EXTENT OF UTILIZATION OF LABORATORIES IN TEACHING AND LEARNING CHEMISTRY IN PUBLIC SECONDARY SCHOOLS IN MERU SOUTH DISTRICT, KENYA.

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AUGUST, 2015
DECLARATION

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

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DEDICATION

This work is dedicated to my mother Beth M. Njoka for educating me, for her priceless love, support and encouragement in the course of the study. Mother you have been a great source of inspiration.
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ABBREVIATIONS AND ACRONYMS

CDF : Community Development Fund

DEO : District Educational Officer

KCSE : Kenya Certificate of Secondary Education

KNEC : Kenya National Examination Council

MOE : Ministry of Education

SMASSE : Strengthening Mathematics and Science in Secondary Education

SPSS : Statistical Package for Social Sciences

UNESCO : United Nations Educational Scientific and Cultural Organization
ABSTRACT

Laboratories are of utmost importance in the teaching and learning of science subjects, Chemistry included. A Chemistry laboratory offers the environment and resources for teaching practical Chemistry skills which help students handle examination and the day to day affairs of their lives. This study was premised on establishing the extent of utilization of Chemistry laboratories in teaching and learning the subject. It was mainly concerned with availability of Chemistry laboratories in schools, the resources available in the laboratories, how teachers and students integrated the laboratories and its resources in the teaching and learning of the subject. The study also delved into the teacher and students attitude towards chemistry practical work. This was done with the aim of identifying the prevailing Chemistry practical learning situation in schools, with the specific focus on major problems encountered in secondary school Chemistry laboratories. The study aimed at giving recommendations that could be embraced to enhance effective utilization of Chemistry laboratories which would ultimately culminate in better students’ performance in Chemistry. The study which was a descriptive survey was conducted in Meru South District. It targeted a population of 40 public secondary schools, from which eight were sampled using a combination of simple random, stratified, purposive and systematic sampling procedures. The respondents were 13 Chemistry teachers, 8 heads of science departments, 180 form 3 Chemistry students and 6 laboratory technicians. Questionnaires, interview schedule and an observation schedule were used to collect data which was analyzed using descriptive statistics inform of percentages, means and frequencies with the aid of the Statistical Package for Social Sciences. The study established that some schools did not have a chemistry laboratory at all. In other instances where laboratories were available and were fairly equipped, it established they nonetheless lacked vital requirements such as a fume chamber, first aid kit, gas taps and running water. Further, it was established that the main activities in the laboratories were teacher demonstrations though when group practicals were used, the number of students per group were unusually big. It is recommended that all schools should have adequately equipped laboratories. Additionally, qualified technicians should be employed to ease the teachers’ work to enable proper utilization of the laboratories which will enhance good performance in practical work and ultimately the overall Chemistry grades in internal and national examinations.
CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter introduces the problem of the study. It focuses on; background of study, statement of the problem, objectives of the study, theoretical framework, conceptual framework and definition of terms used in the study

1.2 Background of the Study

The government of Kenya recognizes the importance of Science and Mathematics in the realization of the vision 2030; which aims at making Kenya a globally competitive country by the year 2030. In regard to this, a huge number of resources are channeled towards the learning of Science and Mathematics at all levels of the education system. Further, the government has put in place a programme to in-service Science and Mathematics teachers in secondary schools in a programme known as Strengthening of Mathematics and Science in Secondary Education (SMASSE), (M.O.E, 2005). The program was born out of the need to improve performance in the crucial Mathematics and Science subjects that had been hitherto unimpressive, by equipping classroom teachers with adequate practical skills and hands – on experience (Ogembo, 2012).

The current 8-4-4 system of education requires that the three science subjects namely; Biology, Physics and Chemistry be properly taught to students. The syllabuses of the subjects stated include an adequate proportion of practical activities covering form one to form four. Similarly, the end of course examination for the subjects also has a complete practical examination. Therefore, the teaching and learning experiences require that the students attain proficiency both in theory and practical aspects of the subjects. While some of the practical activities can be done in class or outside in the open, most practical work can only be done in the laboratory. This is
because the activities require instruments, apparatus and chemicals found in the laboratories (Twoli, 2006).

For a good performance to be realized in a science subject such as chemistry, the laboratory is therefore of paramount importance. Research has shown that availability of teaching and learning resources make a significant contribution in performance in the Sciences. For instance, Eshiwani (1988) observes that most of the poorly performing schools spent less money on the purchase of teaching and learning resources. Orodho (1996) on the other hand, observed that there is a positive and significant relationship between students’ achievement in physics and chemistry and the level of adequacy of laboratories, apparatus, chemicals and exposure of students to practical exercises.

Chemistry is important in many aspects of life. It is a key subject in most careers in the education system. These include; Medicine, Veterinary medicine, Nursing, Engineering and Biotechnology among others. Chemistry is also a key subject for the development of Science and technology in any country. Science and technology play a central role in the modernization and growth of economic and social systems (Lewis, 1972). The development of human resources in this field therefore has become a priority in many less industrialized countries (UNESCO, 1973). Currently students’ performance in the subject is low both at the national and local level (Meru South District). During the release of 2004 K.C.S.E results, the then minister for education noted that,

The poor performance in these subjects, Mathematics and Sciences remain a matter of concern to my Ministry. I appeal to all secondary school teachers, Parents and other leaders to make deliberate efforts to improve the delivery of quality performance in these key subjects. (East African Standard Newspaper No. 270028 of 2004 pg 4).

Available statistics show that students’ achievement in Chemistry has remained low nationally and at the district level in Meru south. There has been an outcry from stakeholders on poor
performance in Chemistry in the country. The same trickles down to Meru South District. Chemistry is the poorest performed science subject in the country (Table 1.1). It is usually ranked second last after Mathematics. In Meru South district, the performance in chemistry is far below the national mean grades as is attested to by the data in Table 1.2 and Table 1.3. Chemistry, a practical oriented subject is concerned with the study of matter and its transformation through processes such as heating, electrolysis and other chemical processes, (Twoli, 2006). In teaching and learning, Chemistry is divided into two main components; theory and practical. This study focused mainly on the practical part which is usually carried out in the laboratory to boost manipulative and process skills which are vital for further education and related place of work.

Table 1.1 provides information on national performance of KCSE candidates in Mathematics and Science subjects for the period from 2006 to 2012.

Table 1.1 National K.C.S.E Percentage Scores in Mathematics and Sciences (2006-2012)

<table>
<thead>
<tr>
<th>Year</th>
<th>Mathematics</th>
<th>Physics</th>
<th>Chemistry</th>
<th>Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>19.04</td>
<td>40.32</td>
<td>24.91</td>
<td>27.45</td>
</tr>
<tr>
<td>2007</td>
<td>19.73</td>
<td>41.31</td>
<td>25.39</td>
<td>41.95</td>
</tr>
<tr>
<td>2008</td>
<td>21.30</td>
<td>36.21</td>
<td>22.74</td>
<td>30.34</td>
</tr>
<tr>
<td>2009</td>
<td>21.13</td>
<td>31.31</td>
<td>19.12</td>
<td>27.15</td>
</tr>
<tr>
<td>2011</td>
<td>22.16</td>
<td>32.62</td>
<td>23.66</td>
<td>28.62</td>
</tr>
<tr>
<td>2012</td>
<td>21.23</td>
<td>32.71</td>
<td>20.06</td>
<td>28.89</td>
</tr>
</tbody>
</table>

Source: KNEC report (2006-2012)

According to information in Table 1.1, during the four years, Chemistry was ranked below Biology and Physics in terms of performance. In 2009, performance in Chemistry was even
lower than that of Mathematics - a subject that has consistently posted the lowest achievement over the years. The assertion is further strengthened by data in Table 1.2 which gives the mean achievement in the subject between 2002 and 2012.

Table 1.2 National K.C.S.E Chemistry Mean Scores (2002-2012)

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean Score (Max = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>4.112</td>
</tr>
<tr>
<td>2003</td>
<td>4.49</td>
</tr>
<tr>
<td>2004</td>
<td>4.766</td>
</tr>
<tr>
<td>2005</td>
<td>4.048</td>
</tr>
<tr>
<td>2006</td>
<td>5.979</td>
</tr>
<tr>
<td>2007</td>
<td>6.094</td>
</tr>
<tr>
<td>2008</td>
<td>5.458</td>
</tr>
<tr>
<td>2009</td>
<td>4.692</td>
</tr>
<tr>
<td>2010</td>
<td>4.697</td>
</tr>
<tr>
<td>2011</td>
<td>4.472</td>
</tr>
<tr>
<td>2012</td>
<td>4.394</td>
</tr>
</tbody>
</table>

Source: KNEC report (2002-2012)

Data in Table 1.2 shows that although the national students’ performance in Chemistry has been below average, there was a steady improvement in performance from 2002 to 2007 with the best mean score being realized in 2007 but went down the following years. The trend in achievement in the subject at the national level seems to be a mirror copy of achievement at the district level in Meru south as is shown in Table 1.3.
Table 1.3 Meru South K.C.S.E Chemistry Results

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean Score (Max = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>3.612</td>
</tr>
<tr>
<td>2006</td>
<td>3.605</td>
</tr>
<tr>
<td>2007</td>
<td>3.525</td>
</tr>
<tr>
<td>2008</td>
<td>3.8188</td>
</tr>
<tr>
<td>2009</td>
<td>3.648</td>
</tr>
<tr>
<td>2010</td>
<td>3.375</td>
</tr>
<tr>
<td>2011</td>
<td>3.4859</td>
</tr>
<tr>
<td>2012</td>
<td>3.776</td>
</tr>
</tbody>
</table>

*Source: D.E.O Office (Meru south)*

According to information shown in Table 1.3, the district performance in chemistry has been consistently below the national averages. The trend has however been inconsistent over the years with a gradual drop from 2005 to 2007, an improvement in the year 2008 followed by a drop in the succeeding two years. The mean score then improved in the next two years. The magnitude of the dismal performance in Chemistry in the district over the years informed the need for this study to find out whether the poor performance could be improved by effective organization and use of the most important resource; the Chemistry laboratory

1.2 Statement of the Problem

Students’ performance in chemistry has been poor. This has been a national concern because chemistry is a vital subject and a key entry to various careers. The poor performance is an indication that learners leave the education institutions without the intended knowledge and skills outlined in the chemistry syllabus. The world over, various researches have been carried out on the factors that lead to students’ poor performance in sciences in general and more specifically Chemistry. According to available research findings, these factors include: poor teaching
methodologies (Friedman, 2000), poor capital investment in terms of provision of science resources (Agusiobo, 1998), low teacher morale, substandard internal evaluation, poor administration and leadership, inadequate supervision and inspection of schools (Chiriswa, 2002), lack of support from parents, insecure working relationship between head teachers and their staff and students’ indiscipline (Yeya, 2002) among others. More specifically, Orado (2009), in her study on causes of poor performance in Chemistry in Nairobi found that there is a general trend of poor performance in the practical paper at national level thus resulting in overall poor achievement in the subject. However to date, there is very little if any, empirical data on the contributions of Chemistry laboratory which is a very vital requirement for teaching chemistry to the achievement levels in the subject at various levels. This research therefore attempted to make its contribution by filling this gap.

1.4 Objectives of the Study

The study was guided by the following objectives

(i) To establish the availability of chemistry laboratories and resources available in Chemistry laboratories in secondary schools in Meru South District

(ii) To establish how Chemistry teachers and students use laboratories in the teaching and learning of Chemistry in secondary schools Meru South District

(iii) To determine students’ attitude towards the use of laboratories in learning of Chemistry in secondary schools Meru South District.

(iv) To find out how chemistry laboratory apparatus and chemicals are stored in secondary schools in Meru South District
(v) To identify the problems encountered in the use of Chemistry laboratories in the teaching and learning of Chemistry in secondary schools Meru South District

1.5 Research Questions

The study was geared towards answering the following questions

(i) Which resources are available in school Chemistry laboratories?

(ii) How do teachers and students use the Chemistry laboratories?

(iii) What is the students’ attitude towards the use of chemistry laboratories?

(iv) How are apparatus and chemicals stored in Chemistry laboratories?

(v) What are the problems encountered in the use of Chemistry laboratories?

1.6 Significance of the Study

It was hoped that the findings of this study would be useful to a number of stakeholders in the education sector. They include Chemistry teachers, Chemistry students, school principals, school laboratory technicians, curriculum developers and future researchers.

Since teachers are the curriculum implementers in schools, the findings of the research would sensitize them on better ways of organizing and using the Chemistry laboratories. It would also help them in utilizing existing facilities and in setting new ones. With regard to students, the findings would sensitize them on the importance of the laboratory experience in their studies. School Principals on the other hand will be informed on the various requirements needed in a Chemistry laboratory and therefore use the findings to sensitize teachers, students and parents on the importance of Chemistry laboratory in teaching thus the need to order for chemicals and
apparatus. The findings would also provide school laboratory technicians with better ways of organizing Chemistry laboratories for easier retrieval of apparatus and chemicals. Additionally, the research would enable Chemistry curriculum developers to have an insight into the practical activities which are useful in making the learners understand the scientific concepts and principles. They would also stimulate interest of future researchers to undertake further investigation.

1.7 Scope and Limitations of the Study

1.7.1. Scope

The study dealt with Chemistry teachers, students, heads of science departments and laboratory technicians in stratified randomly selected secondary schools in Meru South District. The district was selected because of the dismal performance in chemistry.

