EFFECT OF LABORATORY RESOURCES AVAILABILITY AND USABILITY ON STUDENTS' ACHIEVEMENT IN PRACTICAL CHEMISTRY IN SOTIK SUB-COUNTY, KENYA

BY

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DECLARATION

Declaration by the Student

This thesis is my original work presented to the University of Eldoret, Kenya. The work has never been presented for a degree in any other learning institution. No part of this thesis may be reproduced without the prior knowledge of and authorization from the author and/or University of Eldoret.

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DEDICATION

This thesis is dedicated to my parents, Rosemary Atieno and Paul Masime, for facilitating my education. I thank them for supporting me with determination, commitment, sacrifice and hard work along with my brothers and sisters. They enabled us get equal opportunities to pursue education. May God bless you abundantly.

ABSTRACT

In the years 2010 and 2011, poor results in Chemistry were recorded among secondary school students in Sotik Sub-County. Lack of efficient use of laboratory resources was cited as one reason for the poor performance. As such, there was need to determine which teaching and learning resources were available in various school laboratories, their usability in teaching Chemistry, and their relationship with students' achievement in Chemistry. Three research questions and one hypothesis were formulated to guide the study. The research questions were: What resources are available for teaching and learning of Chemistry in Secondary schools in Sotik Sub-County? To what extent do teachers and laboratory technicians use the available resources in teaching Chemistry? To what extent does the use of Chemistry learning resources affect Students' performance in Chemistry? The hypothesis stated that there is no significant difference between the control and experimental groups in terms of performance in Chemistry in Sotik Sub-County. The target population was drawn from members of Sotik Sub-County secondary schools, while an accessible population of 30 secondary schools was selected for descriptive survey and four secondary schools for quasi-experiment, which were selected using purposive sampling method, followed by simple random sampling. The study adopted quasi-experimental and descriptive survey designs. Chemistry Assessment Test, Checklist and Questionnaire based on Likert scale and open-ended structure were among the instruments of research that were used in data collection procedure. Data was coded and analysed descriptively using SPSS and presented using frequency tables, means and percentages, while hypothesis was tested using Kruskal Wallis and Mann-Whitney U-Test at a 0.05 level of significance. The major finding of the study was that efficient use of available laboratory resources positively affects students' achievement in Chemistry. The main recommendation of the study is that deliberate efforts should be made by policy makers, the Sotik Sub-County Education Officer (SSCEO), and principals to ensure that schools are well equipped with laboratory resources. Chemistry teachers and students are also urged to make efficient use of the resources provided for teaching and learning to elicit adequate hands-on active participation of students during Chemistry theory and practical lessons. Further studies on how technology impacts on Chemistry achievement in Sotik Sub-County should be conducted.

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ACRONYMS

SMMASE	Strengthening of Mathematics and Sciences in Secondary Education
ASEI	Activity Students Experiment Improvisation
PDSI	Plan Do See Improve
HOD	Head of Department
KCSE	Kenya Certificate of Secondary Education
KCPE	Kenya Certificate of Primary Education
INSET	In-Service Training
KNEC	Kenya National Examination Council
MOE	Ministry of Education
RoK	Republic of Kenya
GoK	Government of Kenya
CAT	Chemistry Assessment Test
SCC	Sub-County Commissioner
SSCEO	Sotik Sub-County Education Officer
SCEO	Sub-County Education Officer
MSc	Master of Science
BSc	Bachelor of Science
B.Ed	Bachelor of Education
BA	Bachelor of Arts
PGDE	Post Graduate Diploma in Education
M.Phil	Master of Philosophy
FPE	Free Primary Education
NACOSTI	National Commission of Science, Technology and Innovation

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To all I say, may God bless you and shower you with His abundant blessings.

CHAPTER ONE
INTRODUCTION

1.1 Introduction

This Chapter presents the background information on the teaching and performance of Chemistry in Kenya, the statement of the problem, the purpose of the study, objectives and research questions, significance of the study, justification of the study, assumption of the study, scope and limitations of the study, theoretical and conceptual framework and finally, operational definition of terms.

1.2 Background to the Study

Laboratories play a significant role in efficient Chemistry education. Chemistry laboratory classes are supplementary to Chemistry education and make up a crucial part of teaching Chemistry courses. These classes assist students and teachers to comprehend abstract Chemistry concepts (Park & Oliver, 2008; Demirtas, 2006), like the mole concept, which always constitute a greater percentage in KNEC exams hence better achievement. Research has shown that active forms of learning such as activity based learning, group work and project work are associated with provision of laboratory resources that are then put into proper use to give the desired outcome (Kolb & Kolb, 2005). These desired outcomes may be classified as passing in Chemistry national examination, at the first point, which in turn leads to technological development, industrialization, and the promotion of Kenya's Vision 2030.

The present scientific developments and economic growth across the world come with various challenges which include genetic engineering, ecological impacts of modern technology, dangers of nuclear war, global warming, new drug resistant diseases, among others (Munishi, Muni, Okumu, Mutai, Mwangasha, Omolo & Munyeke, 2004; Olufunke, 2012), and can be solved if Chemistry students are trained to use laboratory resources to find science-based solutions to these problems. To do this, Chemistry students need to be exposed to skills acquired by appropriate use of the laboratory. It is also worth noting that adequate utilization of the laboratory positively impacts on students' achievement in Chemistry (Wanjiku, 2013).

Laboratory is, therefore, essential in the teaching of sciences. If it is availed, sufficiently stocked with the requisite provisions and efficiently used, the success of Chemistry instruction is inevitable. These provisions include apparatus, chemicals, benches and enough laboratory space that is usually specified in the laboratory design (Kenya Accreditation Service, 2013). The laboratory design is crucial as it may influence a teacher's selection of an instructional method (Hofstein & Lunetta, 2004). An effective laboratory environment requires various conditions like teachers' preparation room, where teachers prepare and plan for classes, and students' experimental room, where students use apparatus and reinforce their practical skills to introduce innovative activities (Oladejo, Ojebisi, Olosunde & Isola, 2011).

Researchers in science education opine that learning is enhanced and understanding level is improved when students are engaged in practical experiments (Hofstein & Lunetta, 2004). These experiments are conducted in laboratories and involve innovative activities. Hofstein and Lunetta (2004) posit that a positive relationship exists between the independent variable of laboratory resources and the dependent variable, achievement of students in Chemistry. Omebe and Akani (2015) have also found that physics and chemistry students taught with instructional resources achieved higher and better than those taught without instructional resources. According to Arubayi (1987), effective and efficient utilization of laboratory resources affects students' attitude towards the learning of Chemistry and the more the resources are utilized the more students' interest is promoted vis-à-vis enhanced performance in the subject. Thus, students' active participation in hands-on experimental activities fosters understanding because "seeing is believing" (Bellamy, Erickson, Fuller, Kellog, Rosenbaum, Thomas & Wolf, 2007).

In other sections of the world, among the factors that have been identified that affect the outcomes in Chemistry is laboratory in-adequacy (Adeyegbe, 2005; Bajah, 1999; Raimi, 1998; Okegbile, 1996). This inadequacy makes it difficult for learners to grasp "concrete" concepts that are supposed to be conveyed in Chemistry education. Following the above views, since the world is becoming more innovative, students should be exposed to hands-on and innovative practices. These practices will only be mastered by the Chemistry students if teaching is done in such a way that it discourages rote learning. To this end, the inquiry process of learning is always recommended which may be attained by efficient laboratory use.

However, some schools in Kenya still teach Chemistry through the chalk and talk approach due to insufficient laboratory facilities (Wachira, 2005). In addition, Mbiti (1974) observes that when the supply of laboratory resources is delayed, teachers cannot be expected to do their work properly. Thus, inefficient utilization of the laboratory as well as inadequate use of available resources leads to poor teaching methods. Poor teaching methods reduce the hopes of attaining better achievements from the learning process. This is attested to by the poor achievement in Chemistry in KCSE as indicated by the results posted by KNEC over the years (MOE, 2006). The poor achievement is a reflection of inadequate practical work in schools since research has shown that more preference is given to practical examination (Obuong, 2007) than to Papers One and Two, as shown in Table 1.1 below.

Table 1.1: National Overall Performance of Candidates in Chemistry

YEAR	PAPER	MAXIMUM SCORE	MEAN SCORE	STANDARD DEVIATION
2008	1	80	18.28	14.78
	2	80	15.74	13.00
	3 (Practical)	**40**	**11.46**	**5.42**
	OVERALL	200	45.48	31.78
2009	1	80	12.49	9.5
	2	80	14.93	12.04
	3 (Practical)	**40**	**10.86**	**4.55**
	OVERALL	200	38.23	24.53
2010	1	80	18.78	14.48
	2	80	16.19	13.25
	3 (Practical)	**40**	**14.87**	**5.60**
	OVERALL	200	49.79	31.57
2011	1	80	18.43	14.86
	2	80	16.99	13.95
	3 (Practical)	**40**	**11.91**	**6.30**
	OVERALL	200	47.31	33.51

Source: Kenya National Examination Council (2009, 2011, 2012)

Based on the marks scored by a candidate in Chemistry, a grade is awarded on a 12 points grading scale as shown in Table 1.2 below.

Table 1.2: Grading System from Kenya National Examination Council

Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
Points	12	11	10	9	8	7	6	5	4	3	2	1

Source: KNEC (2006)

A student who scores grade A is perceived to have performed excellently and the one who scores grade E is perceived to have performed poorly. Consequently, to obtain an overall grade of B- and above in Chemistry, a candidate must at least score a D+ or higher in practical paper (KNEC, 2006). This implies a student must score at least 33% in Chemistry practical, meaning that of the total 40 marks a student can score in the practical, he/she needs to garner 13 marks. This indicates a clear correlation between laboratory use and students' performance in Chemistry. Similarly, the results below show that the general performance of students' in Chemistry practical in KCSE has been very poor compared to other science subjects.

