ☐

   (ii) B.S.C ☐

   (iii) DIPED ☐

   (iv) Others specify ☐
6. Which class do you teach physics?

Form 1 [ ] form 2 [ ] form 3 [ ] forms 4 [ ]

7. Number of years of teaching experience _______________________

SECTION II: QUESTIONS

How does the practical contribute to the performance in physics? Below are some possible reasons for the low performance in physics. For the letters SA (strongly agree), A (for agree) NS (for not sure), D (for disagree), SD (for strongly disagree). Tick the appropriate box.

<table>
<thead>
<tr>
<th>REASONS</th>
<th>SA</th>
<th>A</th>
<th>NS</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Students consider theory work to be more important than practical work in physics.</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2. Some students do not like performing some experiments in physics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Lack of resources in the laboratory makes students fail to do physics practical.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Students hate writing a report after practical.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. Physics practical with many connecting wires scare students.

7. Girls fear the practical involving magnetism and electricity.

8. Most of the teachers teaching physics in schools are females.

9. Students believe that they can do without practical work in physics.

10. Students believe all physics practical pose safety threat.

11. Improvisation is very expensive.

12. Students hate physics practical due to many graphs that needs to be drawn.

13. Procedures in physics practical are complicated.

14. Students believe interpretation of graphs in physics practical is complicated.

15. Students fail to follow instructions given in the physics practical
APPENDIX B

PHYSICS STUDENT'S ATTITUDE TOWARDS PRACTICAL WORK.

In secondary physics syllabus, experiments are emphasized. We are interested in knowing your feelings about physics practical. The information you will provide shall be kept confidential and used only for this study. Honestly answer the questions given below;

SECTION 1: BACKGROUND INFORMATION

1. Name of your school
   __________________________

   Class __________________________

2. Type of school: Boys □   Girls □   Mixed □

3. Gender: Boy □   Girl □

Section II: Tick appropriately

Read the following statements about physics practical and against each statement are letters SA(strongly agree), A(for agree), NS(for not sure), D(for disagree), and SD(for strongly disagree). Tick the most appropriate depending on your feelings

1. Practical work in physics is equally important as theory work.
   [SA]   [A]   [NS]   [D]   [SD]

2. I enjoy doing physics practical
   [SA]   [A]   [NS]   [D]   [SD]
3. Practical work in physics is difficult.

4. Instructions given in physics are very complicated.

5. Practical work in physics is meant for both boys and girls.

6. Physics practical involves use of complicated apparatus.

7. The practical becomes easy when few apparatus are used in that practical.

8. Physics practical is only meant for schools with laboratories

9. Physics teachers discourage students from doing experiments

10. Physics practical do not contribute to the overall grade in K.C.S.E.

11. Physics practical do not in any way influence one's choice of carrier

12. Physics practical demotivates students due to lack of enough resources.
13. The physics students lack enough guidance during physics practical.

14. Materials and equipments used during practical are unfamiliar.

15. Most teachers who teach physics in secondary schools do not have enough time for the students.

16. Majority of the teachers who teach physics are males.

17. Physics practical is only meant for bright students.

18. Practical work in physics is only important during the final examination.

19. The practical work in physics is not important in understanding the theory.

20. Girls lack role models due to lack of female teachers in most of schools to teach physics.
SECTION III

In secondary school physics syllabus the experiments are emphasized in each topic.