1.7.2 Limitations of the Study

Time and funds limited the extension of the study to other parts of the country. The study was also confined to public secondary schools in Meru South District but private schools were not included due to the same reasons. The information therefore may not be adequate to generalize the situation in all schools in the district and in other districts in Kenya.

Although several resources are used in teaching and learning Chemistry, only the resources found in the laboratory were studied.
1.8 Assumptions of the Study
The study assumed that the sampled schools follow a uniform Chemistry syllabus, have Chemistry laboratories and laboratory technicians. It also assumed that teachers arrange demonstrations and practical work for students and all the respondents were truthful in responding to the questions.

1.9 Theoretical Framework
The researcher embraced Jerome Bruner’s constructivism theoretical arguments that learning is an active process in which learners construct new ideas or concepts based upon their current or past knowledge, (Bruner, J. 1996). He also argues that humans generate knowledge and meaning from interaction between their experiences and their ideas. The theory is associated with pedagogic approaches that promote active learning and discovery processes. Hands on experiences are therefore necessary for effective learning as the learner is required to do something in the process of learning. The teacher should try and encourage students to discover principles by themselves. Chemistry teachers can achieve this by giving practicals in the laboratory. The various laboratory experiences expose the learners to hands on activities thus actively participating in the learning process. If well planned in a properly set laboratory, laboratory experiences can develop scientific thinking and also develop practical abilities.

1.10 Conceptual Framework
The conceptual framework of the study relates the various ways or methods of teaching Chemistry. A hand on activities intensifies the understanding of various chemistry concepts. Though several methods can be used to teach Chemistry, Dale (1969), observes that different
methods require different resources. It is therefore the role of the teacher to choose the most appropriate method to use. However, the method to be adopted for use depends on several factors. According to Wellington (1989), these factors include the learner, the learning objectives and resources available as the determinant factors for teaching sciences. The teacher should consider the objective to be achieved, the learner and the nature of the content to be taught. Equally, the science teacher should be well equipped with the use of a variety of methods and procedures of teaching science. Layton (1989) indicates that whichever method a teacher adopts for a lesson, it must aim towards effectiveness in quantity (quality benefiting the learners) and quality (effectiveness) of learning. Most learning tasks involve a combination of any of the following process; recognition, memory algorithmic, problem solving, understanding and change of attitude. To achieve any of these processes require a particular instructional approach or a combination of approaches.

In secondary school teaching, the chemistry content is well elaborated in the chemistry syllabus. The syllabus provides the objectives for teaching chemistry as well as the time limit for every topic. The syllabus is thus very important in teaching chemistry and a chemistry teacher is expected to implement the curriculum through teaching the content as it is in the syllabus. The methods of instruction are various depending on the nature of the content. Some content involves theory work and the instruction can be in classroom. These include; concepts, laws, use of various substances and applications of various processes in real life situations. However, others involve practical work and can only be taught using a Chemistry laboratory. These include acquisition of skills such as handling of apparatus, reading calibrations, observing phenomena and ability to follow procedures (manipulative skills). Also taught in the laboratory are the various process skills. The theory and the practical concepts complement each other. The
theory and the practical content are therefore equally important and should be taught effectively in order to realize good results. Performance in Chemistry depends on how well the two are done.

In teaching Chemistry, the syllabus is the main reference. Teaching can be done using the various methods. It can also be done in various places. The theory can be taught in the classroom while the practical is done in the laboratory. Both theory and practical reinforce each other. This study focused on the practical work done in the laboratory. Figure 1.1 summarizes the conceptual framework for this study.

**Figure 1.1: Conceptual Framework**

![Conceptual Framework Diagram]

Source: Njoka E, 2011
The model indicates that effective utilization of Chemistry laboratories is influenced by among other factors teachers’ and students’ characteristics, resources available, methods used in teaching and the manipulative and process skills taught to students. The teaching takes place in the laboratory and in the classroom. Resources available in the laboratory and their effectiveness and ineffectiveness are among other factors that affect students’ performance in Chemistry. For this study, the dependent variable was students’ performance in chemistry. The independent variables were laboratory resources, time, teachers’ characteristics and students attitude towards chemistry. A school policy on effective utilization of chemistry laboratory was the intervening variable.
1.10 Definition of Terms

Chemistry: A branch of science that deals with the study of structure and composition of Substances and the way they behave under different circumstances.

Demonstration: A method of teaching whereby someone shows a process or how certain things are done as others observe.

Laboratory: A room equipped with necessary equipments for carrying out experiments which is used by teachers and students for the study of any science subject.

Laboratory Technician: A person whose occupation is to work in the laboratory.

Performance in chemistry: The grades students get in Chemistry examinations.

Practical: Use of apparatus and chemicals to observe phenomena.

Public schools: Schools supported by government especially in paying students’ tuition fees and hiring teachers.

Resources: Anything that is used to help in the process of teaching and learning.

Sciences: Biology, Chemistry and physics as taught in secondary schools.
CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction
This chapter looks into researched literature pertaining to Chemistry laboratories. It goes into details of the roles of laboratory work, skills taught in the laboratory and methods of teaching Chemistry.

2.2 Role of Laboratory Work In Chemistry
Chemistry is a practical oriented science subject. Chemistry presents students with abstract ideas. This is because it deals with invisible concepts such as atoms. The only way to remove the abstractness of the subject is to give students experiences that can enhance their understanding of the subject. Most of these experiences can only be given in the laboratory (Nderitu, 2009). Miller (2004) observes that abstract ideas cannot simply be transferred from teacher to students. The students must play an active role in appropriating these ideas and making personal sense of them. According to Hofstein (1991), laboratory activity (practical work) is contrived learning experiences in which students interact with materials to observe phenomena. These experiences may have different levels of structure specified by teachers or laboratory handbook (manuals) and may include phases of planning and design, analysis and interpretation as the central performance phase. According to Woolnough (1991), care should be taken because it is not just enough for students to do something in the laboratory but rather laboratory experiences need to be designed so that they focus attention. He also notes that in many countries, over the last few decades, science has been taught in part involving students in teacher guided, activity based lessons. Through such activities, students are expected to develop their investigatory skills and
through their results of experimentation to develop sound scientific knowledge. Ausubel (1968),
observer that the laboratory gives the students appreciations of the spirits and the method of
science, promotes problem solving, analytic and generalization ability, provide the students with
some understanding of the nature of science. Woolnough and Allsop (1985) stresses that if we
want the students to acquire skills that are used by practicing scientists and if we are concerned
with the teaching of the process skills of science, practical work seems to be vital in this context.

Levinson (1994) cautions that practical work activity should not be a sit and watch
demonstration or a recipe practical because such do not promote intellectual or cognitive skill
development. In a laboratory, numerous experiences may be provided in which students
manipulate materials, gather data, make inferences and communicate the results in a variety of
ways (Tamir and Lunetta.1981). Studies have shown that students have different attitudes
towards laboratory work; some enjoy it while others do not. Tasker (1981) found that secondary
school students saw little connection between practical work classes and other science lessons. A
mention of science lessons to students and they think of laboratories, some do it with delight,
others with lack of joy. After the First World War, the laboratory acquired a central role not just
as a place for demonstration and confirmation but also as the core of the science learning
process. According to Hofstein (1991), practical activities are central in science teaching. They
enhance the achievement of objectives of science education (cognitive, psychomotor and
affective). The practical skills are tested in chemistry paper three. The paper tests students’

- Ability to follow a set of instructions
- Manipulative skills such as the ability to handle apparatus.
- Ability to make accurate observations.
Ability to record observations accurately

Ability to make accurate deductions.(KNEC report,2005)

According to Cartnell (1975), practical work in chemistry may be divided into several types as shown below;

1. Experiments done by students
2. Experiments shown directly to students
3. Experiments shown indirectly to students by the use of some kind of visual aid.
4. Experiments which are merely described, either verbally or in writing by the teacher or in a book.

It is assumed that the order or priority at school level is 1>2>3>4 and that only a few experiments come into category four. At tertiary level, categories one and four are predominant. In addition, it also seems clear that, in order for experimental work in chemistry to be productive, it should include several currently accepted reasons;

i. To develop observational, manipulative, preparative and instrumental skills.
ii. To acquire, illustrate and amplify chemical knowledge.
iii. To recognize the precision and limitation of laboratory work
iv. To record accurately and communicate results clearly
v. To develop personal responsibility and reliability in conducting experiments.
vi. To plan and carryout further laboratory work by the effective use of available laboratory resources.(UNESCO,1973)

Apparatus used in the laboratories are becoming more advanced and expensive such as computers. This is inevitable if science has to keep pace with technology as the two are
symbiotic, (Clarke, 1985). Even the less glamorous apparatus in the laboratory are becoming more expensive. This has led to more improvisation, both by the students and teachers.

According to Lewis (1972), practical work enhances learning by allowing students to work together in groups hence discussing among themselves in a language familiar to all. Practical work support the general aims of education such as creativity, autonomy, self-confidence, heightening of interests and enjoyment of learning.

**2.3 Skills taught in the laboratory**

The skills taught in chemistry are the same as those taught in science education. Science education is the field concerned with sharing science content and process with individuals not traditionally considered part of scientific community. The target individuals may be children, college students or adults within the general public. The world of science education comprises science content, some social science and some teaching pedagogy, (Duit, 2006). According to Twoli (2006), skills taught in the chemistry laboratory are practical skills. The skills are of two types namely; manipulative skills and process skills.

**2.3.1 Manipulative Skills**

Manipulative skills are also known as motor skills. The skills deal with the ability to handle and arrange apparatus and materials for proper experimentation (Twoli, 2006). If students have proper manipulative skills, they will make accurate observations and record the data collected accurately. This will then translate to accurate interpretation. Manipulative skills include handling, arranging, fixing, pouring, heating, filtering and weighing.
2.3.2 Process Skills

The science process skills are tools that students use to investigate the world around them and to construct science concepts, (Yockey, 2001). They are a means to learning and are essential to the conduct of science. Process skills are more cognitive in nature, (Twoli, 2006). Jenkins (1985), gave the following as the main process skills which should be emphasized in any science practical session. They include; observing, classifying, measuring, communicating, inferring, predicting, interpreting, experimenting skills, comparing, contrasting, organizing and analyzing. The skills are not just useful in science but in any situation that requires critical thinking. The process skills are integrated together when scientists design and carry out experiments or in everyday life when we all carry out fair test experiments. All the skills are important individually as well as when they are integrated together.

Observing skills

Observing is the fundamental science process skill, (Michael J, 1990). Observing refers to noting the properties of objects and situations using the five senses of seeing, hearing, touching, smelling and tasting. An observation is simply a record of sensory experience made using the five senses. Scientists use observations skills in collecting data. The ability to make good observations is also essential to the development of other science process skills,(Yockey, 2001). The simplest observations made using the senses are qualitative such as the colour of a
precipitate or the temperature of a solution. Others are quantitative and involve numbers or quantity such as the mass of a solid.

**Classifying skills**

Classifying is relating objects and events according to their attributes,(Michael J, 1990). Places, objects, ideas and events may be classified. It involves grouping objects like categories. Items can be classified at many different levels, from the very general to the very specific.

**Measuring skills**

To measure is to express the amount of an object or substance in quantitative terms or comparing an object to a standard, (Hofstein A, 1991). It is the process of making observations that can be stated in numerical terms. Examples of measurement include; length in meters, volume in litres, mass in grams, force in Newton and temperature in degrees Celsius. All measurements should be given in SI units.

**Communicating skills**

Communicating is the process of describing, recording and reporting experimental procedures and results to others. It is a way of sharing information with others. It is representing observations, ideas, theoretical models or conclusions by talking, writing, drawing or making physical models, (Michael J, 1990). Communication may be oral, written or mathematical. Communication skills enable one to organize ideas using appropriate vocabulary, graphs, other visual representations and mathematical equations. An example is describing the relationship between melting time for an ice cube and amount of salt sprinkled on the cube by writing about it or by constructing a graph. Communication is essential in science given its collaborative nature.
Inferring skills

According to Wellington J,( 1989), to infer is to give an explanation for a particular object or event. It is a process of drawing conclusions based on reasoning or past experience. Inferring also has got to do with interpretation of information.

Predicting skills

Predicting is forecasting a future occurrence based on past observations or on the extension of data. It is the process of stating in advance the expected results of tested hypothesis. A prediction that is accurate tends to support the hypothesis and can be used in planning a test of that hypothesis, (Yockey, 2001).

Interpreting skills

Interpreting refers to considering evidence, evaluating and drawing conclusions by assessing the data. It is answering, the question, “what do your findings tell you?” Put in other words, it is giving explanations, inferences or hypothesis from data that have been placed in data table or graph, ( Wellington J, 1989)

Experimenting skills

Experimenting is testing a hypothesis through manipulation and control of independent variables and noting the effect on dependent variables. It involves interpreting and presenting results in the form of a report that others can follow to replicate the experiment. Experimenting is an integrated process skill, (Yockey, 2001).

Comparing skills

Comparing involves assessing different objects, events or outcomes for similarities. This skill allows students to recognize any commonality that exists between seemingly different situations.
A comparison skill to comparing is contrasting in which objects, events or outcomes are evaluated according to their differences, (Michael J, 1990).

**Contrasting skills**

Jenkins (1985) explains that Contrasting involves evaluating the ways in which objects or outcomes are different. It is a way of finding subtle differences between otherwise similar objects, events or outcomes.

**Organizing skills**

Organizing is the process of arranging data into a logical order so that the information is easier to analyze and understand. The organizing process includes sequencing, grouping and classifying data by making tables and charts, plotting graphs and labeling diagrams, (Wellington J, 1989)

**Analyzing skills**

The ability to analyze is critical in science. Students use analysis to determine relationship between events, to indentify the separate components of a system to diagnose causes and to determine the reliability of data, (Hofstein A, 1991).