Table 1.3: Comparison Overall Performance of Physical Sciences

Year	Entry	Practical Paper	Subject	Maximum Score	Mean Score
2008	72299	3	Physics	40	20.88
	296937	3	Chemistry	40	11.46
	274215	3	Biology	40	17.30
2009	104883	3	Physics	40	15.22
	329730	3	Chemistry	40	10.86
	299302	3	Biology	40	15.86
2010	109811	3	Physics	40	22.37
	347364	3	Chemistry	40	14.87
	317135	3	Biology	40	18.42
2011	120074	3	Physics	40	22.24
	403070	3	Chemistry	40	11.91
	363817	3	Biology	40	18.84

Source: Kenya National Examination Council (2009, 2011, 2012)

Students' understanding of Chemistry concepts is very important. For efficient and effective practical to be done, for better achievement, there should be sufficient laboratory facilities. These facilities constitute one of the potent factors that contribute to academic achievement in school system (Hallak, 1990). Students' assessment in Chemistry also tests their ability to select apparatus and put laboratory resources to their correct use (KNEC, 2012) during practical sessions. To achieve this, students require continuous practice on the efficient use of the laboratory. Therefore, Chemistry students should be encouraged to carry out as many practical/experiments as possible. Unfortunately, some candidates are unfamiliar with some basic apparatus until the time of the national examinations (KNEC, 2004). The cumulative effect of poor training is incompetence at work in the Chemistry industry (Nyongesa, 2015). It is pertinent to ask, can the low achievement in Chemistry be due to unavailable resources?

Therefore, there is need to increase teachers and students' capacity to effectively utilize available teaching resources (if available) to enhance achievement in Chemistry education (Bello, 2011). This study thus aimed to establish the nature of relationship between the availability and use of Chemistry learning resources and academic achievement of students in secondary schools in Sotik Sub-County, Bomet County, Kenya.

1.3 Statement of the Problem

In Kenya, Abungu, Okere and Wachanga (2014) found that using available resources in Chemistry laboratory processes facilitates students' achievement more than chalk and talk teaching approach. Similarly, Otieno (2012) found out from his study that the poor achievement of students in Chemistry can be attributed to lack of laboratory resources and inadequate use of laboratory resources in the Chemistry teaching and learning processes. According to KNEC (2012), there is evidence to suggest that students are not sufficiently exposed to laboratory resources before KCSE examinations. As such, students demonstrate register low performance in Chemistry practical examinations. Further, research has also shown that teachers mostly use chalk and talk method in teaching Chemistry (Wachira, 2005) giving minimal room of utilizing available Chemistry laboratory resources to facilitate hands-on activities and students' active participation during classes (Metto & Makewa, 2014). Moreover, to the best of the researcher's knowledge, little research has been done in Kenya so far, especially in Sotik Sub-County, on the availability of laboratory resources for teaching and learning Chemistry, there usability and the effectiveness of their incorporation into teaching and learning by teachers to enhance achievement in Chemistry. This study, therefore, sought to establish the extent of availability and use of laboratory resources and how these affect students' achievement in Chemistry in secondary schools in Sotik Sub-County.

1.4 Purpose of the Study

The purpose of the study was to determine the impact of availability and usage of laboratory resources on the performance of secondary school students in Chemistry in Sotik Sub-County, Kenya.

1.5 Objectives of the Study

The main objective of the study was to ascertain the degree of availability and use of Chemistry laboratory resources for teaching and learning of Chemistry in Secondary Schools in Sotik Sub-County and how these variables influence academic achievement of Chemistry students.

1.5.1 Specific Objective

The specific objectives of the study were:

i. To determine the available laboratory resources for teaching and learning of Chemistry in secondary schools in Sotik Sub-County

ii. To determine the extent of use of the available laboratory teaching and learning resources in Chemistry instruction in secondary schools in Sotik Sub-County

iii. To establish the relationship between the use of available Chemistry learning resources and the academic achievement of students in Chemistry

1.6 Research Questions

The study was designed to address the following specific research questions:

i. What Chemistry laboratory resources are available for teaching and learning of Chemistry in Secondary schools in Sotik Sub-County?

ii. To what extent do teachers and laboratory technicians use the available Chemistry laboratory resources in teaching Chemistry?

iii. To what extent does the use of Chemistry laboratory learning resources affect Students' achievement in Chemistry?

1.7 Hypotheses of the Study

The study was guided by the following null hypothesis:

H_{01}: There is no significant difference between the availability and use of Chemistry laboratory resources and students' achievements in Chemistry in Sotik Sub-County.

1.8 Significance of the Study

The findings of the study will have both theoretical and practical implications for the future of Chemistry education in Sotik Sub-County and other schools in Kenya that could be experiencing similar challenges. The study sought to make the following specific significant contributions:

i. The education officials, principals, laboratory technicians, teachers and students will use the findings to strengthen Chemistry performance in Sotik Sub-County and other parts of Kenya.

ii. Practically, the study will inform actions that will lead to improvement in Chemistry subject achievement in national examinations and sensitize teachers in the use of the available resources in teaching the subject.

iii. The study will enable the school administrators to realize the importance of Chemistry teaching and learning resources and put them at the forefront in sensitizing teachers on its utilization.

iv. The study will enable students to develop the basic process skills in Chemistry to prepare them for future scientific inquiry processes.

v. The study will assist the principals and Heads of Department in sufficiently equipping their school laboratories to assist students master the Chemistry inquiry process.

vi. The study will enable early preparation of students in practical skills to boost their courage or confidence while performing experiments in national examinations at the end of their secondary school course work.

vii. The study will inspire creativity among Chemistry teachers and students to enable them to improvise where the available laboratory equipment are insufficient.

viii. The basic process skills in Chemistry practicals are important in attaining the Vision 2030 which relies greatly on scientific innovations.

1.9 Justification of the Study

Kenya has put in place a number of strategies to ensure that it attains industrialization and becomes a middle-income country by the year 2030. The sciences, Chemistry included, constitute one of the pillars of the Kenya Vision 2030 (GoK, 2007). Therefore, more emphasis has been given to training in physical sciences. In fact, most schools have made Chemistry a compulsory subject. Nevertheless, students' achievement in Chemistry is often affected by a number of factors, including the availability and use of Chemistry laboratory teaching and learning resources and the nature of instruction used by the teachers. In Sotik Sub-County, the poor achievement in the sciences, including Chemistry, has raised concerns among education stakeholders, Sub-County Education Officer, parents, teachers and students in the Sub-County on poor achievement in Chemistry. In response to the above views, this study was undertaken in an attempt to find ways to bridge the gaps on the causes of low achievement in Chemistry in Sotik Sub-County. In uncovering such causes and proposing ways to deal with them the study would contribute to the economic growth of the Sub-County and propel it towards industrialization.

1.10 Assumptions of Study

The following assumptions were made in the study:

i. That all the respondents would co-operate and provide reliable responses.
ii. That all teachers teaching Chemistry in various schools in the Sub-County were well-trained to select and use available Chemistry teaching and learning resources.
iii. That at the time of sitting Chemistry assessment test all schools had completed Form 2 Chemistry syllabus.

1.11 Scope and Limitations of the Study

1.11.1 Scope of the Study

A lot of factors may be responsible for the poor achievement in Chemistry recorded in secondary schools in Sotik Sub-County. Nevertheless, this study only explored factors relating to availability and use of Chemistry teaching and learning resources. The study also was conducted in only four secondary schools in Sotik Sub-County for the case of experimental design. Schools that had been in existence for less than 4 years were not included in the sample. Other factors were not examined due to limitations of time and finances. It was impossible to document all the factors that contribute to poor achievement in Chemistry in a single academic study such as this one.

1.11.2 Limitations of the Study

The following limitations were encountered during the study:

- The weather conditions in the Sub-County at the time made it difficult to navigate the roads while collecting data from the sampled schools.
- Some costs were incurred that the researcher had not budgeted for and since the researcher was self-sponsored, it was difficult to cover the work within the expected time.

1.12 Theoretical Framework

The study was based on the theoretical framework of Constructivism as propounded by Jean Piaget (1896-1980) and Lev Vygotsky (1896-1934). The framework posits that all human beings are better able to understand the information that they themselves construct in the laboratory through interaction with laboratory resources and apparatus. These apparatus and learning resources provide a first-hand learning experience in a social advancement process that involves interaction with the 'real world' and collaboration among learners who are at the centre of the learning process.

According to Piaget's Constructivism, the Chemistry teacher must put emphasis on the significance of experiences in students learning while using laboratory resources. Two key components summarize Piaget's Constructivism, namely assimilation and accommodation. Assimilation helps a Chemistry learner to incorporate new experiences into the old experiences in the Chemistry laboratory. It leads a Chemistry learner to rethink what they already know and adjust their positions acquired knowledge in the laboratory. On the other hand, accommodation entails reframing the laboratory resources world and new experiences into the mental capacity already present. In this study, it is argued that laboratory learning resources help learners to assimilate and accommodate Chemistry concepts and experiences as they learn.

Piaget's Constructivism also defines the role of the teacher as a mere guide in the laboratory learning process. Based on the Constructivist approach, the researcher theorized that students who are given an opportunity to use laboratory equipment or resources in the laboratory learning process have the ability to perform better in Chemistry examinations. They are also able to creatively translate their Chemistry laboratory knowledge into useful innovations in their lives and society. On the other hand, when students are placed in an environment without laboratory resources for teaching and learning Chemistry, they will also perform dismally in examinations and become poorly educated.