There is an experiment to be carried in order to improve on the theory. The topics in physics syllabus are listed and the experiment(s) that are supposed to be carried out in each topic. Tick the most appropriate depending on whether the experiment was done or not.
<table>
<thead>
<tr>
<th>FORM</th>
<th>TOPIC</th>
<th>EXPERIMENT</th>
<th>DONE OR NOT DONE</th>
</tr>
</thead>
</table>
| ONE  | Measurement (1) | a) Determination of the volume of irregularly shaped objects  
b) To investigate the relationship between volume and height in liquids | |
|      | Force | a) To illustrate up thrust in liquids  
b) To investigate friction in liquids | |
|      | Pressure | a) To investigate how pressure is transmitted in liquids.  
b) To demonstrate the existence of the atmospheric pressure. | |
|      | The particulate nature of matter | a) To demonstrate Brownian motion in liquids.  
b) To demonstrate diffusion in liquids. | |
|      | Thermal expansion | a) To compare the expansion of different liquids  
b) To demonstrate the expansion of gases. | |
| Heat transfer | a) To compare thermal conductivities of various conductors.  
b) To compare radiation from different surfaces. |
| rectilinear propagation and reflection at plane surfaces | a) To investigate how the light travels.  
b) To form images in a pin hole camera.  
c) To investigate the size of image in a plane mirror. |
| Electrostatics(1) | a) To investigate the law of charges.  
b) To charge an electroscope by contact and conduction. |
| Cells and Simple circuits. | a) To investigate the effect of series and parallel arrangement on current and E.M.F  
b) To demonstrate polarization in a simple cell |
| Magnetism | a) To determine the poles of a magnet.  
b) To classify objects into magnetic and non magnetic materials.  
c) To make a magnet by induction and stroking methods |
| Table 1 |  |
|---------|  |
| **Measurement** (11) | a) To determine the diameter of objects using vernier calipers and micrometer screw gauge.  
   b) To estimate the size of a molecule in an oil drop experiment. |
| **Turning effect of a force.** | a) To investigate the turning effect of a force.  
   b) To verify the principle of moments. |
| **Equilibrium and centre of gravity** | a) To determine the centre of gravity of regular objects.  
   b) To demonstrate stable, unstable and neutral equilibrium using a cone. |
| **Reflection at curved surfaces** | a) To determine the centre of curvature of a concave mirror.  
   b) To determine the linear magnification of a concave mirror. |
| Magnetic effect of an electric current | a) To investigate the magnetic effect of a current flowing through a conductor.  
  b) To investigate how the size of current flowing in a solenoid affects the strength of an electromagnet |
|--------------------------------------|----------------------------------------------------------------------------------------------------------|
| Hooke’ law                           | a) To investigate Hooke’s law.  
  b) Making of a spring balance. |
| Waves                                | To demonstrate compression and rarefactions using a slinky spring. |
| Waves (1)                            | To demonstrate compression and rarefactions using a slinky spring. |
| Sound (1)                            | a) To demonstrate the production of sound using a tuning fork.  
  b) To demonstrate the transmission of sound in solids, liquids and gases. |
| Fluid flow                           | a) To investigate the effect of a ruler on stream lines.  
  b) To investigate the relationship between the speed of water and the pressure it exerts. |
<table>
<thead>
<tr>
<th>THREE</th>
<th>Linear motion</th>
<th>a) To determine the acceleration due to gravity.</th>
</tr>
</thead>
</table>
|       | Refraction of light. | a) To investigate the path of light through a rectangular glass block.  
b) To determine the refractive index using rectangular and triangular glass blocks.  
c) To determine refractive index by real and apparent depth method. |
|       | Work, energy, power and machines | a) To determine the mechanical advantage and the velocity ratio of inclined plane. |
|       | Current electricity (ii) | a) To investigate the current and voltage in a parallel and series arrangement.  
b) To investigate the relationship between current and voltage across a nichrome wire.  
c) To determine the resistance of a resistor using the voltmeter-ammeter method) To determine the internal resistance of a cell. |
<table>
<thead>
<tr>
<th>Electrostatics( ii)</th>
<th>a) To demonstrate charging and discharging of a capacitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating effect of electric current</td>
<td>To investigate the factors that determines the heat produced by an electric current</td>
</tr>
</tbody>
</table>
| Quantity of heat | a) To determine the specific heat capacity of a solid by the method of mixtures.  
   b) To investigate the effect of supplying heat to a solid |
| Gas laws | a) To investigate the relationship between pressure and volume of a fixed mass of a gas at constant temperature.  
   b) To investigate the relationship between volume and temperature of a given mass of gas at constant pressure. |
Emphasis on the use of a laboratory in teaching of physics is beneficial if it results to development of practical skills and scientific way of solving problems. The main facilities in the laboratory are water, gas and electricity. The main stages involved when carrying out a practical are preparation, performance and discussion. The information obtained will be used to identify how the students carry out the physics practical. The researcher will use a tick to show that the skill was utilized and a cross to show that the skill was not used.

<table>
<thead>
<tr>
<th>SKILL</th>
<th>UTILISED OR NOT UTILISED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Measuring</td>
<td></td>
</tr>
<tr>
<td>2. Handling of instruments</td>
<td></td>
</tr>
<tr>
<td>3. Observation</td>
<td></td>
</tr>
<tr>
<td>4. Recording of data</td>
<td></td>
</tr>
<tr>
<td>5. Analyzing of data from students</td>
<td></td>
</tr>
<tr>
<td>6. Making conclusions</td>
<td></td>
</tr>
<tr>
<td>7. Writing laboratory reports</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

INTERVIEW SCHEDULE

The views of both the students and physics teachers are very important concerning physics practical. The information obtained from this schedule will be used to determine the usefulness and the relationship between practical work and performance in physics. The researcher posed questions to the students and teachers from the sampled schools.