### 2.4 Methods and Strategies of Teaching Chemistry

There are two main teaching strategies or teaching approaches. A strategy is a way and means of carrying out teaching. The two teaching strategies are;

i) Expository

ii) Heuristic

#### 2.4.1 Expository Strategy

These are methods that assume learners as passive recipients of information while the teacher is considered as the overall giver of knowledge, (Praagh, 1989). Expository strategies are teacher
talking kind of teaching. If any practical is involved, it is usually done by the teachers through demonstrations. Expository methods are also referred to as traditional methods. They are not common in the teaching of chemistry.

2.4.2 Heuristic strategy

Praagh (1989) defines heuristic approach as methods which involve the attitude of the discoverer. Such methods involve the learners in finding out instead of being merely told about things. The students get involved in;

i) Search of scientific data

ii) Development of process skills such as ability to make conversations, perform experiments, collect data, make deductions and present the results, handling apparatus and using them for data collection, discuss procedures and observations amongst themselves.

Heuristic approaches in chemistry include methods such as problem solving, project work and laboratory experiments. The methods require a vast range of resources, (Dale, 1969). Dale gave the cone of experience. The cone relates teaching strategies to resources. The top of the cone has the abstract strategies that are more teachers centered and require fewer resources while at the bottom are the learner centered strategies that allow for greater autonomy of the learner and require more resources. The top of the cone begins with verbal symbols and at the bottom there is the direct purposeful experience such as student working with apparatus and chemicals in the laboratory. Figure 2.2 summarizes the Dale’s Cone of Experience
2.4.3 Determinants of Teaching Methods

According to Ole Shanguya (1995), the learner, the learning objectives and the resources available are the main determinants of a teaching method. Das (1985), indicates that in choosing the method of teaching science, the teacher should consider the objectives to be achieved, the learner and nature of content to be taught. The science teacher should be acquainted with the use of a variety of methods and procedures of teaching science. Twoli et al (2007), observes that
there is usually nothing like a better method. If one makes a good choice and prepares well, almost any method is a good method. However since chemistry is a practical subject, hands on activities are of paramount importance.

Eshiwani (1974), notes that the teaching methods in science have for a long time been geared towards the pursuit of knowledge per se and due to such an approach, the teachers are more concerned with the theoretical approach rather than the practical approach. Resources seem to be a limiting factor in the choice of teaching method. Kyalo (1984), noted that teachers disregarded improvising apparatus and hence the lack of appropriate apparatus hinders effective science teaching. Das (1985), recommended that since science is a practical subject, children should be exposed to the practical aspect of science. However the teaching resource requirements for science have always been an issue in terms of their provision to schools.

2.4.4 Methods of Teaching Chemistry

Lecture Method

The method is very expository in nature. Research in education shows that lecture method is used quite a lot (Ornstein, 1995). He defined lecture as a didactic instructional method involving one way communication from the active presenter (teacher) to the mere or less passive audience (learners). According to Twoli et al (2007), lectures can be in form of formal lecture, informal lecture or brief lecture. A formal lecture is a lecture which lasts for most of the entire lessons. The students’ questions and comments are limited. Such lectures are not recommended in schools. Informal lectures lasts between five and ten minutes. They are filled with students’ responses, questions or watching visual aids. They are recommended for use in secondary
schools. Brief lectures last not more than five minutes. They are used for introducing, summarizing, explaining or describing an object or procedure.

Das (1985) gave the following as the limitations of lecture method.

a) Content is easily forgotten because the method encourages memorization of facts. It does not utilize all the senses but only the auditory.

b) It does not offer training for attainment of scientific skills. The method ignores experimentation which is the basis of modern scientific knowledge and the scientific skills are mainly attained by experiment.

c) Lectures can also be boring if lengthy and if the teacher lacks appropriate skill to keep the lesson interesting and retain the learners’ attention.

Demonstration Method

Dale (1969) defines demonstration as a visualized explanation of an important idea or process. The demonstration shows how certain things are done. He further notes that demonstration may require nothing further than observation-accurate observation. Teacher demonstrations are quite common in the sciences and these are usually held in the laboratories. Washton (1974) indicates that demonstrations are frequently used to illustrate, clarify and amplify a scientific concept or principle. Demonstrations should provide opportunities to pupils to make careful observations in order that they can make deductive references. Like any other method of teaching science, it is combined with other methods of teaching such as discussion. Demonstration can either be done by a teacher or a student.

If the purpose of demonstration is to show, verify or illustrate a clear cut scientific principle, the teacher should perform the demonstration. It may be desirable to have some demonstrations performed by students to encourage interest and to stimulate further learning in science through experimentation and further studies. (Washton, 1974: 113)
According to Twoli et al (2007), the following are situations when demonstrations will be preferred.

- When the experiment is dangerous e.g. preparation of poisonous gases
- When the equipment is expensive and complicated for learners
- When the resources are limited
- When time is limited
- Showing a difficult skill among others.

A demonstration encourages interest and stimulates further learning in science through experimentation and further study. Demonstration can be an active and economical method of developing concepts (cognitive). However the teacher should involve students during demonstration because their involvement enhances the ability to take charge of their own learning,(Millar,2004)

**Laboratory Experiments**

The method provides the learners with a direct purposeful experience. Dale (1969) defines direct purposeful experience as something you can get your hands on or something you can sink your teeth into. Twoli et al (2007), note that the learning is arranged to perform some special tasks by manipulating the materials and apparatus under the direction of the teacher. In most schools learners work in groups of two, three or more. The laboratory experiments have a main advantage of giving a chance to learner to practice manipulative and process skills. The role of the teacher is to facilitate in laboratory experiment. Shulman and Tamir (1973), proposed and gave the role of laboratory experience in science education as to arouse and maintain interest, attitude satisfaction, open mindedness and curiosity in science, to develop creative thinking and
problem solving, to promote aspect of scientific thinking and to develop practical abilities. The laboratory experiments should be integrated with other facilities. Ausubel (1968s) notes that the laboratory should be carefully integrated with the textbook, that is, it should deal with the methodology related to the subject matter of the course and not with the experiments chosen solely because of their sustainability for illustrating various strategies of discovery. According to Driver and Bell (1985), the laboratory has been found to offer unique opportunities conducive to the identification, diagnosis and remediation of students’ misconceptions. From the above discussions, laboratory experience is and should be the widely used method.

Fieldwork and Project Work

There is increased use of fieldwork where students go to see science or chemistry being practiced in real life and in its natural setting, (Woolnough and Alsopp, 1985). This has led to what is often called zero-cost science. In addition, it helps in lowering costs. Fieldwork motivates students to make more realistic career choices. It also helps to demystify chemistry, it’s no longer seen as alien and unintelligible. Fieldwork in secondary schools mainly involves visiting industries and other places where chemistry knowledge is applied. Closely associated with fieldwork is project work. Project work is when students take an extended and independent or group of practical work,(Twoli,2006). Project work has often been confused with laboratory practical work. The difference is that in project work students do different manipulated activities or varied library search or different problem-solving tasks independently on individual or group basis while in laboratory work students usually do the same practical in the same place at the same time with the direct supervision of the teacher. Projects in chemistry can be observational or survey,
(Twoli, 2006). Project work lead to increased interest and relevance in the learning of chemistry. The most commonly carried out project work in Kenya is the annual students’ science congress.

2.5 Summary and Research Gap

Literature reviewed for this study has clearly illustrated the importance of chemistry laboratory in teaching and learning of chemistry. Since chemistry is a practical oriented subject, it is anticipated that most of the practical experiences can best be given in the laboratory (Nderitu, 2009). According to Hofstein (1991), laboratory activity (practical work) is contrived learning experiences in which students interact with materials to observe phenomena. Similarly, Ausubel (1968), observes that the laboratory gives the students appreciations of the spirits and the method of science, promotes problem solving, analytic and generalization ability, provide the students with some understanding of the nature of science. Woolnough and Allsop (1985) also stresses that if we want the students to acquire skills that are used by practicing scientists and if we are concerned with the teaching of the process skills of science, practical work seems to be vital in this context. Woolnough (1991), insists that care should be taken in the process because it is not just enough for students to do something in the laboratory but rather laboratory experiences need to be designed so that they focus attention.

Thus, chemistry laboratories should be well equipped and utilized in teaching and learning to enable students who complete secondary schools education graduate with requisite knowledge and skills that would not only enable them compete favourably in the job market but also pursue science and technology related fields. This is could be attributed to the fact that the reviewed literature have shown that the main role of a chemistry laboratory is to enable students develop
and practice manipulative skills (Twoli, 2007). However, the review also showed that there is limited empirical data on extent and influence of the use of chemistry in the teaching and learning of chemistry in country in general and in Meru South District in particular which raises the need for study.
CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research methodology which was used to investigate the extent of utilization of laboratories in teaching and learning chemistry in public secondary schools in Meru South District. The chapter includes research design, location of the study, sampling procedure and research instruments. It also contains data collection procedure as well as the procedure for data analysis.

3.2 Research design

The study adopted a survey research design. According to Mugenda and Mugenda (2003), a survey design is used to collect data from members of a population in order to determine the current status of that population with respect to one or more variables. Survey design was adopted because it involved collecting data in order to answer questions concerning the current status of subject of the study. It was used to access attitudes and opinions about events, individuals or procedure (Gay, 1976). The study embraced a descriptive approach. Descriptive survey is used when collecting information about people’s attitudes, opinions, habits or any variety of education on social issues (Orodho, 2003). Descriptive survey research was intended to produce statistical information about aspects of education that interests policy makers and educators (Borg and Gall, 1989). Data was gathered about the existing conditions in the Chemistry laboratories.
A survey is excellent in measuring characteristic of large populations. It describes, records, analyzes and reports conditions that exist or existed. It is also used to obtain data useful in evaluating present practices and in providing basis of decision making. Survey design allows the use of various instruments such as questionnaires, an interview schedule and an observation schedule among others. The study used questionnaires, an interview schedule and an observation schedule to obtain both qualitative and quantitative data from students, teachers, heads of science departments and laboratory technicians regarding the status and utilization of Chemistry laboratories. Figure 3.1 summarizes the design and process of the study.
RESEARCH POPULATION
Public Secondary School
Chemistry teachers and students,
Head of departments and laboratory technicians

SAMPLING TECHNIQUES

Stratified random sampling
Systematic sampling
Purposive sampling

STUDY SAMPLE
Teachers, Heads of Departments,
Students and Laboratory Technicians

DATA COLLECTION
Questionnaires, Interview Schedule and Observational Schedule

PILOTING
Questionnaires, Interview Schedules and Observational Schedule.

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

SUMMARY AND CONCLUSION

RECOMMENDATIONS

Source: Cohen and Manion (1994)
3.3 Location of the Study

The study was carried out in Meru South District which is one of the districts in Tharaka Nithi County. The district has three divisions. These are Chuka Division, Magumoni Division and Igamba Ng’ombe Division. The district borders Embu West District to the North, Maara District to the South, Tharaka to the East and Mt. Kenya forest to the west. The rationale for choosing Meru South District was that KCSE Chemistry performance has persistently recorded a low mean score. Other factors that influenced the choice of the district are familiarity to the area and limitation of time and money. Meredith (1996) noted that carrying out a research in a setting where you are known as a friend or a colleague makes it easier than if you are regarded as an outsider with unknown motives. This also improves the ethical, legal and public relations in research. Secondary schools in Meru south are boys’ boarding, girls’ boarding, mixed boarding and mixed day schools.

3.4 Target Population

The study targeted all the public secondary schools in Meru South District. The district has 40 secondary schools as is shown in Table 3.1.

Table 3.1. Meru South District Schools

<table>
<thead>
<tr>
<th>Boys Boarding</th>
<th>Girls boarding</th>
<th>Mixed boarding</th>
<th>Mixed day</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>7</td>
<td>26</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: D.E.O Meru South District (2011)

The study targeted 40 heads of science departments, 56 Chemistry teachers, 1464 form three Chemistry students and all the laboratory technicians in public secondary schools. Gay (1992) notes that two types of respondents are crucial. These are the informed specialists and consumers or users. Heads of science departments, teachers and laboratory technicians
represented the informed specialists while the students represented the users of the information and services. Form three students were presumed to have covered a reasonable portion of practical work. The form four class was an examination class while form one and two were presumed not to have covered enough practical work.

3.5 Sample and Sampling Procedure

3.5.1 Secondary Schools

Fifty percent of the populations can be included in the sample (Mugenda and Mugenda, 2003). A sample of ten percent of the population is considered minimum in descriptive research. Based on this information, sampling of schools was as follows;

Table 3.2 Sampled Schools

<table>
<thead>
<tr>
<th>Type of school</th>
<th>Target population</th>
<th>Sampled schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys boarding</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Girls boarding</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Mixed boarding</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Mixed day</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>

3.5.2. Sample Selection Technique

Stratified sampling was used to select from all the categories of schools in the district. According to Gay (1976), stratified sampling is the process of selecting a sample in such a way that identified sub groups in the population are represented in the sample in the same proportion that they exist in the population. It can also be used to select equal sized samples from each of number of subgroup, if sub group comparisons are desired.
Using this technique, the target population was stratified into five non-overlapping sub-populations or strata and items were selected from each stratum (Orodho, 2003). All the schools in the target population were stratified into four groups; boys’ boarding, girls’ boarding, mixed boarding and mixed day. For the boys boarding a coin was tossed since they were two and one was picked. For the other categories, pieces of paper were written and randomly picked from a container to avoid bias. This sample represented 20% of the schools in Meru South District. The total number of the sample was one boys’ boarding school, two girls’ boarding schools, two mixed boarding schools and three mixed day schools.