1.13 Conceptual Framework

The independent variables in this study were the availability and use of Chemistry teaching and learning laboratory resources. The availability was measured using a standard checklist of all resources that every secondary school needs to effectively teach Chemistry. These resources are listed in the secondary schools Chemistry syllabus. The checklist was used to observe the extent to which schools availed these resources. The utilization was measured by examining how both theory and practical lessons of Chemistry had been conducted by teachers. The dependent variable was students' achievement in Chemistry. Achievement was measured based on students' scores in the CAT.

The conceptual framework for this study was as shown in Figure 1.1 below.

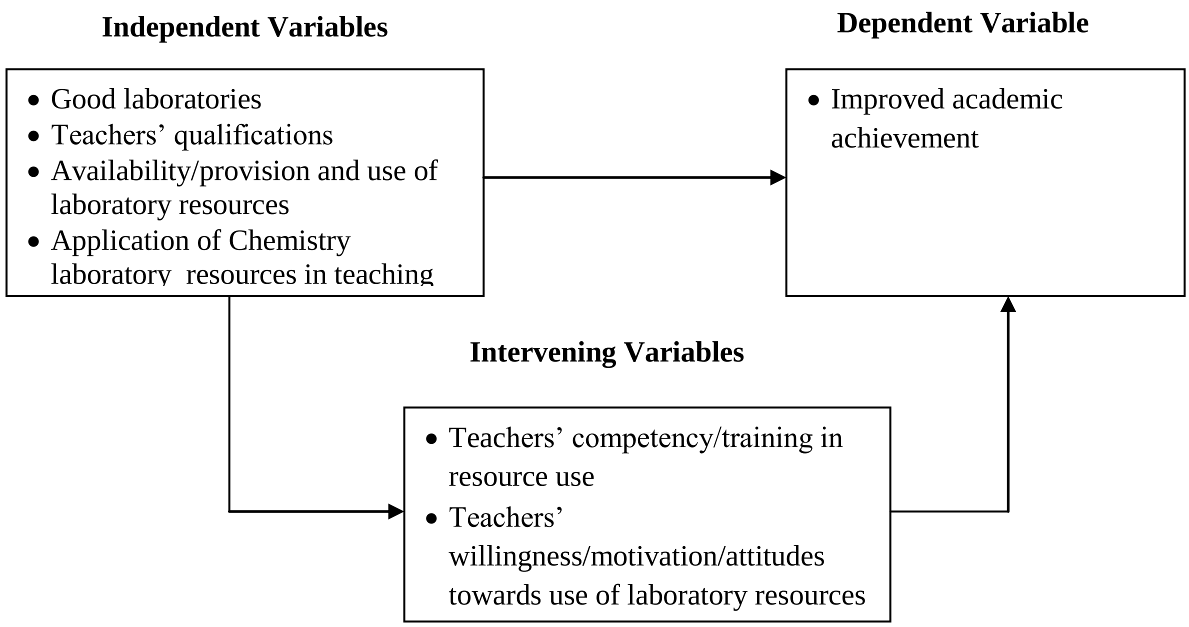

Figure 1.1: The Conceptual Framework
Source: Researcher (2016)

1.14 Definition of Operational Terms

Achievement was used in this study to mean successfully attaining the goals of teaching and learning about something not only in academic world but also in economic and technological world while using laboratory resources. These can be proved by performing well in either written or oral examination offered by KNEC.

Performance was used to mean successful undertaking of tasks, i.e. the use of knowledge as distinguished from merely possessing it. For operational purposes, performance was defined in this study as the scores attained in previous Chemistry exams.

Bestow in this study was used to mean the act of giving approval to do something while utilizing laboratory resources.

Efficient was used in this study to describe the proper organization of the laboratory resources, capability of laboratory technicians, teachers and students to easily access and use them to achieve the best learning outcomes.

Consumables are resources that tend to get used up relatively faster and require constant replacement in the laboratory.

Non-consumables are resources that last longer to require replacement.

*Audio-Visual*s are equipment that uses both sound and pictures to convey information learned in a Chemistry laboratory.

Subsidized Secondary Education refers to education provided by cost sharing among parents and GoK by checking off some school fees for all students.

Peripherals are devices that can be connected to the computer, e.g. printers and monitors.

1.15 Chapter Summary

This chapter has discussed the main introductory elements of the research. The chapter describes the background to the study, the statement of the problem, purpose of the study, objectives of the study, research objectives, questions, scope and limitations, significance and justification of the study, theoretical and conceptual frameworks and operational definition of terms used in the research.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter undertakes a review of literature on the teaching and learning of Chemistry subject while using laboratory resources in key elements of the subject. The review begins with the concept of laboratory and resources. It then examines the history of laboratory resources and use in Chemistry Education; characteristics of laboratory resources and science process skills; availability and provision of laboratory resources and physical facilities. The chapter also examines the role of the laboratory in Chemistry teaching; learning Chemistry in a laboratory environment, and utilization and impact of laboratory resources. According to Adeogun and Ofisila (2008), Chemistry laboratory resources can be categorized into four groups, namely human, material, physical and financial resources. Chemistry laboratory resources are central to the Chemistry educational process because they play an important role in the achievement of Chemistry goals and objectives since they facilitate teachers' work and accelerate understanding in learning on the part of the Chemistry student (Usman, 2007).

2.2 The Concept of Laboratory and Laboratory Resources

Rapid developments in science and technology and cognitive research have made traditional definition of science laboratory, as a room where students use equipment to follow well-defined procedures to test laws and principles, obsolete. The Oxford Advanced Learners Dictionary defines it as a room, building or place used for scientific research, experiments, testing, performing a task to solve a problem. This definition points out to the notion of laboratory experience. Laboratory experience provides opportunities for students, laboratory technicians and teachers to interact directly with the material world using tools, data collecting techniques, models and theories of science (Hofstein & Lunetta, 2004). It involves effective manipulation of systems under investigation, interaction with simulations and physical models which have been used throughout the history of science teaching (Owoeye & Yara, 2011).

Moreover, Schweingruber, Hilton and Singer (2005) describe laboratory learning as a form of practical work taking place in a purposely assigned environment where students engage in planned learning experiences with materials to observe and understand phenomena. These observed and understood phenomena always play a greater role in the learners' academic achievement and can be applied in the technological world since they engage students in discovery and problem-solving activities.

To achieve these technological developments, Owoeye and Yara (2011) add that a laboratory is an environment within the school setting where efficient use of apparatus in learning is given first priority. In the laboratory, students interact with the available resources and apparatus to observe and understand the natural world in its context. It is where the inquiry process is emphasized (Hofstein & Lunetta, 2004). It is becoming increasingly clear to many Chemistry teachers that it is not realistic to expect students to arrive at accepted scientific concepts and ideas by simply memorizing some aspects of scientific research and producing it when required (Millar, 2004). Therefore, the inquiry process involves learning not only in an enclosed room but anywhere where knowledge can be transmitted and attained. This is made possible in laboratories with the relevant facilities and resources for utilization by the learners (Kaptingei & Rutto, 2014).

According to Hofstein and Lunetta (2004), laboratory activities and resources, when utilized appropriately, assist students to understand and engage in the process of knowledge construction using scientific methods. The scientific methods insists on 'practising science' and calls for effective and efficient use of the laboratory, enabling students to better understand what is expected of them. The process of 'practicing science' utilizes laboratory resources to attain the intended outcomes in students' learning. Generally, laboratory resources include the equipment and specimens in a laboratory. In a Chemistry laboratory, they include chemical reagents and laboratory apparatus approved for teaching and learning.

2.3 The History of Laboratory Resources Use in Chemistry Education

The most significant discovery on the importance of learners carrying out scientific experiments took place in 1899 when Liebig established the first laboratory in Britain in 1824 (Reid & Shah, 2007). At the time, practical work was highly regarded and most schools had embraced it in England (Gee & Clackson, 1992). In turn, priority was given to skills used in industries and research centres and much knowledge and innovations were efficiently accumulated (Letton, 1987; Khan, 1996). All of this contributed largely to industrial revolution in Europe.

In addition to industrial revolution, practical experiments assisted in confirming and subsequently refining theories and principles that were taught in class and applied in industries (Hodson, 1990). Over time, practical experiments began to attract criticism. Some scholars asked questions concerning the efficiency of teaching through practical work (Hodson, 1990). Others, like Education Boards in England, opined that there was too much practical work of wrong kind, remote and could not assist in daily development of the students (Hodson, 1993).

However, the proponents of the laboratory work argued that laboratories have a central and distinctive role in Chemistry education. They strongly argued that there are rich benefits to learning that accrue from using laboratory activities (Hofstein & Lunetta, 1982). These benefits include enhanced understanding of scientific concepts which leads to better achievement in Chemistry, improved attitudes and motivational aspects, among others.

In the late 1970s and early 1980, some educators began to question the effectiveness and the role of laboratory work. At the time, the case for the laboratory was not self-evident (Bates, 1978). Critics perceived the laboratory as being time consuming and a waste of time (Pickering, 1980). On the contrary, Roth (1994) stated that laboratory resources and activities have the ability to convey scientific concepts and skills in a simplified manner. This potential is only realized when laboratory resources are efficiently used. Roth (1994) concludes that the merits pegged on laboratory work overweigh its demerits.

Consequently, Conrad and Donaldson (2011) and Tobin (1990) note that meaningful learning is possible in the laboratory if students are given enough time and chance to manipulate laboratory resources. They claim that research does not give evidence of opportunities offered to teachers and students in schools to manipulate laboratory resources while learning or conveying knowledge. Similarly, writing on the role of facilities in teaching Chemistry, Balogun (1982) indicates that no efficient Chemistry learning can take place without laboratory resources for teaching. This is because resources, where they are and efficiently practically used, help develop a learner’s problem-solving skills (Owoeye & Yara, 2011).