**a) For Students**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girl</td>
<td>Is physics meant for boys, girls or both?</td>
</tr>
<tr>
<td>Boy</td>
<td>What is your attitude towards physics?</td>
</tr>
<tr>
<td>Girl</td>
<td>What is the importance of participating in physics practical in school?</td>
</tr>
<tr>
<td>Girl</td>
<td>How often do your improvise during practical work in physics?</td>
</tr>
<tr>
<td>Girl</td>
<td>How many times do you carry out experiments during physics lessons?</td>
</tr>
<tr>
<td>Girl</td>
<td>What is the importance of having a teacher during experiments in physics?</td>
</tr>
<tr>
<td>Boy</td>
<td>Does the practical paper contribute in any to the final grade one acquires in physics during KCSE?</td>
</tr>
</tbody>
</table>
### Gender Question

<table>
<thead>
<tr>
<th>Gender</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>How are physics teachers distributed in your school according to gender?</td>
</tr>
<tr>
<td>Male</td>
<td>How often do you use charts in teaching of physics?</td>
</tr>
<tr>
<td>Female</td>
<td>How many times do you carry out project work when teaching physics?</td>
</tr>
<tr>
<td>Male</td>
<td>How useful is a laboratory in the teaching of physics?</td>
</tr>
<tr>
<td>Female</td>
<td>How many laboratories do you have in your school and how are they equipped?</td>
</tr>
<tr>
<td>Male</td>
<td>How important is a teacher when carrying out experiments in physics?</td>
</tr>
</tbody>
</table>
APPENDIX E

LIST OF SECONDARY SCHOOLS IN MERU CENTRAL DISTRICT AS AT 20/04/011

1. Abothuguchi Boys High School
2. Gaitu Secondary School
3. Gakando girls Secondary School
4. Kaguma Mixed Day Secondary School
5. Kaongo Girls Secondary School
6. Kariene mixed day secondary school
7. Karugwa Girls High School
8. Katheri boys High School
9. Keeru Boys High
10. Kibirichia Boys High School
11. Kibirichia Girls High School
12. Kinjo Girls High School
15. Day Secondary School Kirirwa Mixed
16. Kithirune Day Secondary School
17. Kithirune girls High School
18. Mugambone Mixed Day Secondary School
19. Mbwenjeru Mixed Day Secondary School
20. Munjwa Girls High School
21. Mwangathia Secondary School
22. Nkando Secondary School
23. Ntonyero Mixed Day Secondary
24. Ntugi Mixed Day Secondary School
25. Ntumburi day Secondary school
26. Nyweri mixed day Sec
27. Ruibi Secondary School
28. Ruiga Girls Secondary School
29. St Bonaventure Secondary School
30. St Theresa Girls Secondary School

Source  D.E.O’S office Meru Central
APPENDIX F: MAP OF KENYA SHOWING MERU COUNTY.
Our Ref: E55/CE/13925/09

The Permanent Secretary,
Ministry of Higher Education, Science & Technology,
P.O. Box 30040,
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION MR. NDURU MUGAMBI DAVID – REG. NO. E55/CT/13925/09

I write to introduce Mr. Nduru Mugambi, who is a Postgraduate Student of the University. He is registered for M.Ed degree programme in the Department of Educational Communication & Technology.

Mr. Nduru intends to conduct research for a proposal entitled, “Practical Work in Physics and Performance of Learners in Physics: A study of Secondary Schools in Meru Central District, Kenya.”

Any assistance given will be highly appreciated.

Yours faithfully,

MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL
NCST/RCD/14/012/605

David Mugambi Nduru
Kenyatta University
P.O.Box 43844-00100
Nairobi.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "Practical work in physics and performance of learners in physics: A study of secondary schools in Meru Central District, Kenya." I am pleased to inform you that you have been authorized to undertake research in Meru Central District for a period ending 31st July, 2012.

You are advised to report to the District Commissioner and the District Education Officer, Meru Central District 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.DSC.
DEPUTY COUNCIL/SECRETARY

Copy to:
The District Commissioner
The District Education Officer
Meru Central District.
THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss/Institution
David Muga Umali
of (Address) Kenyatta University
P.C.Box 43844-00100, Nairobi,
has been permitted to conduct research in

Meru Central
Eastern

Location
District
Province

on the topic: Practical work in physics and
performance of learners in physics: A study of
secondary schools in Meru Central District, Ken.


CONDITIONS

1. You must report to the District Commissioner and
the District Education Officer of the area before
embarking on your research. Failure to do so
may lead to the cancellation of your permit.
2. Government Officers will not be interviewed
without prior appointments.
3. No questionnaire will be used unless it has been
approved.
4. Excavation, testing 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) final
draft copies of your final report for Kenyan and
non-Kenyan respectively.
6. The Government of Kenya reserves the right to
modify the conditions of this permit including
its cancellation without notice.