3.5.3 Head of Science Departments

Purposive sampling was used in this category. Considering that each school in the district has one head of science department, only eight, (one each from the sampled schools) were interviewed. This comprised twenty percent of the total population.

3.5.4 Chemistry Teachers

According to Mugenda and Mugenda (2003), there are particular situations when large samples are required:

i) When the accessible population is highly heterogeneous on the variables under study in case of animals or plants.

ii) When it is expected that many subjects in the study will not respond or will drop out and die in the case of animals or plants

iii) When the study requires the sample to be broken into sub groups.
Teachers in charge of the form three students in the sampled schools were used. Purposive sampling was used because affairs of each class are managed by the respective teachers. Thirteen teachers in the sampled schools were incorporated in the study.

3.5.5 Students

A sample size of 10% of the population is considered minimum in descriptive research (Gay, 1976). Based on this information, systematic sampling was employed. One hundred and eighty form three students were incorporated in the study sample. This represented 12.3 percent since there were 1464 form three students in the district.

3.5.6 Laboratory Technicians

Purposive sampling was used. All the laboratory technicians in the sampled schools were included in the sample. In schools with more than one, one was randomly picked. Eight laboratory technicians therefore made the sample.

**Table 3.3 Sampling Grid for the Study Sample**

<table>
<thead>
<tr>
<th>Type of school</th>
<th>Sampled Schools</th>
<th>Head of Science Department</th>
<th>Chemistry Teachers</th>
<th>Chemistry Students</th>
<th>Laboratory Technicians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys’ boarding</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>Girls’ boarding</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>Mixed boarding</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>Mixed day</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>60</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8</td>
<td>8</td>
<td><strong>13</strong></td>
<td><strong>180</strong></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>
3.6 Research Instruments

The research used a number of instruments, including questionnaires, observation schedule and interview schedule.

3.6.1 Questionnaires

A questionnaire is a written list of questions which are related to the topic. The questions are given to one or a number of people in the field who fill the answers. The required information can be extracted from the answers given by the respondents (Mugenda and Mugenda, 2003). Use of questionnaires can reach a large number of people who are able to read and write independently (Orodho, 2003). For the purpose of this study, the researcher constructed questionnaires to facilitate data collection. Some items in the questionnaires were structured (closed ended), to measure the objective responses and others were unstructured (open ended) to measure subjective responses and clarify objective responses to enhance formulation of useful recommendations of the study. The questionnaires were of three categories;

i) Questionnaire for chemistry teachers

ii) Questionnaire for chemistry students

iii) Questionnaire for laboratory technicians

The questionnaires were designed to collect information about the organization and use of chemistry laboratories in schools. Questionnaires were used because they present an even stimulus potentially to a large number of people simultaneously and provide the investigator with an easy accumulation of data (Gay, 1976)
3.6.2 Observation Schedule

Observation method is used because certain types of information can best be obtained through direct examination by the researcher. When the information concerns aspects of material objects or specimens, the process is relatively simple, and may consist of classifying measures or counting (Kimui, 1988). Observation is particularly important when the phenomena being observed cannot communicate back verbally. The data obtained from observation is very reliable because it is first hand information (Meredith, 1996). In this study, double practical lessons were observed to get first hand information on the arrangements of students’ practical and the skills enhanced and students’ conduct while in the laboratory. Storage of apparatus and chemicals was also observed. The observation was done using a self constructed schedule.

3.6.3 Interview Schedule

According to Mugenda and Mugenda (2003), an interview is an oral administration of a questionnaire or an interview schedule. Interviews are therefore face-to-face encounters between the researcher and the respondents. Orodho (2003), notes that in this method, investigation follows a rigid procedure and seeks answers to a set of pre-conceived questions through personal interviews. He further states that the output of an interview to a large extent depends on the ability of the interviewer. With the aid of researchers made interview schedule, selected heads of science departments were interviewed on various aspects of the chemistry laboratory. These included acquisition of resources, availability of technicians and teachers’ participation in practical work.
3.7 Pilot Study

A pilot study was carried out in one of the mixed boarding secondary schools in the target population but not included in the study sample. The purpose of the pilot study was to;

i) Test the reliability of the research instruments

ii) Provide the researcher with basic administrative procedures in carrying out the research

iii) Modify the instruments in terms of the right language, clarity of communication and sufficient space to write the responses

iv) Estimate the appropriate time allocation for administering the research instrument.

3.7.1 Validity of Research Instruments

Validity basically means the accuracy and meaningfulness of inferences which are based on research findings. Orodho (2004) defines validity as the degree to which results obtained from the analysis of data actually represent the phenomenon under investigation. Put differently, it is the degree to which results obtained from the analysis of data actually represent the phenomenon under investigation, (Orodho, 2004). For the purpose of ascertaining that the instruments measured what they were intended to measure, the researcher employed the use of experts who were her supervisors. The expert judgment of the supervisors assisted to improve the content validity of research instruments.

3.7.2 Reliability of Research Instruments

Reliability focuses on the degree to which empirical data indicators are consistent across two or more attempts to measure the theoretical concept. A reliable instrument is the one that has a small error or standard deviation (Orodho, 2004). Reliable instruments do not fluctuate randomly
from one moment to the next. The questionnaires were subjected to spearman’s correlation test using SPSS. A correlation of 0.9 was found on two successive administrations. A correlation of \( r = 0.8 \) or higher is taken as an indicator that the questionnaire is reliable (David and Sulton, 2004)

3.8 Data Collection Procedure

The researcher first obtained a research permit from the National Council for Science and Technology and permission from the District Education Officer to visit schools. The researcher then visited the schools prior to the actual data collection to establish a rapport with school principals and teachers. The form three chemistry teachers were requested to give the time they have a double lesson which was to be observed by the researcher. The researcher personally delivered the questionnaires to the respective schools and respondents during the agreed dates. The researcher observed all the facilities and activities in the chemistry laboratories as with the guidance of the observation schedule. This was after observing a laboratory session being taught in the laboratory. The researcher interviewed the heads of science departments on agreed dates and time.

3.9 Data Analysis

The questionnaires were counter checked for adequate completion by the researcher. The data was coded in a computer and analyzed using the Statistical Package for Social Science (SPSS) both qualitatively and quantitatively. The purpose of the study was to investigate the utilization of Chemistry laboratories in teaching Chemistry. Data was collected on variables such as resources available and their adequacy, availability of laboratory technicians, activities done in
the laboratory, and teachers and students attitude towards the use of laboratories among others. Descriptive statistics namely percentages, frequency distribution and means were used to present the data on the basis of which conclusions were drawn and recommendations made.

3.10 Logistical and Ethical considerations
Before data collection exercise began, the researcher pledged to be professional and ethical. The researcher obtained permission from the Ministry of education and then informed the District Education Officer and principals of schools where the research was done. The concerned persons were informed about the nature of research. After the consent the researcher guaranteed anonymity and confidentiality in order to respect the teachers, technicians and learners who participated. Thereafter the researcher proceeded to discuss with the principals and teachers of selected schools when to deliver the instruments.
CHAPTER FOUR
DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction

This chapter presents the analysis of the collected data, interprets and discusses the findings on extent of utilization of laboratories in teaching and learning Chemistry in public secondary schools in Meru South District. The data was obtained from Chemistry teachers, form three Chemistry students, heads of science departments and school laboratory technicians. This was through filling of questionnaires, face to face interviews and filling an observation schedule. The data obtained from respondents was analyzed using SPSS version 17.

4.2 Chemistry Teachers Bio-Data

An inquiry was made on the type of teachers charged with the responsibilities of handling the Chemistry classes in Meru south district. The findings are discussed under various succeeding subsections.

4.2.1 Teachers’ gender

An inquiry on Meru South Chemistry teachers’ gender yielded the results as summarized in Table 4.2.1.

Table 4.2.1 Teachers’ gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>8</td>
<td>61.5</td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
<td>38.5</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100</td>
</tr>
</tbody>
</table>
According to the information obtained, 8, (61.5%) of the teachers were males while 5, (38.5%) were females which depict a condition of gender disparity with fewer female Chemistry teachers compared to their male counterparts an indication of the effects of gender stereotypes of Chemistry as a male dominated area thus affecting the attitude and ultimately the performance of the girl child of Meru South District in Chemistry.

4.2.2 Chemistry Teachers Age

Similarly, the analysis of age distribution of the Meru South Chemistry teachers was as summarized in Table 4.3.2.

<table>
<thead>
<tr>
<th>Age in yrs</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 – 30</td>
<td>4</td>
<td>30.8</td>
</tr>
<tr>
<td>31 – 40</td>
<td>7</td>
<td>58.8</td>
</tr>
<tr>
<td>Above 40</td>
<td>2</td>
<td>15.4</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>100</td>
</tr>
</tbody>
</table>

From Table 4.2.2 which gives an analysis of the respondents’ ages, it is shown that a majority of the chemistry teachers, 7 (58.8%) were aged between thirty one and forty years followed by those whose ages ranged between twenty five to thirty 4, (30.8%) while 2, (15.4%) were found to be above forty years of age.

4.2.3 Chemistry teachers second teaching subject.

An inquiry was also made on the Chemistry teacher’s second subject in order to assess the level of the teacher’s engagement particularly in practical activities. The findings are represented in Table 4.2.3.
### Table 4.2.3 Chemistry Teachers’ Second Teaching Subject

<table>
<thead>
<tr>
<th>Subject</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>6</td>
<td>46.1</td>
</tr>
<tr>
<td>Physics</td>
<td>3</td>
<td>23.1</td>
</tr>
<tr>
<td>Biology</td>
<td>4</td>
<td>30.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The results show that most of the teachers were also teachers of Mathematics 6, (46.1%) followed by those who also taught Biology 4, (38.8%) and lastly those who taught Physics as their second subject 3, (23.1%). This means that a majority of the teachers (53.9%) being science teachers were in a better position to teach the practical chemistry skills.

#### 4.2.4 Chemistry teachers’ work experience

Work experience is usually an asset that an employee brings to the working place. The level of experience which the Meru south Chemistry teachers bring to their classrooms was an issue under investigation. The findings were as is shown in Table 4.3.4

### Table 4.2.4 Chemistry Teachers Experience in Years

<table>
<thead>
<tr>
<th>Experience in years</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1-5</td>
<td>3</td>
<td>23.0</td>
</tr>
<tr>
<td>5-10</td>
<td>4</td>
<td>30.8</td>
</tr>
<tr>
<td>10-20</td>
<td>4</td>
<td>30.8</td>
</tr>
<tr>
<td>Above20</td>
<td>2</td>
<td>15.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 4.2.4 shows that at the time of study only 3, (23.0 %) had a working experience of less than five years. This means that majority had adequate work experience. Long work experience is advantageous because it could lead to mastery of content.
4.2.5 Chemistry teachers’ academic and professional qualification

Teachers’ preparedness in terms of academic and professional qualification is an important determinant of their output in the classroom. It was therefore the intention of this study to assess the type of teachers that are in Meru south Chemistry classrooms. The findings were as is shown in Table 4.2.5

Table 4.2.5 Chemistry Teachers Academic and Professional Qualification

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Graduate</td>
<td>9</td>
<td>69.2</td>
</tr>
<tr>
<td>Diploma Education</td>
<td>4</td>
<td>30.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Information displayed in Table 4.2.5 shows that 9, (69.2%) of the sampled Chemistry teachers of Meru South District were university graduates and the remaining 4, (30.8%) were diploma holders. This means that all the sampled teachers were professionally qualified to teach in secondary schools and were trained in all aspects of education as far as curriculum implementation is concerned. The researcher further attempted to determine their attendance of in service training for Science teachers and Mathematics (SMASSE) which is a national activity. The results were as is shown in Table 4.2.6.

Table 4.2.6 Teachers In-Service Training (SMASSE)

<table>
<thead>
<tr>
<th>Rating</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ever Attended</td>
<td>10</td>
<td>76.9</td>
</tr>
<tr>
<td>Never Attended</td>
<td>3</td>
<td>23.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
The study found that 10, (76.9%) of the chemistry teachers had attended SMASSE while 3, (23.1%) had never attended. The In service training is said to be advantageous to teachers as it led to revitalization of the pre-service training which made them better teachers. The findings therefore manifest that a majority of the districts Chemistry teachers having attended the in service training should have the requisite revitalized skills that it offers those that attend.

4.3 Availability of Chemistry Laboratories and Laboratory resources

The main purpose of the study was to find out how Chemistry laboratories are utilized in teaching and learning of Chemistry in secondary schools. In regard to this, the first objective was to establish the availability of chemistry laboratories and laboratory resources. It was therefore imperative to determine from the onset whether schools had a laboratory facility. In this regard, the heads of science department were asked the questions. Its findings were as discussed under the various sub sections.

4.3.1 Availability of Chemistry Laboratory

The heads of science department were asked whether their school had a Chemistry laboratory. Their response was as is shown in Table 4.1

<table>
<thead>
<tr>
<th>No. of Schools</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available</td>
<td>8</td>
</tr>
<tr>
<td>Not Available</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4.3.1 shows that 7 (87.5%) of schools in Meru south district have a Chemistry laboratory while 1 (12.5%) do not. On further probing it was revealed that the school that didn’t have the
facility had a store for the apparatus and chemicals and teachers carried them to class whenever they had a practical lesson or a practical examination.