2.4 Characteristics of Efficiently Utilized Laboratory Resources and Science Process Skills

2.4.1 Characteristics of Efficiently Utilized Laboratory Resources

Inquiry-type laboratories have the potential to develop students' abilities of posing scientific questions and systematically engaging in fact-finding activities of measuring, identification of problems, recording, classification, observation and data collection (Davis & Krajcik, 2005). For these scientific process skills to be attained resources must be availed and efficiently used.

This reliable achievement in the laboratory can only be attained if teachers, students and laboratory technicians are sensitized on the importance of fully utilising Chemistry laboratory equipment. Studies on the exposure of students to Chemistry process skills have concluded that learners acquire each process skill through certain stages (Saat, 2004; Feyzioglu, 2009). This is attained by efficient manipulation of laboratory resources, through some given level of interaction and after some given duration of time. It is often noted that when students are manipulating laboratory resources, they exhibit high enthusiasm for learning.

Attaining required results calls for laboratory resources that are learners friendly and should not expose them to risks. This is especially because most high school learners are still young and still find the inquisitive process of great interest to them. Therefore, basic experiments are required. The following are some of the characteristics expected in laboratory resources:

- They should allow manipulation without many complications to attain science process skills.

- They should not pose danger to the user and where danger is unavoidable its harms should be manageable.
- It is not necessary for them to be placed in an enclosed room provided they are accessible and applicable to the inquiry process.
- They should allow synthesis and application of the knowledge acquired from them in the industrial world for industrial revolution.

Garnett, Garnett and Hackling (1995) and Feyzioğlu (2009) argue that if laboratories are well utilized, they could contribute to improve conceptual understanding, application of chemical skills and techniques, and ability to analyse inter-variable relationships by students via Chemistry process skills.

2.4.2 Science Process Skills

The teaching of Chemistry process skills is hampered by various factors, including much attention being given to syllabus coverage in most secondary schools at the expense of other activities, and utilization of various laboratory resources (Coil, Wenderoth, Cunningham & Dirks, 2010). Consequently, the best Chemistry education syllabus is one that allows high school students, laboratory technicians and teachers to "think like [a] scientist" (Handelsman, 2007), and implement scientific concepts and even improvise where necessary. Thinking like a scientist, therefore, requires science process skills which are also necessary for students' academic achievements in the subject. For these achievements to be attained, it is important to note that efficient utilization of various Chemistry process skills in the laboratory must be put into consideration during laboratory activity sessions.

Activity based laboratories have been recommended for Chemistry learning process because they involve students in “doing.” According to Beaumont-Walter (2001), most Chemistry educators agree on these since the best method to educate learners in Chemistry is by experimentation. In the same way, “doing” of Chemistry experiments should be intertwined with theoretical learning of the subject. These will enhance students’ mastery of the principles of inquiry needed for efficient laboratory use and to know how it correlates to achievement in Chemistry education (Haigh, France & Forret, 2005).

For the principle of inquiry to be given much focus, problem solving abilities in Chemistry are more important than the theoretical knowledge itself (Haigh *et al.*, 2005). Possible Chemistry hypotheses created in the technological world can be tested using the basic and integrated Chemistry skills if the learners are well acquainted with the skills. These process skills answer students’ questions on technology, and it is possible when the first priority is given to them during the experimentation process.

Chemistry students need to be able to question and determine how variables relate to one another. For this to happen, schools need to equip laboratories with resources to enable learners to acquire the best knowledge through experimentation. Consequently, efficiency and achievements correlate during the experimentation process and learners, with the help of teachers and laboratory technicians, can always have the ability to create larger concepts from smaller ideas if assisted well through Chemistry process skills (Wynne, 1999). Some of the Chemistry process skills that are used during Chemistry laboratory sessions are: observations, measuring, classification, prediction, experimentation and recording, manipulation of apparatus and drawing of conclusions. In this study, only three process skills were considered, namely manipulation, observation and drawing conclusion. These three play a major part in KCSE exams (KNEC, 2012).

2.4.2.1 Manipulation of Apparatus

Students can easily master manipulative skills if more time is accorded to them to undertake experiments. Indeed, KNEC practical examination emphasizes on ‘doing’. This is a manipulative process that allows learners to take the first 15 minutes reading questions carefully in order to understand what they are expected to do during the experimentation process (Bunguswa, 2012). This is especially possible if the resources necessary for Chemistry practical sessions are availed to students in sufficient proportion. Learning to properly manipulate laboratory equipment calls for triangulation of various “cognitive overloads”, i.e. data recording and interpretation through observation (Dius, Schafer, Nussbaum, Stewart, Carlson & Samozvanov, 2009). This is often more challenging while aiding the achievement of Chemistry laboratory learning goals.

Students’ mastery of skills for manipulating Chemistry resources is hindered when students lack active participation in experimental design (Bennett, Seery & Sovegjarto-Wigbers, 2009). Important factor in Chemistry education teaching is to induct students on how to handle apparatus during manipulative process to achieve accurate results from a laboratory process (Prince & Felder, 2007). The effectiveness of laboratory processes depends on whether or not correct apparatus are used in experiments.

Ekane and Ifeoma, (2011) identifies manipulative skills expected of students in practical Chemistry as: following instructions, measuring, using indicators, using pipette, taking reading and recording, using spatula, heating with a Bunsen burner, handling glass ware and recording results of practical. In addition, Ekane and Ifeoma (2011) argue that acquisition of Chemistry laboratory skills is very important for successful achievements in given Chemistry examination parameters such as doing chemical arithmetic, interpreting practical experiences and results of experiments and making logical deductions and inferences from observations.

2.4.2.2 Observation Skills

Chemistry observation skills need to be continually developed to enable students to master Chemistry content while using laboratory resources. This continuity helps students to relate previously learned Chemistry laboratory observation skills to new contexts and content. In turn, improved mastery of observation skills leads to students' better achievement and ensures there is efficient use of laboratory resources (Bennett *et al*, 2009).

Observation skills in a laboratory utilize the five human senses of sight, touch, smell, taste and hearing (Vitti & Torres, 2006). In most cases, Chemistry teachers and students tend to emphasize on the sense of sight at the expense of the rest. This impedes Chemistry students' on mastery of basic Chemistry laboratory skills.

2.4.2.3 Inferences

Vitti and Torres (2006) posit that drawing of inferences requires "critical thinking" and it is the only means by which students can fully master Chemistry content and perform well in standard examinations. The "critical thinker" must ask questions such as: what are the assumptions? What have I seen before that reminds me of these? Why do I think that this is going to happen? Once these questions have been answered well, conclusion is drawn and utilized in the integration and application of knowledge for better achievement (Dius *et al.*, 2009). Chemistry students should be advised to focus not only on passing examinations but also to apply the skills they attain from the practical laboratory experiments in industrial and technological world to improve their lives and societies.

According to Iwuchukwu (2000), the mastery of Chemistry process skills among students in schools has been poor. This poor mastery of laboratory process skills has been a hindrance to achievement in Chemistry in most high schools level (Egbutu, 2006; Njelita, 1999). In Kenya, the introduction of SMASSE resource centres was meant to assist in equipping schools with resources in various sub-counties so as to improve the teaching process skills. The question is: are these centres used appropriately and effectively?

2.4.2.4 Communication

The KNEC advises Chemistry teachers to ensure students are exposed to several practical experiences as early as possible so that they can improve their psychomotor skills (KNEC, 2004). These skills will in turn improve their communication skills. Three major areas are examinable in high school practical Chemistry in Kenya and require greater attention in terms of communication with examiners. These are:

1) Quantitative analysis, where mathematical concepts are required to determine the quantity of matter in a substance.
2) Physical Chemistry, which is further sub-divided into:
    a. Thermo chemistry

b. Reaction rates

c. Solubility and Solubility Curves.

3) Qualitative analysis in Organic Chemistry, e.g. alkenes and alkynes and in-organic ions, e.g. Cu^{2+}, Fe^{2+}.

Students are expected to express the observations they have made and inference derived from practical experiments through talking (i.e. thinking aloud to model their thought process) and writing or drawing graphs in Chemistry practical papers (Vitti & Torres, 2006). This helps them to build conceptual frameworks for understanding phenomena. Drawing the required graphs using conventional procedures, for example, gives students a scientific acumen for learning and solving problems through the inquiry method. It is important to note that presentation of the knowledge acquired in the Chemistry laboratory is an essential skill in the communication of one's ideas.

2.5 The Role of Laboratory Resources in Chemistry Education

Initially, the laboratory work was conceived to give opportunity for Chemistry students to acquire manipulative skills and provide experience in making observations in a critical manner and in the process gain a variety of experimental techniques (Reid & Shah, 2007). However, very little justification is given for laboratory works today (Reid & Shah, 2007).

Chemistry is a practical oriented subject. It is useful in a world where innovation has been given a greater priority. This justifies the need for laboratory practical work. However, the argument for the role and position of the laboratory in Chemistry teaching is still unclear (Reid & Shah, 2007). The common justification for the need of Chemistry laboratory in schools is to help students pass their Chemistry examinations (Reche, Kareanki, Nthia & Kariuki, 2012). This is not the primary purpose of a Chemistry laboratory.

The main reasons for questioning the relevance of laboratory work in schools is that most Chemistry laboratory activities are expensive in terms of apparatus and chemicals i.e. resources (Carnduff & Reid, 2003). Therefore, most schools, to avert the great cost that is to be encountered, expose their students to laboratory activities for the first time during Chemistry KNEC examination (KNEC, 2004). In addition, teaching Chemistry theory in isolation from practical experiences does not allow students to master the skills needed to compete favourably in the job market after school. Yet, as Wachira (2005) notes, in Kenya the teaching of Chemistry is largely done through the chalk and talk method.

Without the laboratory experience, students are left with scanty knowledge of Chemistry made of merely abstract and theoretical concepts (Reid & Shah, 2007). This may in part explain why most graduates prefer white colour jobs to more innovative and creative ones. It is important to state that technological and social innovation constitute the means through which any developing country like Kenya can attain value addition from individual citizens to its economic growth.

As already mentioned, achievement in Chemistry national examination has for long been the only measure of the importance of laboratory resources in Chemistry education in secondary schools in Kenya. Indeed, the quality of output is equated with students' examination performance (Nwadiani, 2000). According to Adeyemi (2001), the best measure of output from secondary school Chemistry education is the number of school leavers after their course and what they pursue after their education process.

However, as Ebong (2006) reiterates, effectiveness can only be realized if the materials available are put to use. This means that effective Chemistry teaching and learning cannot take place without adequate laboratory facilities. Indeed, teachers cannot teach Chemistry effectively without laboratory facilities (Ihuarulam, 2008). As such, this study was designed to ascertain the extent to which teachers of Chemistry in secondary schools in Sotik Sub-County utilize the available Chemistry teaching and learning resources and the impact of this utilization on students' achievement in the subject.

The main roles of Chemistry laboratories are: for affective purposes (Gungor, Eryilmaz & Fakioglu, 2007), inquiry purposes, discovery purposes and problem solving purposes. Other benefits of a laboratory in Chemistry teaching and learning are:

i. It arouses the interest of learners and helps students better understand Chemistry concepts and theories.
ii. Inquiry in the laboratory is inductive, has undetermined outcome and requires that students generate their own procedures (Lagowski, 2002; Lagowski, 2005). This imparts students with the spirit of innovation.
iii. Discovery learning is meant to personalize the information students acquire making it meaningful. It also enhances better retention among students as they go through practical experiences through laboratory resources.
iv. A problem based environment, the laboratory encourages students to apply their understanding of concepts to answer questions for which answers do not yet exist. This is achievable through laboratory resources that are effectively used.

Therefore, there should be optimum use of the available laboratory techniques and resources if good performance is to be achieved (Republic of Kenya, 2005) in Chemistry teaching and learning.

2.6 Availability and Provision of Instructional Materials and Laboratory Physical Facilities

Failure to provide the requisite laboratory resources or to utilize them once availed for teaching has been identified as one of the reasons for the continued inability of students to identify and state the uses of simple laboratory apparatus and the poor achievement in Chemistry education (Arakoyu & Ugonwa, 2012). Ajayi and Ayodele (2001) posit that adequate supply of laboratory instructional resources has significant effects on students' achievement and enhances the effectiveness of instructional delivery and supervision. The lack of laboratory resources in some schools causes teachers to embark on the lecture method of instruction since some of these schools are unable to purchase the required resources for laboratories practical learning.

At the same time, learning can occur through one's interaction with the environment (Owoeye & Yara, 2011). Environmental factors, including available resources that can aid students' learning outcomes, have both positive and negative influence on students' learning. For proper Chemistry learning, well-equipped laboratory is an indispensably necessary environment in the schools.

Oni (as cited in Owoeye & Yara, 2011) avers that facilities constitute a strategic factor in an organizational functioning. According to Oni (as cited in Owoeye & Yara, 2011), for high productivity to be achieved, availability, adequacy and relevance of equipment need to be given first priority in the Chemistry laboratory. It is important to note that availability of resources, like well-equipped laboratories, with standard stools, current practical manuals, among other advanced technologies, will not only enhance teaching and learning of Chemistry but also help the student to acquire the required process skills in sciences which are crucial for any industrial work.

Schools in many developing countries, Kenya included, lack the necessary laboratory (among other) facilities and those available are mostly of substandard quality. This is a serious problem considering most scholars identify a highly significant relationship between the quality of facilities and performance in Chemistry (Owoeye & Yara, 2011). Higher academic achievement is the chief objective of any educational institution. Higher performance in Chemistry, and indeed all other science subjects, is heavily dependent on efficient use of laboratory apparatus. A laboratory environment that is well-equipped with the requisite resources is vital in boosting students' and teachers' self-confidence in undertaking scientific processes. Good performance will also in turn make schools to invest more in the subject by equipping laboratories well (Soyibo & Nyong, 1984; Ogunbanwo, 2014).

The period between July 1998 and June 2003 saw the government of Kenya (GoK), with the assistance from the government of Japan, through Japan international Co-operation Agency, begin to strengthen the teaching of secondary school Chemistry through a cascade teacher education pilot project (SMASSE). Through SMASSE, PDSI and ASEI processes, Chemistry teachers and school administrators were taken through INSET programmes on improvisation to assist in boosting the number of equipment in schools. Obviously, improvisation for some of the Chemistry teaching and learning equipment may not be possible. In such scenarios, schools have no choice but to purchase these equipment. Unfortunately, some of these equipment may be too expensive for some schools. How should schools cope with such scenarios and how is this affecting achievement in Chemistry among schools in Sotik Sub-County? Why is it that still in 2011, eight years after the introduction of SMASSE project, Chemistry performance in Kenya in general, and Sotik Sub-County in particular, is still low despite all the teachers undergoing the SMASSE INSET programme?

2.7 Utilization and Impact of Laboratory Resources

Students cannot conduct experiments if the necessary facilities are not provided (Kehinde, Chen, Ayodele & Akinwale, 2011; Ajayi, 2007). When instructional aides are in short supply, teaching and learning is impaired. Subsequently, the quality of academic programmes is adversely affected. According to Kehinde *et al.* (2011), Ajayi (2007) and Okebukola (2002), effective teaching-learning process cannot be guaranteed with inadequate instructional materials. Instructions given in form of practical work improve the learners' level of understanding (Dahar & Faize, 2011). Not only do resources make learning (of Chemistry or any other subject) activity oriented, but they also improve students' attitudes towards learning, make the learning student-centred and students self-reliant in their studies. The indispensability of the resources to the teaching of Chemistry cannot be over emphasized (Arokoyu & Ugonwa, 2012).

Chemistry examinations always test students' mastery of facts, concepts and level of understanding of the subject content. All these cannot be achieved without laboratory experiments. Hands-on activities have been identified as being able to provide the perfect base towards achieving this goal. Once understanding of basic scientific skills in Chemistry has been attained, application of the knowledge in industrial world would be inevitable for economic, technological and growth of the society.

It is important to note that in most developing countries science and technology are the most underdeveloped sectors. This is because the countries' education systems are not fully equipping learners with the needed skills in the laboratory, nor do they have the relevant equipment for economic, scientific and technological development (Dike, Nwofor, Chineke & Okoro, 2010). Maduagwu and Nwogu (2006) report that the quality of education is greatly determined by the availability or lack thereof of these facilities in the Chemistry laboratories.

Studies have shown that students sometimes make observations or gather data during laboratory experiences that appear to contradict known scientific principles or concepts (Olsen, Hewson & Lyons, 1996). One reason for this could be the resources utilized are not up to standard. In some cases, students are overwhelmed by complex, laboratory manuals and equipment that teachers use during the instruction process. Schools and teachers may also respond to these challenges by scheduling fewer or shorter laboratory activities (or eliminating them entirely) resulting in poor mastery of laboratory processes skills and subsequently poor achievement.

Therefore, for better achievement in examination results and technological development, laboratory resources are required to facilitate teaching and learning in Chemistry. Empirical studies have established that students achieve greater learning both in cognitive and psychomotor domain when resources are used for instructional purposes (Ifeakor, 2006).

2.8 Learning Chemistry in a Laboratory Environment

Many Chemistry educators agree that laboratory plays a central role in Chemistry education (Hofstein, Shore & Kipnis, 2004). At the same time, they are in unison that students' conceptual understanding and constructive learning in Chemistry is always attained where teachers utilize the inquiry method of teaching and learning (Hofstein, Tami & Shore, 2001). However, this can only happen when the available learning resources are effectively utilized. Moreover, students are inspired to love the subject when laboratory resources are utilized effectively and efficiently. Therefore, for efficient Chemistry learning in the laboratory environment to be achieved, it is more important to answer the following questions:

i. What is the goal of Chemistry teacher in laboratory work?
ii. What is the goal of the Chemistry student in the laboratory work?
iii. How do the resources students' uses in the laboratory influence what they learn?

2.8.1 Students Goal in the Laboratory

The inquiry type Chemistry laboratory is central to learning Chemistry (Hofstein *et al.*, 2004), since it involves the process of conceiving problems, formulating hypotheses, designing experiments, gathering and analysing data and drawing conclusion about Chemistry problems that affect students in school and also in the general world. If Chemistry laboratory resources are appropriately used, students will solve most of the problems ranging from passing examination to even creating jobs after school.

In addition, the need to solve these problems makes Chemistry students to conduct research independently as well as in groups thus they learn to use laboratory resources in scientific investigations effectively (Lunetta, Hofstein & Clough, 2007). Hofstein (2004) avers that evaluating the effectiveness of the Chemistry laboratory utilization by Chemistry students is not easy and the parameters are not clearly defined. As such, understanding the goals that governs students during the inquiry laboratory processes may assist in evaluating the effectiveness of Chemistry laboratory resources utilization. It may also render the often perceived complex experiments, that do not allow easy collection of data, simple hence allow transformation of Chemistry attained knowledge in future for betterment of students. The main goals of the Chemistry laboratory environment are:

i. It assists in the acquisition of the experimental skills by the students.
ii. The laboratory possesses require resources that may be used readily by the students during the learning process hence transmitting the knowledge attained to development.
iii. It should engage the learner creatively towards the process of acquisition of knowledge (Conrad & Donaldson, 2011).
iv. It assists in developing skills regarding co-operation and communication and therefore Chemistry laboratory is a unique learning environment (Hofstein, 2004).