The researcher also sought to find out the number of laboratories in each school and how they are organized for various uses. The assessment of the organization of laboratories was based on the number available for the sciences and whether each subject had a laboratory designated for its specific use. Schools were expected to have either three laboratories with 1 being designated for specific use by each subject, two laboratories with one being designated for two sciences and the other for the remaining science subjects and lastly in those schools with only one used for all the three sciences. The results of the findings were as is shown in Table 4.3.2

<table>
<thead>
<tr>
<th>Table 4.3.2 Number of Laboratories in School</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Laboratories</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

The results in Table 4.3.2 show that most of the sampled schools 3 (42.8%) had only one laboratory while an equal number 2, (28.6%) had either two or three laboratories each.

4.3.3 Availability of Laboratory Technicians

Laboratory technicians are a major human resource in any science laboratory. They help manage the laboratory, arrange the apparatus, prepare solutions and assist teachers when giving practicals to students. Table 4.3.3 shows the prevalence of laboratory technicians in Meru South district.
Table 4.3.3 Number of School with Laboratory Technicians

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technician available</td>
<td>6</td>
<td>75.7</td>
</tr>
<tr>
<td>Technician not available</td>
<td>2</td>
<td>24.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

According to information contained in Table 4.3.3, 6, (75.7%) of the sampled schools had laboratory technicians while the remaining 2, (24.3%) indicated not having one. In the schools where a laboratory technician was absent, the science teacher doubled as the technician. In schools with a technician, it was the intention of the research to ascertain whether they possessed relevant technical training to enable them discharges their duties effectively. Table 4.3.4 gives their responses.

Table 4.3.4 Training of Laboratory Technician

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technician trained</td>
<td>4</td>
<td>66.7%</td>
</tr>
<tr>
<td>Technician not Trained</td>
<td>2</td>
<td>33.3%</td>
</tr>
</tbody>
</table>

From Table 4.3.4, it is evident that out of the six laboratory technicians sampled, 4, (66.7%) had the relevant training to work in a laboratory while 2’ (33.3%) did not have any training. Training is necessary for a technician as it makes his or her working easy and efficient. Untrained technicians usually rely on teachers and may make mistakes due to lack of the necessary expertise. It also interested the researcher to find out the technicians’ workload.

To find out the technicians' workload, the six laboratory technicians responded to a question on the number of the laboratories they manage. Their responses were as is indicated in Table 4.3.5
Table 4.3.5 Laboratory Technicians' Workload

<table>
<thead>
<tr>
<th>No. of laboratories managed by a technician</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>33.3</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>66.7</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4.3.5 shows that two out of six technicians, (33.3%) indicated that they manage one laboratory while four said they manage two laboratories, (66.7%) It is worth noting that in schools with only one laboratory, it caters for the three science subjects. This means that though a technician in such a school may be said to be managing only one laboratory, the work could still be overwhelming since the technician would also be in charge of the other Science subjects.

4.3.4 Resources Available in the Laboratory and their Adequacy.

Laboratory resources availability and their adequacy relative to the students' population in the sampled schools of Meru south district was an important investigative parameter of this study. The findings are shown in Table 4.3.6
Table 4.3.6 Resources Available in the Laboratory and their Adequacy

<table>
<thead>
<tr>
<th>Apparatus</th>
<th>Adequate</th>
<th>No</th>
<th>%</th>
<th>Not adequate</th>
<th>No</th>
<th>%</th>
<th>Not Available</th>
<th>No</th>
<th>%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benches</td>
<td>5</td>
<td>62.5</td>
<td>2</td>
<td>25</td>
<td>1</td>
<td>12.5</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Stools</td>
<td>5</td>
<td>62.5</td>
<td>2</td>
<td>25</td>
<td>1</td>
<td>12.5</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Tap Water</td>
<td>5</td>
<td>62.5</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>37.5</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Gas and Gas Taps</td>
<td>5</td>
<td>62.5</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>37.5</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Working Fume Chamber</td>
<td>2</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>75</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Glass Ware (Burettes, Pipette, beakers, flasks)</td>
<td>6</td>
<td>75</td>
<td>2</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Chemicals and reagents</td>
<td>8</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Fire extinguishers</td>
<td>7</td>
<td>57.5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>12.5</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>First Aid kit</td>
<td>3</td>
<td>37.5</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>62.5</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Safety Materials e.g. gloves and gas masks</td>
<td>0</td>
<td>87.5</td>
<td>4</td>
<td>50</td>
<td>4</td>
<td>50</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Preparation room</td>
<td>7</td>
<td>87.5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>12.5</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Storage space</td>
<td>7</td>
<td>87.5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>12.5</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Space for class work</td>
<td>7</td>
<td>87.5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>12.5</td>
<td></td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

From Table 4.3.6 which gives a summary of the data obtained from an analysis of laboratory resources and facilities shows the level of availability and adequacy as outlined under each item.

a) Benches and Stools

The results show that 5 (65.5%) schools were adequately equipped with working benches, 2 (25%) were inadequately equipped while 1 (12.5%) did not have working benches at all. In schools with adequate benches and stools students sat and worked comfortably and freely in the laboratory. The relaxed working environment seemed to act as a motivator. In schools with inadequate benches and stools, students were forced to squeeze around the available benches while some carried their chairs to the laboratory. This led to wastage of time and burdened the students.
b) **Tap Water and Gas Taps**

Water is very necessary in any laboratory since most activities in a chemistry laboratory require it. Gas taps and availability of gas are equally necessary. This is because some chemical processes require heating. Of the schools sampled, 3 (37.5%) did not have running water and gas. The students therefore carried water in buckets to the laboratory and either used potable burners or other forms of heating. In the remaining laboratory, 5 (62.5%) there however was running water and gas taps.

c) **Glassware**

Glassware constitutes most of the apparatus in the chemistry laboratory. The reason why glass is mostly used is because of its transparency which makes it possible for observations to be made and also due to its conductivity of heat. The results obtained showed that all the schools sampled had glassware, with the level of adequacy varying from adequate in some schools to inadequate in others. Of the sampled schools, 6 (75%) had adequate glassware while in 2 (25%) schools they were in adequate. In schools with inadequate glassware, students have to work in large groups thereby inhibiting their level of development of manipulative skills. During examinations, practical assessment takes place in many shifts each accommodating fewer students. This takes quite a long time at times. For schools with many students the sessions extend to night time. This is often tiring and discouraging to both the students, teachers and technicians as it will keep them in the laboratory for unnecessary long hours.
d) **Functional Fume Chamber**

The results showed that 2 (25%) schools had a functional fume chamber while the remaining percentage 6 (75%) did not have. Fume chambers are used when carrying out experiment that involves emission of poisonous fumes and also in preparation of poisonous gases such as Chlorine and Nitrogen (IV) Oxide. Doing such experiments in absence of fume chamber puts the health of many teachers and students at risk. Teachers tend to omit such activities for their safety and for that of the students in schools without fume chamber.

e) **Safety materials (gloves and gas masks)**

In all the laboratories, SAFETY FIRST is the most important slogan that all laboratory users have to adhere to. The adherence is important to prevent imminent dangers that luck within the laboratory on improper handling of laboratory chemicals and materials. Some of the protective wear that is supposed to be available in the laboratories includes gloves and gas masks. Of the schools sampled, 4 (50%) did not completely have the protective wears while the remaining 4 (50%) had inadequate levels of the protective gears. This ultimately led to avoidance of activities which involved handling of corrosive substances such as concentrated acids and preparation of poisonous gases such as chlorine, nitrogen (iv) oxide and sulphur (iv) oxide among others.

f) **Preparation Room and Space for Storage**

Space availability was found not to be an issue as 7 (87.5%) of the sampled schools had adequate storage and preparation room and only 1 (12.5%) lacked both. This was confirmed by the researcher when she personally observed how chemicals and apparatus were stored. The stores had shelves. Apparatus and chemicals were well arranged and each could be assessed with ease.
This was found to be predominant in schools with technicians. Schools without a laboratory technician also had a problem with storage and preparation room. Their stores were small and congested.

Overall analysis of the data on availability of laboratory and laboratory resources shows that most schools have laboratories as buildings with some having more than one laboratory hence there being a specific laboratory for Chemistry. Further, the findings showed that there was adequate space in the laboratories with most having technicians some of who were trained though most lacked vital equipment. This has implications that many practicals cannot be carried out hence not many skills can be developed (Hudson, 1985). According to Jenkins (1985), a laboratory should be well equipped if it is to serve its purpose. The study revealed inadequacy in chemistry laboratories. It concurs with Majani (1989) whose study revealed inadequacy of teaching and learning resources but differs with Orado (2009) who found that schools in Nairobi are well equipped with apparatus and materials to enable students engage in a variety of activities in chemistry practical work. The study showed that there are schools within Meru south district which to date still do not have chemistry laboratories. Very little practical work, mostly of the form of teacher demonstration was said to be taking place in such schools. In other schools, though a laboratory was available, they were found to be insufficient because they were also being used for the teaching and learning of the other science subjects. The case was further compounded in double or triple streamed schools where Chemistry was also compulsory for the large student population. In such cases the laboratory timetable was found to be congested leaving very little room for adequate preparation time for both the Chemistry teacher as well as the laboratory technician.
Further to the preceding observations, some of the laboratories were found to be lacking some important equipment and facilities. These included fume chamber, running water and gas taps. Fume chambers are used when carrying out activities that involve production of toxic gases such as chlorine, ammonia, nitrogen (IV) oxide and hydrogen sulphide to mention but a few. It is also used to store chemicals which produce poisonous fumes. When absent, teachers may shy off from carrying out such activities which in turn disadvantages the students. If such activities are done in its absence, it puts the health of the students and teachers at risk. Water is useful in the laboratory as a solvent, coolant and for collection of gases. Gas burners on the other hand are required to provide source of heat important for most reactions. It was also discovered that most laboratories lacked a first aid kit. It is advisable to have the kit because while in the laboratory accidents can occur. Further, no single school had adequate safety materials like gloves and gas masks. They were either inadequate or not available in all the schools visited. Safety of teachers, technicians and students should always be catered for.

It can therefore be concluded that the practical work done in such cases were not adequate to prepare students for their end of the course examination. Laboratory resource and facilities availability is therefore one of the major causes of students’ poor performance in Chemistry in Meru South District. This research finding seems to concur with those of several researchers. For instance, Lewis (1972) stated that practical work enhances learning by allowing students to work together in groups hence discussing among themselves in a language familiar to all. Okafor (1996) reported that schools with no laboratories were ill-equipped with human and material resources and are likely to affect student’s achievement in Chemistry. However, it contradicts
that of Rughubir (1979) who argued that availability of instructional resources does not necessarily translate into effective teaching and learning of a subject and hence improved achievement in the subject.

The researcher further sought to enquire how schools obtained laboratory resources. To find out how schools acquire resources in their laboratories, the heads of science departments were asked the sources of funds for stocking the laboratories. They all reported that schools fund stocking of laboratories. They were further asked the persons involved in the process. From the analysis of the interview schedules, the following were found to be involved:

(i) Principals
(ii) Heads of science departments
(iii) Chemistry teachers
(iv) Tendering committees
(v) Laboratory technicians

4.4 Chemistry Teachers and Students Use of Laboratories in Teaching and Learning of Chemistry

The second objective of the study was to find out how both teachers and students use laboratories in teaching and learning chemistry. All education systems heavily depend on teachers to execute its programs. It is therefore the role of chemistry teachers to make effective use of laboratories in teaching and learning of chemistry for educational standards to be maintained and improved.
4.4.1 Teachers’ Instruction in the Laboratory

Laboratory Chemistry instruction occur in the form of demonstration, group practical, individual practical or projects. An inquiry was made on the prevalence of each of the activities as given by teachers of Meru south district in the course of their teaching. Their responses were as is shown in Table 4.4.1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Once per week</th>
<th>Twice per week</th>
<th>Once in 2 weeks</th>
<th>Once per term</th>
<th>Rarely</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f</td>
<td>%</td>
<td>f</td>
<td>%</td>
<td>f</td>
<td>%</td>
</tr>
<tr>
<td>Demonstration</td>
<td>9</td>
<td>69.2</td>
<td>2</td>
<td>15.4</td>
<td>2</td>
<td>15.4</td>
</tr>
<tr>
<td>Individual practical</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Group practical</td>
<td>1</td>
<td>7.7</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>69.2</td>
</tr>
</tbody>
</table>

Table 4.4.1 shows that the most popular activities are teachers’ demonstrations and group practical. Teacher demonstration was found to be prevalent with 2, (15.4%) of teachers having them twice per week, 9 , (69.2%) once per week and 2, (15.4%) once in two weeks. For group practical, 1 (7.7%) of the respondents indicated giving it once per week, 9, (69.2%) once in two weeks and 3 (23.1%) once per term. Though the least popular, individual practical are the best because they give the students an opportunity to have hands on experience with the apparatus and chemicals. It also gives them confidence and exposure. This is very important because in the final exam they do the practical individually. Millar (2004) observed that the student must play an active role in the learning process if he has to make sense of ideas and concepts presented during the lesson. This is inevitable for any practical lesson to be meaningful.
The researcher also sought to find out whether Meru south Chemistry teachers give students work in form of projects to be carried out in the laboratory. Table 4.3.8 gives the teachers responses

Table 4.4.2 Frequency of Projects

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rarely</td>
<td>5</td>
<td>38.5</td>
</tr>
<tr>
<td>Not at all</td>
<td>8</td>
<td>61.5</td>
</tr>
</tbody>
</table>

Table 4.4.2 shows that projects are not popular in schools since they were either rarely given (38.5%) or not given at all (61.5%) to Chemistry students in Meru south schools. Project work motivates the students and increases their independence. Early introduction of such to students would make them better scientists in future.