2.8.2 Teachers' Goals in the Laboratory

The generation and dissemination of constructive Chemistry knowledge, concepts and ideas to students requires teachers' to actively engage the Chemistry laboratory. This will enable teachers to guide students through their learning difficulties (Hofstein *et al.*, 2001). As such, the main goal of a teacher in using a Chemistry laboratory is to develop, implement and assess the outcomes of inquiry-Chemistry laboratory classes. This makes it easier for the teacher to understand the levels of weaknesses and the strengths of the processes of teaching and learning interactions with students.

Hofstein *et al.* (2001) identify the specific goals of the teacher in using a laboratory as:

i. To provide Chemistry teachers with opportunity to vary their instructional techniques hence avoid monotonous classroom learning environment
ii. To assess students' perception regarding their laboratory learning environment
iii. To assist in the planning and implementation of laboratory experiences by providing the necessary Chemistry resources. This will efficiently assist in achievements of students' experimental skills.
iv. To create an innovative laboratory learning environment by introducing inquiry type experiments
v. To assess students' performance and achievement using different modes of presentation in the Chemistry laboratories while using resources

On the other hand, Talim (2007) observe that the goals of most teachers in laboratory classes while undertaking experiments vary, as do the benefits to the Chemistry students. Among their views are:

i. To help students understand and learn better the provided scientific concepts during manipulation of Chemistry laboratory resources
ii. To assist in enhancing Chemistry students' interest in laboratory work
iii. To help Chemistry students' discover knowledge on their own
iv. To improve Chemistry students' observational skills
v. To enhance their problem solving skills in Chemistry laboratory
vi. To ensure that students learn through experience in Chemistry laboratory

2.8.3 Influence of the Laboratory Resources on Students' Chemistry Knowledge in Kenya

Chemistry education reforms in Kenya have in the recent past focused more attention on the need to integrate computer technologies into learning and teaching in the laboratories (Hofstein, Kesner & Frailich, 2009; Ozmen, 2008; Akwee, 2010; Lawrence & Orodho, 2014). This is meant to improve the understanding of Chemistry concepts by learners. Studies have shown that there is ineffectiveness when traditional approaches of conveying Chemistry knowledge are utilized in Chemistry instruction (Nahum, Hofstein, Mamlok & Krajcik, 2007; Coll & Taylor, 2002). These traditional methods are said to deprive students of the deep conceptual understanding of key concepts (Taber, 2001). However, by introduction of technology as a laboratory resource, the abstract nature of these scientific concepts is minimized.

Nevertheless, physical and mental models have always been used in teaching and learning, especially while dealing with microscopic molecules (Mulavu, Omolo & Micheka, 2012). These assist students visualize basic concepts increasing their understanding of key issues. According to Wanyonyi (2010), without utilization of these models, misconceptions always emerge, since explanation of scientific concepts in Chemistry education relies on microscopic substances that cannot be easily visualized without visible illustrations.

Consequently, numerous studies have reported positive effects of the use of instructional resources on the students' achievement (Schroeder, Scott, Tolson, Huang & Lee, 2007); but this is only possible if the Chemistry laboratory resources are efficiently used. Laboratory instructional resources influence the approach used in learning Chemistry, discourage memorization and algorithmic solving of problems and encourage conceptual understanding and critical thinking (Huitt, 2003).

The curiosity of learners is always aroused when performing experiments in the laboratories through inquiry methods of learning which makes them to be extremely inquisitive (Morgil, Oskay, Yavuz & Ard, 2003). Experiments create visual representations of the chemical interactions for students to easily understand the concepts conveyed (Linn, 1992; Mulavu, 2011). As such, the influence of resources in Chemistry education in Kenya cannot be gainsaid. The study, therefore, sought to determine the availability of Chemistry laboratory resources, the extent of use and their influence on students' achievement in Sotik Sub-County.

2.9 Chapter Summary

The achievement in Chemistry in KNEC examinations in Sotik Sub-County has not been to the desired standards. The study was designed to find out how this can be improved by efficient utilization of Chemistry laboratory resources. The literature review has shown that there is a positive relationship between efficient utilization of laboratory resources and achievement. In addition, almost all scholars agree that many benefits accrue, in terms of understanding when Chemistry laboratory resources are well utilized in the instructional processes.

Despite of this unanimous agreement, there are knowledge gaps that need to be filled in Sotik Sub-County. Therefore, this study was meant to fill the following knowledge gaps in the studies of the availability and use of laboratory resources on students' achievement in Chemistry:

i. To document for the principals, teachers and students the diverse effects of efficient and effective laboratory use on Chemistry achievement

ii. To underscore ways that can be used to strengthen Chemistry achievement in secondary schools by using laboratory resources

iii. To give a comprehensive interpretation of the concept of utilization of Chemistry laboratory resources in the instructional process during Chemistry lessons for schools in Sotik Sub-County and Kenya at large

iv. Identify the most important basic laboratory resources required for instructional processes in teaching Chemistry in Sotik Sub-County, Bomet County and Kenya in general

v. To investigate the relationship that exists between the use and non-use of Chemistry laboratory resources on Chemistry performance by students in the Kenya Certificate of Secondary Education national examination done at the end of their four years' course work

CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter describes the research design, area of study, the target population, sample size and sampling procedure, research instruments, validity and reliability of research instruments, administration of the research instruments, data analysis techniques used, and the ethical considerations of research.

3.2 Research Design

The study adopted the quasi-experimental and descriptive survey design. Shadish, Cook and Campbell (2002) define the quasi-experimental design as one that involves selecting groups upon which a variable is tested, without any random pre-selection processes. The class or groups remains intact.

The quasi-experimental design was preferred by the researcher since it was difficult to choose students in a school setting at random and place them in specific groups and classes. Therefore, they were easier to set up than the true experimental designs which require random assignment of subject. As such, the researcher divided the class using the seating arrangement during the research process. This method was convenient and minimised disruption. Other reasons for this selection included the fact that the design minimized threats to external validity since experiment is done in its natural setting and all subjects involved (Denizen & Lincoln, 2011). Moreover, findings may be applied to other subjects and settings, allowing for some generalizations.

The sample was divided into experimental and control group where a pre-test that involved laboratory was administered to both samples. After a pre-test, an intervening variable was introduced to the experimental group. After two weeks a post-test was administered to both the experimental and control groups and analysis was carried out on how it impacted on achievement. Figure 3.1 below shows the baseline study of the quasi-experimental design used in the study.

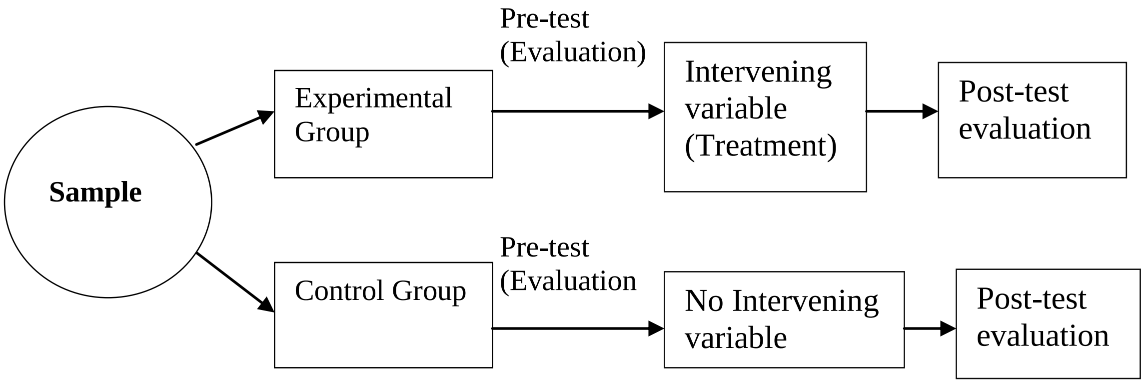

Figure 3.1: A baseline study of the quasi experimental design
Source: Researcher (2013)

Descriptive survey design was also adopted in this study. Descriptive survey design involves collecting data in order to answer research questions concerning the current status of the subject in study and also determines and report the way things are or were (Orodho, 2012). Descriptive survey design was used along with the quasi-experimental research design because the study intended to produce statistical information about aspects of availability of laboratory resources while using questionnaire and checklists.

In this research, a cross-sectional sub-type of descriptive survey design was used because the researcher was interested in establishing the laboratory resources that were available in secondary schools in Sotik Sub-County and the extent to which they were utilized by Chemistry teachers. These did not require a longer time. The descriptive survey research design helped in describing the nature of existing conditions, determining the relationships that existed between the use of Chemistry laboratory resources and Chemistry practical achievement, improve in decision-making and planning on how to access Chemistry laboratory resources (if not available) in Sotik Sub-County.

The study was conducted in four stages. Stage I involved proposal writing and preparation of research instruments. Stage II involved piloting of the research instruments to validate and refine them. Stage III was the data collection from sample population. Stage IV involved data analysis, presentation, conclusion and recommendations.

3.3 Location of the Study

The study was carried out in Sotik Sub-County (formerly Sotik District) in Bomet County, Kenya. The Sub-County is situated in the formerly Rift Valley Province. It borders Bureti Sub-County, Konoin, Bomet, Trans-mara and Borabu Sub-Counties in Kericho, Bomet, Kisii and Narok Counties (see Appendix I).

It is divided into four administrative divisions, namely Ndanai/Abossi, Kapletundo, Chemagel and Manaret/Rongena. It covers an area of 479.2 km^2 with a population of 167,289 persons. The Sub-County has 17 locations and 36 sub-locations. It receives rainfall throughout the year ranging between 1,100mm and 1,500mm annually. Its population comprises a number of ethnic communities and races that speak different languages. The region was purposively selected based on the researcher's experience as a Chemistry teacher in schools in the area. The experience in the region enabled him to realize that in the years 2010 and 2011, results posted in Chemistry were poor leading to an outcry from various quotas hence propelled for a study to be conducted in the region.