Apart from giving them practical work to carry out, teachers should have an opportunity to assess the work done in order to correct the students and ascertain whether they are applying the appropriate scientific principles and processes. The researcher therefore attempted to inquire on the prevalence of Meru south teachers’ assessment of their students’ practical work. The findings were as is shown in Table 4.4.3

Table 4.4.3 How Often Teachers Mark Practical Work

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once per week</td>
<td>1</td>
<td>7.7</td>
</tr>
<tr>
<td>Once in two weeks</td>
<td>6</td>
<td>46.2</td>
</tr>
<tr>
<td>Once per term</td>
<td>4</td>
<td>30.7</td>
</tr>
<tr>
<td>Rarely</td>
<td>2</td>
<td>15.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
According to information contained in Table 4.4.3, 1, (7.7%) of the respondent teachers indicated that they marked their students’ practical books once per week, 6, (46.2%) marked the books once in two weeks, 4, (30.7%) once per term while the remaining 2, (15.4%) confessed that they rarely marked practical books. While a majority indicated assessing their students’ practical work progressively at varying rates, a significant minority showed a worrying trend of not going through learners work to ascertain whether they were applying concepts and principles taught. This could probably be one of the causes of Meru south students’ poor performance in Chemistry.

Also significant to this study was a confession of some of the Chemistry teachers of not having time to go through their students’ practical work book at the end of the practical work. The prevailing scenario therefore is one in which though the students seems to be exposed to some practical work, the quality of the practical could be presumed not to be adequate enough to provide them with ample experience in manipulative and process skills requisite for the competitive end of course examination. Therefore the extent of integration of laboratory in the teaching and learning of Chemistry in Meru South schools could also be a cause of the students dismal performance in Chemistry in the end of course examination. The practice of Meru South district teachers integration of laboratory practice seems to contradict the observations of researchers such as Twoli, (2006) who observed that a teacher who exposes learners to a variety of experiences give them an opportunity to form, test and transfer concepts thus prepare them to perform better. He stresses that it is by reflecting, exploring, testing, amending and revising current concepts to meet new circumstances and experiences that one undertakes meaningful learning which is supported by Khatete (1995) and Harris & Taylor (1983).
Relative to effect of frequency of assessment on performance, the research finding is in agreement with that of Twoli (2006) who stated that assessment is an important aspect of any educational programme. This assertion is supported by Ayot (1987) and Breener (2004) who both stressed that the techniques and frequency of assessment profoundly affect the content of the curriculum, how it is taught and ultimately performance.

A teacher’s workload is an important determinant of how they effectively implement the curriculum and make maximum use laboratories for this case. It was therefore the intention of the researcher to determine Meru South Chemistry teachers’ work load. The results were as is indicated in Table 4.4.4

<table>
<thead>
<tr>
<th>Number of lessons</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-21</td>
<td>2</td>
<td>15.4</td>
</tr>
<tr>
<td>22-27</td>
<td>3</td>
<td>23.1</td>
</tr>
<tr>
<td>28 and above</td>
<td>8</td>
<td>61.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The findings displayed in Table 4.4.4 shows that a large number of teachers 8, (61.5%) were overloaded since they taught either 28 lessons or more per week, 3, (23.1%) had between 22 and 27 lessons while 2, (15.4%) of the sampled teachers taught between 16 and 21 lessons per week. The findings therefore show that a majority of the Chemistry teachers were overworked with preparation for class work and had little time to prepare students practical work especially in schools which did not have laboratory technicians. Even in schools with laboratory technicians, teachers need to be present to guide students. Teachers work load therefore might be affecting the teachers’ use of laboratory in teaching Chemistry in Meru South District. The study further
sought to find out if teachers enjoyed teaching in their schools. The responses were as shown in table 4.4.5

**Table 4.4.5 Teachers Liking for their Work**

<table>
<thead>
<tr>
<th>Teacher enjoy teaching</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>8</td>
<td>61.5</td>
</tr>
<tr>
<td>No</td>
<td>5</td>
<td>38.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

According to information shown in Table 4.4.5, most of the sampled teachers, 8, (61.5%) indicated that they enjoyed teaching chemistry in their schools while 5, (38.5%) did not. The ones who did not enjoy teaching in their respective schools gave the students’ dismal performance in the subject, work overload (some stated that they had to double as laboratory technicians), inadequate teaching and learning resources particularly laboratory apparatus and chemicals and failure by the school administration to provide incentives as some of the factors responsible for their negative attitude towards teaching Chemistry in their respective schools.

### 4.4.2 Students’ use of laboratories

Learning in any science laboratory is an hands on experience (Nderitu, 2009). In a laboratory setting, students use laboratory chemicals, reagents and various apparatus to manipulate materials, gather data, make inferences and communicate the results and their findings. For the purposes of this study the researcher sought to find out Meru south students’ familiarity with various apparatus in the laboratory. The students were given a list of common apparatus and asked whether they could comfortably use them. Their responses were as is shown in Table 4.4.6
### Table 4.4.6 Students Familiarity with use of apparatus.

<table>
<thead>
<tr>
<th>Apparatus</th>
<th>Conversant</th>
<th></th>
<th>Not Conversant</th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of</td>
<td>%</td>
<td>No. of</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>students</td>
<td></td>
<td>students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burette</td>
<td>113</td>
<td>62.8</td>
<td>67</td>
<td>37.2</td>
<td>180</td>
</tr>
<tr>
<td>Pipette</td>
<td>113</td>
<td>62.8</td>
<td>67</td>
<td>37.2</td>
<td>180</td>
</tr>
<tr>
<td>Pipette filler</td>
<td>23</td>
<td>12.8</td>
<td>157</td>
<td>87.2</td>
<td>180</td>
</tr>
<tr>
<td>Thermometer</td>
<td>45</td>
<td>25</td>
<td>135</td>
<td>75</td>
<td>180</td>
</tr>
<tr>
<td>Stop watch</td>
<td>78</td>
<td>43.3</td>
<td>102</td>
<td>56.7</td>
<td>180</td>
</tr>
<tr>
<td>Bunsen burner</td>
<td>153</td>
<td>85</td>
<td>27</td>
<td>15</td>
<td>180</td>
</tr>
<tr>
<td>Volumetric flask</td>
<td>92</td>
<td>51.1</td>
<td>88</td>
<td>48.9</td>
<td>180</td>
</tr>
<tr>
<td>Conical flask</td>
<td>173</td>
<td>96.1</td>
<td>07</td>
<td>3.9</td>
<td>180</td>
</tr>
<tr>
<td>Gas jar</td>
<td>127</td>
<td>70.6</td>
<td>53</td>
<td>29.4</td>
<td>180</td>
</tr>
<tr>
<td>Fume cupboard</td>
<td>0</td>
<td>0</td>
<td>180</td>
<td>100</td>
<td>180</td>
</tr>
<tr>
<td>Test tube and boiling tubes</td>
<td>180</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>180</td>
</tr>
</tbody>
</table>

Results of an analysis of Meru south students’ familiarity with laboratory equipments a summary of which is displayed in Table 4.4.6, shows that conical flask is the most manipulated laboratory equipment, (96.1%), by the sampled students, followed by Bunsen burner, (85%), then gas jar, (70.6%) and both burette and pipette, (62.8%). However, none of the sampled students seemed to be conversant with the use of the fume cupboard. This may be due to its absence in most schools. It also indicates that activities that involve the use of the fume chamber are rarely done or probably not done at all in schools in Meru south district. Notably, the use of pipette fillers, thermometer and stop watch recorded very low rating with a majority of respondents indicating that they are not conversant with them. The number of students conversant with them stood at 12.8% for pipette filler, 25% for a thermometer and 43.3% for stop watch respectively. The three are very common apparatus for use in most national practical examination. This could therefore be a pointer to one of the reasons why the students are performing poorly in the national examination. This could be due to inadequate exposure of the
students to proper laboratory experience that involves manipulation of all the requisite apparatus and materials.

4.4.3 Observed Laboratory practices

The researcher observed 7 double lessons carried out in the seven of the sampled schools. The 8th school was not observed since it did not have a laboratory. The aim was to get first hand information on how teachers and students use the laboratories. In all the 7 lessons observed, the students did practical on their own. None featured a teacher’s demonstration although it was what teachers do frequently in the laboratory (Table 4.4.1). This might have happened because the researcher had informed the teachers that she would observe their laboratory class. Various issues were assessed as is discussed based on several attributes.

4.4.3.1 Punctuality in the Laboratory

Time for a double lesson is eighty minutes. If not utilized well, the students might fail to complete the intended work. The researcher got to the laboratory before the lessons started. In all the lessons the researcher observed, both the teachers and the students were present in the laboratory on time.

4.4.3.2 Arrangement of the practical work

The researcher got to the laboratory before class time to observe who does the arrangement of the apparatus and reagents. It was observed that of the total situations, in 4 instances, (57.1%) the apparatus were arranged by the teacher and the technician while in 3 cases, (42.9%) the arrangement was done by both the teacher and the students.
4.4.3.3 Mode of Giving Instruction

Laboratory instructions may be given in various formats. These can be in worksheets, pre-prepared booklets or writing on the chalkboard for a school class lesson. In all the observed lessons none had worksheets or booklets. The main form of instruction was use of chalk board and verbal communication.

4.4.3.4 Size of Groups

The practicals were done in groups. In most cases, the number of members in a group was equal and ranged between 2-5 and above 5 as is shown in Table 4.3.7

Table 4.4.7 Size of groups

<table>
<thead>
<tr>
<th>Group Members</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2-5</td>
<td>3</td>
<td>42.9</td>
</tr>
<tr>
<td>Above 5</td>
<td>4</td>
<td>57.1</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4.3.7 shows that a majority of learners performed practical in large groups of more than 5 students per group, (57.1%) while 42.9% of the observed cases had groups of between 2-5 students. Groups with 2-5 students are considered reasonable as each student would get a chance to handle the apparatus. Groups with more than 5 students may not be the best as they are crowded and some students may be passive and little or nothing.

4.3.3.4 Consultation among Students

During the practical, it was observed that the students freely interacted amongst themselves. This was however affected by the large group sizes. This showed that apart from the practical skills the students were learning, they were also developing their interactive and communicative skills. Gunstone and Champagne (1990), observed that meaningful learning in the laboratory
would occur if students were given sufficient time and opportunities for interaction and reflection.

4.3.3.5 Teachers’ Assistance to Students

One role of a teacher is to guide the students. This can be in handling apparatus, interpreting procedures or recording the data obtained. Table 4.3.8 records the observed teacher’s involvement in students’ laboratory work.

**Table 4.4.8 Teachers’ Assistance to Students**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers assist students</td>
<td>5</td>
<td>71.4</td>
</tr>
<tr>
<td>Students perform the practical without teacher’s assistance</td>
<td>2</td>
<td>28.6</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>100</td>
</tr>
</tbody>
</table>

Information contained in Table 4.3.8 about Chemistry teachers’ involvement during students laboratory work shows that in most of the cases, (71.4%), students were being assisted by the teachers where necessary. This indicated that the students were willing to be assisted and learn what they didn’t know. According to Wilson, (1999), the teacher needs to be aware of the potential difficulties students have with some concepts for him to carry out his or her role effectively. It also shows that the students had the right attitude towards what they were doing in the laboratory. It is only in a few cases, (28.6%) that the students were found to be performing the practical on their own without the assistance of the teacher.

The researcher observed the students’ general conduct while inside the laboratory with specific areas of interests as grooming, relating with one another, safe handling of apparatus and the extent of their interest in the lesson. For all the 7 lessons, the conduct was above average.
With regard to students’ familiarity with laboratory apparatus and equipment, the findings showed that students were well conversant with apparatus such as conical flask, Bunsen burner, gas jar, burette and pipette, probably due to high frequency of their usage. However, none of the sampled students seemed to be conversant with the use of the fume cupboard. This may be due to its absence in most schools. It also indicates that activities that involve the use of the fume chamber are rarely done or probably not done at all in schools in Meru South District. Notably, the use of pipette fillers, thermometer and stop watch recorded very low rating with a majority of respondents indicating that they are not conversant with them. The three are very common apparatus for use in most national practical examination. Inadequate exposure of the students to proper laboratory experience that involves manipulation of all the requisite apparatus and materials could therefore be a pointer to one of the reasons why the students are performing poorly in the national examination. The findings concur with that of Bhagwan (2005) who stated that students learn and retain better what they learn when engaged in authentic learning. This is also supported by Twoli (2006) who asserts that Chemistry curriculum is more laboratory based and a large proportion of learning is spent on practical or hands – on experiences. A teacher who exposes his/her students to selective apparatus and laboratory experience therefore disadvantages them.

Further, the study established that a majority of learners performed practical in large groups of more than 5 students per group. This is critical since groups with 2-5 students are considered reasonable as each student would get a chance to handle the apparatus while groups with more than 5 students may not be good since they are crowded and some students may be passive thus learn very little. However, Chemistry teachers were found to be actively involved during students laboratory work in assisting the students where necessary. This indicates that the
students were willing to be assisted and learn what they didn’t know. According to Wilson (1999), a teacher needs to be aware of the potential difficulties students have with some concepts for him to carry out his or her role effectively.