3.4 Target Population

There were two thousand six hundred and thirty-three (2,633) students in Sotik Sub-County enrolled in Form II in Secondary Schools at the time of the study. Chemistry was compulsory in all the schools in the study area at the time of study. This population was comprised of students pursuing Chemistry as a subject.

There were a total of thirty (30) Chemistry teachers in various secondary schools and an equivalent number of laboratory technicians. These Chemistry teachers had various levels of expertise and taught diverse topics in Form II Chemistry which required varying teaching methods to better facilitate students understanding and retention.

The study involved four (4) purposively selected secondary schools for quasi-experiments and thirty secondary schools for descriptive survey that were selected by simple random sampling, in the study area. The newly started schools were excluded since they had not administered KCSE examinations. The target population for the study was drawn from Form II students in Sotik Sub-County studying Chemistry while the accessible population was Form II students in the selected secondary schools in the Sub-County.

3.5 Sample Description, Size and Sampling Procedures

3.5.1 Sample Description

The primary sources of information in the study were:

a) Form II students who were purposively selected since they had studied *Salts I,* a topic that is examinable in KNEC practical examination. Form I students were considered not yet adequately exposed while Form III and IV, were considered to be very busy. It was purported; therefore, most Secondary School administrators in the Sub-County would not allow the researcher to conduct his research study on these classes.

b) Chemistry teachers and laboratory technicians in the schools were purposively selected since they were assumed to have the required knowledge of various laboratories in their schools. The researcher was, therefore, depending on them to achieve the required objectives of the research.

3.5.2 Sample Selection Technique

a) Sub-County: Sotik Sub-County was purposively selected. It was selected due to the researchers' in-depth knowledge of the region. His ability to easily interact with various Chemistry teachers in the Sub-County was also regarded as an important factor during selection of this region to be included in the research study, as these enabled the researcher to realize that there was dismal achievement in Chemistry in the year 2010 and 2011 in KCSE.

b) Schools: Stratified sampling technique was used to select the schools according to their type and their previous KCSE Chemistry mean grades for the years 2010 and 2011 performance. The sub-groups of schools that led to the type of schools were:

i. County National School

ii. County Schools

iii. Sub-County Schools

Stratification was done according to previous performance in KCSE Chemistry examinations. The researcher decided that the schools that scored mean grade of C- and above were good performing schools and those that scored a mean grade of D+ and below as poorly performing schools. In the above sub-groups, schools with mean grade of D+ and below were purposively selected as they could give in-depth information on the Chemistry laboratory resources and the extent of their utilization. To avoid biasness, simple random sampling was used to select sample schools to be included in the study.

c) **Chemistry teachers and laboratory technicians:** Professional expertise was given first priority while choosing Chemistry teachers and laboratory technicians to be included in the study. Those Chemistry teachers teaching Form Two (2) were chosen. This was done purposively since they were trained specifically to handle Chemistry laboratory resources.

3.5.3 Sample Size

At the time of the study, Sotik Sub-County had 30 Secondary Schools (SSCEO office, Sotik, 2011; see Appendix IV), which sat for the KNEC exams in the year 2010 and 2011. Eight (8) secondary schools were girls schools, 20 were mixed-gender schools, and 3 were boys' boarding schools.

The researcher used Fisher's formula to calculate the sample size as shown below.

$$n_0, = \frac{\{z^2 p\ (1-p)}{e^2}$$

Where:

z - is the standard variate at 95 per cent confidence interval (1.96).
p - is the estimated proportion performance from previous studies.
e - This is the estimated error/sampling error at 3 per cent (The desired level of precision).
(1-p) - Estimated proportion of the non-performance.
n_0 - Sample size

According to Adesoji and Olatunbosun (2008), the proportion of performance in their studies revealed that 7.2 per cent of the total effect on achievement in Chemistry was accounted for by predictor variables. Therefore this percentage was taken as "p". This implies that:

$$\text{The sample size, } n_0 = \frac{\{1.96^2 \times 0.072(1-0.072)\}}{0.03^2}$$

$$n_0 = 285.2004.$$

From the above value, the researcher used n_0 (as 285 for practicability) to calculate the *n*, the sample size per school as follows:

$$n = \frac{\text{Student proportion per school x Calculated sample size } (n_0)}{\text{Total number of students in Form II in Sub-County}}$$

This provided the sample size of students per school and in case of Sotik Sub-County, it was as shown below.

Table 3.1: Students Samples Size for the Study per School

Secondary Schools in the Sub-County	Students in Form 2 per School	Sample Size per School
Akshar	45	5
Saruchar	46	5
Kaplong Girls	171	19
Kaplong Boys	265	29
Chebilat	116	13
Kamureito	63	7
Ndanai	82	9
Muiywek	88	9
Moi Minaret Boys	197	21
Kiptulwo	40	4
Tarakwa	50	5
Kanusin	76	8
Kimolwet	48	5
Kapkelei	91	10
Solyot	74	8
Kamirai	50	5
Gelegele	35	4
Kamungei	139	15
Kapkures	45	5
Gorgor	99	11
Tembwo	48	5
Motiret	33	4
Chesilyot	107	12
St Joseph	35	4
Rotik	60	6
Ngariet	254	27
Kipsingei	54	6
Oldebesi	20	2
Chebirbelek	54	6
Sigorian	32	3
Kipsimbol	42	5
Kipsonoi	36	4
Chebole	38	4
Total Number of Students	**2633**	**285**

Source: Sotik Sub-County Education Officer Office (2012)

To obtain these samples from the schools, the researcher used simple random sampling to “dip pick” the samples from schools. Therefore, the total number of students that was provided with questionnaire was two hundred and eighty-five (285) as was calculated above. The total number of teachers and laboratory technicians who were provided with questionnaire were thirty (30). On the other hand, the researcher used the observation checklist himself to examine apparatus and resources present in the same thirty (30) schools. All the thirty (30) schools were included in the sample for the case of checklists and questionnaire for teachers and laboratory technicians since assumption of normal population would be poor (Yamane, 1967; Israel, 1992). This was because they were fewer in number hence the entire population was included in the sample.

In education and social sciences, a sample of between 10 per cent and 30 per cent of the total population is appropriate for the study (Lawrence & Orodho, 2014). In this study, 12 per cent of the thirty schools were considered for the study in terms of experimental design and this translated into four schools.

These four (4) secondary schools were purposively selected from boarding schools. Boarding schools were selected since they could allow the researcher to undertake the necessary experiments past the required time and these avoided conflict with the administrations. Those schools that scored a mean less than 3.500 and below were selected, since informative schools that possessed the required characteristics (Mugenda & Mugenda, 2003, p. 50) were needed from Sotik Sub-County. Among the four experimental schools, simple random sampling was used to select sample schools to be used as control and experimental groups since they were more than four. Some neutral representatives of the schools that scored a mean of less than 3.5 were given a task to “dip pick” folded papers in calibrated as experimental, control or not included. Two (2) schools were selected as control group while the other two (2) schools were experimental group. From these schools, Form Two intact classes were selected using simple random sampling in cases where more than one streams were available since only a stream was needed for the study.

In experimental group, one school was denoted as “Kap” while the other as “Kam”. In pre-test, “Kap” (pre-test one) had a total of fifty-seven (57) participants while “Kam” (pre-test two) had a total of forty-seven (47) participants. During experiment, the experimental group experienced mortality rate. The mortality rate was experienced due to some students who were sent home to bring school fees. At the time of post-test one, “Kap” had fifty-two (52) participants. On the other hand, post-test two, “Kam” had forty (40) participants. Consequently, in the control group, one school was labelled as “Aksh” and the other as “Chol”. In pre-test one, “Aksh” had a total of sixteen (16) participants who were involved in the study while pre-test two, “Chol” had a total of thirty-four (34) participants. Similarly, in post-test one, “Aksh” had eighteen (18) participants. In the post test two, “Chol” had thirty-three (33) participants.

3.6 Research Instruments

The researcher used a questionnaire, checklists and Chemistry achievement test (CAT) to collect data. Triangulation of these instruments was meant to give a more detailed and balanced picture of the situation (Altrichter & Elton, 2008; Creswell, 2003; Woolley, 2005). The use of these instruments together also helped overcome the weaknesses or intrinsic biases and problems that could have arisen from a single method.

3.6.1 Questionnaire

The researcher used a self-administered questionnaire. There were two types of questionnaire, namely Chemistry students' questionnaire (see Appendix II) and Chemistry teachers' and laboratory technician questionnaires (see Appendix I). The Chemistry teachers' and laboratory technicians' questionnaire was used to ascertain the level of availability of various laboratory resources in the sampled schools and its use. The Chemistry students' questionnaire was used to determine the extent of use of Chemistry learning resources in the Sub-County. The questionnaire was administered to the laboratory technicians, teachers and students in sampled schools seeking their views on laboratory equipment availability and use.

The questionnaire contained both open-ended and closed-ended items. Open-ended questions were included to enable the researcher to explore in-depth opinions of participants. The researcher administered the questionnaire in person to respondents at their respective stations and waited for the feedback from the respondents to collect the document for analysis.

3.6.2 Checklist

The checklist was used to cross-check the available resources in the laboratories of the sampled schools with the help of Chemistry teachers and laboratory technicians. The researcher also observed the physical facilities in the laboratories, the general conditions of the laboratories and the manner in which teachers taught the science process skills to students in the laboratories. The checklist was administered before the commencement of experiments. This guided the experimental group on the treatment that was administered and any equipment that is needed to be improvised during experimental process.