4.5 Students’ Attitude towards Chemistry Practical Work

The study intended to find out the students’ attitude towards chemistry practical work. This is because the practical work is usually carried out in the laboratory in various activities. The sampled students filled a five point Likert scale in which they were required to give their views regarding given statements as; strongly agree(SA), agree(A),undecided(U),disagree(D) or strongly disagree(SD). Numerical values were then assigned to the responses as follows SA=5, A=4, U=3, D=2 and SD=1. The mean score for each item for all the respondents were calculated as a testament of the students’ level of favorable or unfavorable feelings towards Chemistry as a subject. For the purposes of this analysis, favorable feelings were taken to range from 3<x<5 while unfavorable feelings ranged from 1<x<3 for positive statements and vice versa for negative statements where x is the item mean score. The statements were grouped and coded as either positive represented by P or negative represented by code N as is shown in Table 4.5.1
Table 4.5.1 Codes of items on the Likert scale

<table>
<thead>
<tr>
<th>Statement</th>
<th>Nature</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry is important for my future career</td>
<td>Positive</td>
<td>P1</td>
</tr>
<tr>
<td>Chemistry practical is necessary for a good grade</td>
<td>Positive</td>
<td>P2</td>
</tr>
<tr>
<td>Teachers should be present to guide us when doing practical</td>
<td>Positive</td>
<td>P3</td>
</tr>
<tr>
<td>Practical should be done individually</td>
<td>positive</td>
<td>P4</td>
</tr>
<tr>
<td>Group or individual practical are better than teachers demonstration</td>
<td>Positive</td>
<td>P5</td>
</tr>
<tr>
<td>Teachers should leave us alone in the laboratory to do practicals</td>
<td>Negative</td>
<td>N1</td>
</tr>
<tr>
<td>Practicals should be done in large groups</td>
<td>Negative</td>
<td>N2</td>
</tr>
<tr>
<td>Mathematics should be excluded in chemistry practical</td>
<td>Negative</td>
<td>N3</td>
</tr>
</tbody>
</table>

Table 4.5.1 shows that of the statements given to the students, five were positive while 3 were negative. The frequency of the students’ responses to the statements were analysed and the findings are as shown in Table 4.5.2

Table 4.5.2 Frequency of Students’ Responses to Likert scaled statements

<table>
<thead>
<tr>
<th>Code</th>
<th>SA Frequency</th>
<th>SA %</th>
<th>A Frequency</th>
<th>A %</th>
<th>U Frequency</th>
<th>U %</th>
<th>D Frequency</th>
<th>D %</th>
<th>SD Frequency</th>
<th>SD %</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>92</td>
<td>51.1</td>
<td>88</td>
<td>48.9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P2</td>
<td>87</td>
<td>48.3</td>
<td>93</td>
<td>51.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P3</td>
<td>103</td>
<td>57.2</td>
<td>71</td>
<td>39.4</td>
<td>1</td>
<td>0.6</td>
<td>1</td>
<td>0.6</td>
<td>4</td>
<td>2.2</td>
</tr>
<tr>
<td>P4</td>
<td>47</td>
<td>26.1</td>
<td>113</td>
<td>62.8</td>
<td>1</td>
<td>0.6</td>
<td>15</td>
<td>8.3</td>
<td>4</td>
<td>2.2</td>
</tr>
<tr>
<td>P5</td>
<td>61</td>
<td>33.9</td>
<td>60</td>
<td>33.3</td>
<td>5</td>
<td>2.8</td>
<td>38</td>
<td>21.1</td>
<td>16</td>
<td>8.9</td>
</tr>
<tr>
<td>N1</td>
<td>16</td>
<td>8.9</td>
<td>2</td>
<td>1.1</td>
<td>9</td>
<td>5.0</td>
<td>38</td>
<td>21.1</td>
<td>115</td>
<td>63.9</td>
</tr>
<tr>
<td>N2</td>
<td>25</td>
<td>13.9</td>
<td>9</td>
<td>5.0</td>
<td>2</td>
<td>1.1</td>
<td>103</td>
<td>57.2</td>
<td>41</td>
<td>22.8</td>
</tr>
<tr>
<td>N3</td>
<td>21</td>
<td>11.7</td>
<td>4</td>
<td>2.2</td>
<td>4</td>
<td>2.2</td>
<td>69</td>
<td>38.3</td>
<td>56</td>
<td>31.1</td>
</tr>
</tbody>
</table>

The mean score were calculated for all statements both negative and positive statements and the results were as is shown in Table 4.5.3.

Table 4.5.3 Mean Scores for Likert Scale Statements

<table>
<thead>
<tr>
<th>Statement Code</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>N1</th>
<th>N2</th>
<th>N3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.57</td>
<td>4.48</td>
<td>4.49</td>
<td>4.02</td>
<td>3.62</td>
<td>1.7</td>
<td>2.3</td>
<td>2.44</td>
</tr>
</tbody>
</table>
Table 4.5.3 shows that the mean of positive statements were in range $3<x<5$ while those of negative statements ranged between $1<x<3$. This indicates that the students’ attitude towards chemistry practical work is generally positive. They were aware that the practical work is necessary for their performance in chemistry.

From the foregoing observations on Meru South District Chemistry students’ attitude towards Chemistry practicals, it was found that the students’ attitude towards chemistry practical work is positive. The results indicated that students were aware that practical work is necessary for their performance in chemistry. This was however not reflected in the chemistry performance in the district. Chemistry teachers should take advantage of this positive attitude, which could be done through increasing the frequency of practicals. Students should also be involved in the organization of practical and improvisation of resources such as models, thus enhance their motivation. It can therefore be concluded that the poor performance of Meru South District Chemistry students is not as a result of their attitude towards the subject. The findings contradicts that of Majani , (1989) on factors that contribute to poor performance in O- level chemistry which showed that students’ attitude towards chemistry was largely responsible for the poor performance which is supported by that of Orado, (2009).

4.6 Storage of Apparatus and Chemicals in the Laboratory

The fourth objective of the study was to find out how schools stored apparatus and chemicals in the laboratory. According to Driver and Bell, (1985), the laboratory has been found to offer unique opportunities conducive to the identification, diagnosis and remedy of students’ misconceptions. The extent of organization of the laboratory and arrangement of equipments and chemicals could promote or inhibit the realization of the stated objectives. In was therefore the
intention of the researcher to ascertain the level of effectiveness of the laboratories in offering a conducive learning environment to the chemistry lessons. To achieve this, the researcher used a constructed observation schedule.

4.6.1 Availability of space

It was observed that except for 1 station, (12.5%), there was adequate space in all the other laboratories.

There was adequate space for storage of laboratory apparatus and equipment. The apparatus and chemicals could be easily retrieved in most of the stores.

4.6.2 Records Keeping

In any laboratory, records’ keeping is of paramount importance. It assists in making purchases. With proper records, the laboratory users can easily know the availability of what they intend to use. An assessment was made on the availability of laboratory records and the outcome was as is indicated in Table 4.6.1

Table 4.6.1 Availability of Laboratory Records

<table>
<thead>
<tr>
<th>Nature of the record</th>
<th>Available</th>
<th>Percentage</th>
<th>Not Available</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record of Apparatus</td>
<td>6</td>
<td>75</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Record of Chemicals</td>
<td>3</td>
<td>37.5</td>
<td>5</td>
<td>62.5</td>
</tr>
<tr>
<td>Record of dysfunctional Apparatus</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 4.6.1 shows that in 6 cases, (75%), there were records of apparatus, 3, (37.5%) cases of records of chemicals used in the laboratory. However, none of the laboratories were found to keep records of dysfunctional apparatus. Record keeping is very important and should be done perfectly. It makes work easier especially when the staff changes. There was an attempt to record keeping of laboratory apparatus and chemicals, with the recording of laboratory apparatus being more prominent. Record keeping is very important and should be done properly. It makes work easier especially when the staff changes,(Das,1985).

4.6.3 General organization of the store

The researcher sought to find out how school laboratories are arranged. This was done through direct observation in the stores. The data obtained was as is shown in Table 4.6.2

<table>
<thead>
<tr>
<th>Table 4.6.2 Organization of Stores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
</tr>
<tr>
<td>Apparatus labeled</td>
</tr>
<tr>
<td>Chemicals labeled</td>
</tr>
<tr>
<td>Poisonous substances indicated</td>
</tr>
<tr>
<td>Apparatus can easily be retrieved</td>
</tr>
<tr>
<td>Chemicals can easily be retrieved</td>
</tr>
</tbody>
</table>

Table 4.6.2 shows that more caution is taken in storage of chemicals than of apparatus. The results show that 75% of the cases had labeled all the chemicals whereas only 37. 5% of the cases had labeled their apparatus. The apparatus and chemicals could be easily retrieved in most of the stores at 75% for both apparatus and chemicals. However, 25% of the cases observed had a problem in accessing and retrieving the apparatus and chemicals. Further it is worth noting that
only a few of the visited schools, (25%) had labeled the poisonous substances. This could pose a health hazard in the other stores where such materials were not labeled, (Twoli, 2007).

4.7 Problems encountered in the use of laboratories

It was the intention of the researcher to find out the problems encountered in the use of laboratories in Meru South District.

Concerning the laboratory technicians, the study found that 24.3% of the sampled schools didn’t have laboratory technicians and in schools with laboratory technicians,(33.3%) were found not to have the relevant training as it is indicated in Table 4.2.2 and Table 4.2.3. Training is necessary for a technician as it makes his or her working easy efficient. Untrained technicians usually rely on teachers and may make mistakes due to lack of necessary expertise.

Absence of technicians leaves an overworked teacher with extra work in the laboratory. This may demoralize the teacher. It could also make teachers perceive practical work as a burden and avoid it as much as possible. Overworked teachers may not have enough time to organize and administer practicals. The study also found that the chemistry teachers workload was not friendly for many of them as indicated in table 4.3.4 with a good majority (61.5%) having a workload of more than 28 lessons. In schools without laboratory technicians the overworked teachers may have limited time to prepare for students’ laboratory work

Lack of some laboratory apparatus was also found to pose a problem in the use of laboratories (Table 4.3.5) Lack of vital laboratory resources such as running water and a reliable source of heating may complicate achieving tasks related to their use. Most common methods of
improvisation such as use of water in basins or stove for heating are often cumbersome particularly with regard to large student population. Inadequacy of apparatus also led to students working in large ineffective groups as it is indicated in Table 4.4.7

The students were also found to be conversant with the use of some laboratory resources (Table 4.4.6). For instance, none of the students was conversant with the use of the fume cupboard. The other apparatus which many students didn’t know how to use were pipette fillers (87.2%), thermometers (75%) and stop watches at 56.5%.

Record keeping was also found to hinder effective use of laboratories in Meru South District. As it is in indicated in table 4.6.1 on availability of laboratory records, 65% of the sampled schools didn’t keep records of chemicals while 25% didn’t keep the record of apparatus. Schools may therefore purchase chemicals and apparatus already in stock. This may lead to wastage when chemicals expire before use.
CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.

5.1 Introduction

This chapter summarizes the findings of the study carried out in Meru South District on utilization of Chemistry resources in teaching and learning of the subject in public secondary schools. The findings were obtained from the research instruments which were questionnaires, interview schedule and an observation schedule. It also makes conclusions based on the research findings and ends with various recommendations.

5.2 Summary of Findings

The study sought to find out the extent of utilization chemistry laboratories in teaching and learning in secondary schools in Meru South District. It covered a survey of eight public secondary schools sampled from a total of forty public secondary schools in the district. The respondents for the study were eight heads of science departments, seven laboratory technicians, thirteen chemistry teachers and 180 form three chemistry students. The instruments used for data collection were an interview schedule, an observation schedule and three questionnaires for students, teachers and laboratory technicians.

The study found that in Meru South District, there are still some schools which do not have chemistry laboratories or laboratories for that matter. Those without a laboratory however had some apparatus and chemicals stored in a room. Though a majority of schools visited attested to having at least one laboratory, only a small percentage had a specific laboratory for each science subject, Chemistry included. Further, a majority of the sampled schools with a laboratory had a
laboratory technician most of whom are trained. The laboratory technicians were found to be overworked.

In terms of laboratory resources, only a few schools could be said to have adequately equipped laboratories. Conspicuously missing from most of the laboratories visited were fume chambers, first aid kits and protective gear such as gloves and masks.

In relation to pedagogical approach in practical work, teachers were found to prefer demonstrations and group practicals while project works were the most unpopular method of teaching. Further, individual practicals were rare and group practicals were done in large groups thus disadvantaging the students’ development of manipulative skills. Worse still, marking of the students’ practical work was found to be inconsistently done. All the Chemistry teachers in the district were found to be adequately trained to handle the subject. They either had a bachelor’s degree in education or a diploma in education. Some had attended in-service training while others had not. However a significant minority of the teachers didn’t seem to like handling Chemistry practical work in the laboratory for various reasons

Chemistry students in the district were found to have a positive attitude towards the chemistry practical work. The impact of the positive attitude however did not seem to feature in the national examination results. Some students were conversant with use of some apparatus while others were not.
Storage of apparatus and chemicals was found to be relatively good but records were not well kept in most schools. In acquisition of the laboratory resources, school principals, heads of science departments, chemistry teachers and laboratory technicians participated.

The study found that absence, lack of training and overworking of technicians was a problem encountered in the use of how laboratories w in the district under study. Other problems included students unfamiliarity with use of some apparatus and overworked teachers especially in schools without laboratory technicians.

5.3 Conclusion

From the research findings of this study, it is clear that utilization of laboratories in Meru south is not adequate. This according to some respondents was due to missing apparatus which means that the chemistry syllabus is not well covered. Some students were not conversant with use of some apparatus and therefore could not be in a position to handle a practical examination in which such apparatus are to be used effectively. This could be the major reason why performance in Chemistry in the district is low.

5.4 Recommendations

From the observations made in the preceding sections, various recommendations relative to policy and for further research have been proffered and are discussed separately.
5.4.1 Policy Recommendations

The study recommends that schools invest to ensure that they have a specific Chemistry laboratory adequately equipped with all the required teaching and learning resources for Chemistry practicals.

Similarly, each school should strive to employ a laboratory technician to help ease teachers’ work. The technicians should be trained on their work including efficient record keeping which enable them discharge their responsibilities professionally.

Further, it is recommended that students be introduced to the use of all the apparatus in their lower classes thus ensure adequate mastery of practical skills for practice and examination purposes.

Lastly, it is important that teachers take advantage of the students’ positive attitude and give them adequate practical work thus improve their performance in the subject.

5.4.2 Suggestion for Further Research

The researcher proposes further study in the following areas: First and foremost, it is suggested that the study be extended to other districts in Kenya to ascertain its complementarities. Secondly, the same research should be carried out using varied research designs. Thirdly, the same study could be conducted in other science subjects, and finally, it is suggested that research on factors impeding effective use of laboratories be undertaken.
REFERENCES


Eshiwani G.S (1988). Education in Semi Arid Areas; a study of Determinants of school achievements in Kajiado District. BER, Kenyatta University, Nairobi

Gay L.R. (1976). *Education Research: Competencies and Applications*. Columbus: Merrill publishing CO,


APPENDIX I: CHEMISTRY STUDENTS QUESTIONNAIRE

The purpose of this questionnaire is to collect information for research purposes. The study is about the chemistry laboratories. It is hoped that the findings will assist improve the conditions in our laboratories for the good of the learners. This work will not be marked. Feel free and answer the questions as accurately as possible. (Tick √ in the appropriate box)

1. Type of your school?
   i. Boys boarding
   ii. Girls boarding
   iii. Mixed boarding
   iv. Mixed day

2. Gender
   a) Male
   b) Female

3. Do you go to learn in the Chemistry Laboratory?
   a) Yes
   b) No

   If yes, how often

4. What are the main activities in the laboratory?
   a) Teacher demonstration
   b) Individuals practicals
   c) Group practicals
5. In what form were you when you went for the first chemistry practical in the laboratory?

a) Form one
b) Form two
c) Form three

6. How often do you go to the Chemistry Laboratory for a practical?

a) Twice per week
b) Once per week
c) Once in two weeks
d) Once per term
e) Rarely

7. Who arranges for your laboratory practical work?

a) Teacher
b) Technician
c) Students

8. Who supervises you while in the laboratory?

a) Teacher
b) Technician
c) Prefect
d) Nobody
9. How do you find Chemistry practical sessions?
   
a) Very interesting  
   b) Interesting  
   c) Boring  
   d) Very boring  

10. For each of the following questions, respond by ticking in the appropriate box

SA – Strongly Agree   A – Agree   U – Undecided   D – Disagree   SD – Strongly Disagree

<table>
<thead>
<tr>
<th></th>
<th>SA</th>
<th>A</th>
<th>U</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chemistry is important for my future career</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Chemistry practical are necessary for a good grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Teachers should leave us alone in the laboratory to do practicals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Teachers should be present to guide us when doing practicals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Practicals should be done individually</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Practicals should be done in large groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Group or individual Practicals are better than teachers demonstration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Mathematics should be excluded in Chemistry practicals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11. Can you comfortably use the following apparatus on your own?

<table>
<thead>
<tr>
<th>Apparatus</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burette</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipette</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipette Filler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermometer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop Watch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunsen burner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fume cupboard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas jar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volumetric flask</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conical flask</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test tubes and boiling tubes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX II: CHEMISTRY TEACHER QUESTIONNAIRE

This questionnaire gathers information strictly for research purposes. It is hoped that the information will be useful to our school laboratories. The information given will be kept confidential. (Tick √ in the appropriate box).

1. Name of your school ________________________________

2. Type of your school
   a) Boys boarding ☐
   b) Girls boarding ☐
   c) Mixed boarding ☐
   d) Mixed day ☐

3. Gender
   a) Male ☐
   b) Female ☐

4. Age in years
   a) Below 25 ☐
   b) 25 – 30 years ☐
   c) 30 – 40 years ☐
   d) Above 40 years ☐

5. For how long have you been teaching chemistry?
   a) Less than 1 year ☐
   b) 1-5 years ☐
c) 5 - 10 years

d) 10-20 years

e) Above 20 years

6. What is your level of education?
   a) Post graduate
   b) Graduate
   c) Diploma
   d) Form 6
   e) Form 4

7. Which other subject do you teach?
   a) Maths
   b) Physics
   c) Biology
   d) Any other (specify) _________________________________

8. How many lessons do you teach in a week? _________________________________

9. How many Chemistry lessons do you teach in a week? ________________________

10. Do you have a laboratory technician in your school?
    a) Yes
    b) No

11. If yes is the technician trained?
    a) Yes
    b) No
12. How often do you carry the following activities in the laboratory? Use the key given below

A- Once in a week
B- Twice in a week
C- Once in two weeks
D- Once in a term
E- Rarely
F- Not at all

<table>
<thead>
<tr>
<th></th>
<th>A.</th>
<th>B.</th>
<th>C.</th>
<th>D.</th>
<th>E.</th>
<th>F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Do a demonstration in the laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) Give group practicals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iii) Give individual practicals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iv) Give Chemistry projects to be carried out in the laboratory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(v) Mark student’s practical work</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. Do you give practicals as identified in the syllabus?

a) Yes   

b) No   

If no, why

_____________________________________________________________________

_____________________________________________________________________

87
What should be done to improve the situation?

____________________________________________________________________

____________________________________________________________________

14. Do you enjoy teaching chemistry?
   a) Yes □
   b) No □

If no why

____________________________________________________________________

____________________________________________________________________

15. Have you ever attended SMASSE, seminar or any in-service course?
   a) Yes □
   b) No □

Explain

____________________________________________________________________

____________________________________________________________________
16. Below is a list of requirements in a Chemistry Laboratory. How do you rate them in your school? Tick (√)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Adequate</th>
<th>Not adequate</th>
<th>Not available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas taps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working fume chamber</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass ware</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical and reagents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire extinguisher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety materials e.g. gloves and gas masks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparation room</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space for storage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space for class work</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17. Do you give practical exams?

a) Yes [ ]

b) No [ ]

If yes, at what form do you start?

a) Form 1 [ ]
b) Form 2

Form 3

If No, why? __________________________________________________________

18. Which are the biggest limitations in the Chemistry laboratory?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
APPENDIX III: QUESTIONNAIRE FOR THE LABORATORY TECHNICIAN

This questionnaire is for research purposes. The work will not be marked. You are requested to answer the questions as accurately as possible. (Tick √ in the appropriate box)

1. Name of your school ________________________________

2. Type of your school
   a) Boys boarding   
   b) Girls boarding 
   c) Mixed boarding 
   d) Mixed day     

3. Gender
   a) Male   
   b) Female 

4. For how long have you been in this school _____________________

5. Are you trained or not trained as a laboratory technician?
   a) Trained   
   b) Not trained 

6. How many laboratories do you manage?
   a) One       
   b) Two      
   c) Three    
   d) More than three
7. How many laboratories are in this school?
   a) One  
   b) Two  
   c) Three  
   d) More than three  

8. How are laboratories organized?
   a) One for each science subject  
   b) One for all the science subjects  

9. Which class frequents the Chemistry Laboratory for practicals so much?
   a) Form One  
   b) Form Two  
   c) Form Three  
   d) Form Four  

10. Do teachers carry out the practicals before giving to the students?
    a) Yes  
    b) No  
    c) Not sure  

11. Are students allowed to go to the laboratory without a teacher?
    a) Yes  
    b) No  

12. Is there any improvisation of apparatus in the laboratory?
    a) Yes  
    b) No  

13. Does the school administration inspect the laboratory?
   a) Yes □
   b) No □

14. Does the school administration inspect the Laboratory?
   a) Yes □
   b) No □

   If yes, how often
   a) Weekly □
   b) Monthly □
   c) Termly □
   d) Yearly □

15. What is the standard of the apparatus and chemicals in the laboratory?
   a) All of standard quality □
   b) Some are substandard □
APPENDIX IV: INTERVIEW SCHEDULE FOR HEADS OF SCIENCE DEPARTMENTS

The purpose of this interview is to gather information strictly meant for research purposes. The information you give will be kept confidential. You may ask for further clarification if a certain question is not clear.

1. How many chemistry teachers do you have in your schools?
2. Comment on the chemistry teachers’ workload
3. Does your school have a specific chemistry laboratory? How are the laboratories organized?
4. Which facilities miss in the chemistry laboratory?
5. Is the chemistry laboratory efficient in teaching?
6. How comfortable are you with laboratory technician in your school?
7. Do you give the technicians teaching timetables?
8. Do you consider the chemistry laboratory adequately stocked for effective teaching?
9. What are the limiting factors in stocking of the chemistry laboratory?
10. Which administrative factors are setbacks in stocking the chemistry laboratory?
11. Who are the persons involved in stocking the chemistry laboratory? How are they involved?
12. What is the source of funds for stocking chemistry laboratories?
13. Does your school have laboratory worksheets?
APPENDIX V: OBSERVATION SCHEDULE

1. Name of school ________________________________

2. Type of school
   a) Boys boarding
   b) Girls boarding
   c) Mixed boarding
   d) Mixed day

   a. Laboratory lesson
      1) Teacher present in the laboratory on time ______________
      2) Students present in the laboratory on time ______________
      3) Number of students in a set up
         a) One
         b) 2-5
         c) Above 5
      4) Students allowed to consult each other
         a) Yes
         b) No
      5) Teacher assists the student to handle apparatus
         a) Yes
         b) No

   Is laboratory technician present in the laboratory?
   a) Yes
   b) No
6) General conduct of the students in the laboratory

   a) Very good  
   b) Good  
   c) Average  
   d) Below average  

b. Records keeping

   1. Record of all apparatus available  
   2. Record of all chemicals available  
   3. Record of obsolete apparatus available  
   4. Record of dysfunctional apparatus  

c. Organization

   1. Apparatus labeled  
   2. Chemicals labeled  
   3. Poisonous substances indicated  
   4. Apparatus can easily be retrieved  
   5. Chemicals can easily be retrieved  

APENDIX VI: MERU SOUTH DISTRICT SECONDARY SCHOOLS as at 30th May 2011

1. Chief Petro Secondary
2. Chuka Boys
3. Chuka Girls
4. Ibiriga Secondary
5. Ikawa Secondary
6. Ikuu Boys
7. Ikuu Girls
8. Itugururu Secondary
9. Kaanwa Secondary
10. Kajiampau Secondary
11. Kajuki Secondary
12. Kambandi Secondary
13. Kamwimbni Secondary
14. Kangoro Secondary
15. Kanyoro Secondary
16. Kathigiririni Secondary
17. Kathwanwa Secondary
18. Kiamucii Secondary
19. Kiamuriuki Secondary
20. Kiang’ondu Secondary
22. Kiaritha Secondary
23. Kibumbu Secondary
24. Kiereni Secondary
25. Kirege Secondary
26. Kiunguni Secondary
27. Maabi Secondary
28. Magenka Secondary
29. Magumoni Day Secondary
30. Magumoni Girls
31. Makawani Secondary
32. Makuuni Secondary
33. Mpukoni Secondary
34. Mutuguni Secondary
35. Ndagani Secondary
36. Ndagoni Day Secondary
37. Ndagoni Girls
38. Njuri Secondary
39. Rubate Secondary
40. St. Paul’s Njaina Secondary
APPENDIX VII: MERU SOUTH DISTRICT MAP
APPENDIX VIII: PERMISSION TO VISIT SCHOOLS

MINISTRY OF EDUCATION

Telegram: “Elimu”, Chuka
Telephone: Chuka 630353
FAX: 064 630166
Email: msouthedu@gmail.com
When replying please quote:

MS/ED/GA/36/158

REPUBLIC OF KENYA

27th June, 2012

To
All Principals
MERU SOUTH DISTRICT

RE: EVALINE MUKAMI NJOKA –TSC NO. 492754

The teacher named above is a Post Graduate Student of Kenyatta University. She is currently undertaking a research for a thesis entitled “Utilization of Chemistry Laboratories in Teaching Chemistry in Public Secondary Schools in Meru South District, Kenya”

Authority has been granted to her to visit all our Public Secondary Schools for the research. Please accord her the necessary assistance.

Thank you in advance.

KANYAMBA W.K.
FOR: DISTRICT EDUCATION OFFICER
MERU SOUTH

CC,
Provincial Director of Education
Eastern Province
P.O. Box 123
EMBU.
APPENDIX IX: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:

Prof/Dr./Mr./Mrs./Miss/Institution
Evaline Mukami Njoka
of (Address) Kenyatta University
P.O.Box 43844 00110, Nairobi
has been permitted to conduct research in

Location
Meru South
District
Eastern
Province

on the topic: Utilization of chemistry laboratories in teaching Chemistry in public secondary schools in Meru South District, Kenya


Applicant's Signature

Secretary
National Council for Science & Technology

Research Permit No. NCST/RCD/14/012/169
Date of issue: 9th January, 2013
Fee received: KSH. 1,000