3.6.3 Chemistry Assessment Test (CAT)

Chemistry Assessment Test was used to measure the learners' achievement scores. The question in the CAT was based on the content taught to Form Two students in the sampled schools as per Kenyan Secondary School Syllabus. The CAT had two sections labelled as section A and section B. Section A had two (2) short questions that tested the ability of learners to use Chemistry laboratory resources and questions involving reactions in the apparatus. Question one was further sub-divided into part (a) and (b) while question two was sub-divided into parts (a) to (f).

Section B involved one question labelled as question three (3). It was a question that required students to comprehend and apply learnt knowledge and chemical laws as required by KNEC practical examinations. It was a question on qualitative analysis.

The CAT had a maximum of 30 marks, practical questions that tested for Chemistry process skills, knowledge and efficient use of the available laboratory resources, and application of concepts under cognitive domain to learning. The short and long answer item format was modelled on the KNEC Chemistry practical paper, which was considered appropriate as it was a common format at secondary school level in Kenya (KNEC, 2006). The main focus was on laboratory utilization, process skills and utilization of available laboratory resources. The CAT was used to measure students' achievement.

3.7 Piloting

The researcher used the test and re-test method to establish the validity and reliability of the research instruments. The questionnaire was re-tested on thirty (30) students in a school in Bomet Sub-County after testing and correcting anomalies in duration of two weeks. The research assistants and the researcher coded and tested for reliability and validity of the piloted instruments of research. Bomet Sub-County was selected due it accessibility to researchers work place hence the control and experimental groups could be taken care of by the researcher himself. The school was also selected since it had characteristics such as those of sampled schools in the study i.e. the school mean in Chemistry was below 3.5. In the case of the CAT, an intact class of forty-five (45) students was administered with a copy each. The procedure used was identical to the one that was employed in the actual study, where a pre-test was administered and after duration of two weeks, a post test was administered. The experimental group was treated while using available laboratory resources while he control group was not treated. The CAT was scored and analysed to ascertain performance. In the process of scoring, ambiguous and vague questions were identified and correction made.

The aim of pilot testing of the instruments was to find deficiencies in the items, e.g. unclear directions, insufficient space to write the responses, clustered questions, and wrong phrasing of questions were corrected. Vague questions were also revealed and rephrased. It also helped in determining the validity and reliability of the instrument.

3.8 Validity and Reliability of Research instruments

The researcher ascertained if the instruments (especially the questionnaire) were valid and reliable by test and re-test procedure to a selected sample before the administration of the instrument to the actual population.

3.8.1 Validity

Content validity is a measure of the degree to which data collected using a particular instrument represents a specific domain of indicators or content of a particular concept (Mugenda & Mugenda, 2003). Content validity was used to evaluate if the content of the administered CAT, questionnaire and checklist concentrated on issues dealing with efficient utilization of laboratory resources. Moreover, two (2) KNEC examiners in Chemistry were provided with the CAT to evaluate its content. The second expert (KNEC examiner) was requested to determine whether or not the set of items in checklists accurately presented the concepts understudy, and the adequacy of the language used.

They approved the set questions in the CAT, especially section B. On the other hand, they recommended that some of the questions in the checklist be restructured and others be abolished so as to fit Form Two (2) students' standards. The experts also observed that there was a chemical that was not always easily available in the laboratory due to its cost and recommended that it should be changed.

3.8.2 Reliability

To measure the reliability of the instrument, a test- retest method was used to estimate the degree to which the same results may be obtained with repeated measure of accuracy with the above instruments. From an interpretivist's perspective, reliability is concerned with demonstrating that the researcher has not invented misrepresented data or has been careless in data recording and analysis (Mason, 2002).

The research instruments were tested in a school in Bomet Sub-County. This was done by giving out the CAT, questionnaire and checklist to students, Chemistry teachers and laboratory technicians' to fill. After duration of two weeks, the researcher gave back the instruments to the same subjects to re-test the instruments. The collected data were correlated using Spearman and Pearson's Correlation Coefficient (R). From the results, values of 0.771, 0.669 and 0.835 for questionnaire, checklist and CAT, respectively, were obtained indicating a higher positive correlation coefficient hence the instruments were suitable to be adopted.

3.9 Administration of the Research Instruments

The researcher sought authority to conduct the study from Dean's office, School of Education, University of Eldoret, NACOSTI, the Ministry of Education (MOE) headquarters, through the Sotik Sub-County Commissioner's (SSCC's) offices. The researcher also sought permission to conduct the study from Sotik Sub-County Education Officer (SSCEO) and the principals of all the secondary schools involved in the study.

With the assistance of principals and HODs science, relevant Chemistry laboratory resources were assessed and analysed to ascertain the effectiveness of laboratory use in science processes. The researcher visited the sampled schools and administered the questionnaire to students, laboratory technicians and Chemistry teachers in a span of one week. In the same week, the researcher administered the pre-test to the selected samples and used observation checklists to confirm if some science process skills were well understood by students and if some most frequently used laboratory resources were available in the sampled schools.

3.10 Data Analysis

After data collection, all questionnaires, CATs and checklists were organized and assessed for accuracy, completeness and uniformity. The researcher with the help of two assistants marked and scored the pre-test and post-test and generated quantitative data which was analysed. The researcher went through questionnaire and checklists to ascertain their numbers and see if all the items were responded to. The number of questionnaire distributed were two hundred and eighty-five (285) as was calculated using Fisher's formula, thirty (30) for Chemistry teachers and laboratory technicians. Thirty checklists were used by the researcher to assess the availability of laboratory resources in various schools. The return rate was one hundred per cent.

The classification of the data into usable categories, coding and tabulation then followed. Descriptive statistics was used to answer research questions, hypothesis and objectives in relation to the research topic. Percentages and frequencies were used to summarize data for every variable. The experimental data that was collected and analysed using Kruskal Wallis test and Mann-Whitney U-Test which was non-parametric test since the data collected did not pass the parametric test.

3.11 Ethical Considerations

The researcher adhered to the rules and regulations governing the design and conduct of research and the expected etiquette of research throughout the process of research. As such, the researcher ensured that the anonymity of the respondents was well guarded (Whelan, 2007). The researcher asked the respondents for informed consent before embarking on research. Moreover, the researcher requested permission from the Ministry of Education Science and Technology to allow him to carry out the research. The researcher further asked for permission from principals of the institution to undertake the research in their institutions.

3.12 Chapter Summary

The study adopted a descriptive survey and quasi-experimental research designs. Descriptive survey design was purposely useful in answering objective 1 and 2 by generating percentages and frequencies. Quasi-experimental design was used in answering objective 3. In addition, triangulation of instruments was used. In this case, a questionnaire for Chemistry teachers and lab technicians was combined with an observation checklist and a Continuous Assessment Test (CAT). The instruments were subjected to a pilot study conducted with Form II students in a neighbouring sub-county to test their reliability and validity. Finally, with the help of two research assistants, the researcher administered the instruments. The collected data was analysed and presented with ethical considerations being made in the entire research process.

CHAPTER FOUR
DATA PRESENTATION, ANALYSIS, AND INTERPRETATION

4.1 Introduction

This chapter presents the results of the study on the availability and use of laboratory resources and how this relates with students' achievement in Chemistry. The findings of the study were presented and analysed according to the objectives of the study, namely:

- To determine the available resources for teaching and learning of Chemistry in secondary schools in Sotik Sub-County
- To determine the extent of use of Chemistry learning resources for teaching and learning of Chemistry in secondary schools in Sotik Sub-County
- To determine the relationship between the use of Chemistry learning resources and students' achievement in Chemistry

4.2 Demographic Characteristics of Students

4.2.1 Gender

The numbers of female and male students that took part in this study were almost equal in ratio, approximately 1:1. Male students constituted 129(45.2%) while their female counterparts constituted 156(54.8%) as shown in Table 4.1 below.

Table 4.1: Gender of Students

		Frequency	**Per cent**	**Valid Per cent**	**Cumulative Per cent**
Valid	Female	156	54.8	54.8	54.8
	Male	129	45.2	45.2	100.0
	Total	**285**	**100.0**	**100.0**	

4.2.2 Secondary School Entry Marks

The study sought to establish the level of performance of students when they entered secondary school. The results were as shown in Table 4.2 below.

Table 4.2: Secondary School entry Grade

		Frequency	**Per cent**	**Valid Per cent**	**Cumulative Per cent**
Valid	Between 301-400	147	51.6	51.6	51.6
	Between 201-300	138	48.4	48.4	100.0
	Total	**285**	**100.0**	**100.0**	

It is evident from the findings in Table 4.2 that most students were above average. It was noted that 147(51.6%) scored 301 marks and above while 138(48.4%) scored KCPE marks of between 201 and 300. This implied that most students had the ability to read and write which are the core skills in undertaking practical Chemistry lessons in the laboratory. Similarly, this finding concurs with findings of Jagero (2013) who found out ha students who performed well in KCPE are likely to perform well in KCSE and so in Chemistry practical classes, if well exposed. It was assumed that based on their scores in KCPE, such students had acquired the basic skills used in Chemistry processes such as recording, observations, interpretation of collected data, inferring and measuring, which are crucial components in Chemistry laboratory use and achievement.

The background of the entry behaviour is critical in efficient laboratory use since most hands-on activities in the Chemistry laboratory require the students to develop and pass their own judgments and interpretation of facts, validate laws and reinforce new laws and ideas. All these are necessary in the development of scientific skills and culture.

4.3 Demographics of Chemistry Teachers and Laboratory Technicians

4.3.1 Gender

As indicated in the pie-chart below, male teachers and laboratory technicians constituted 23(78%) while their female counterparts constituted 7(22%).

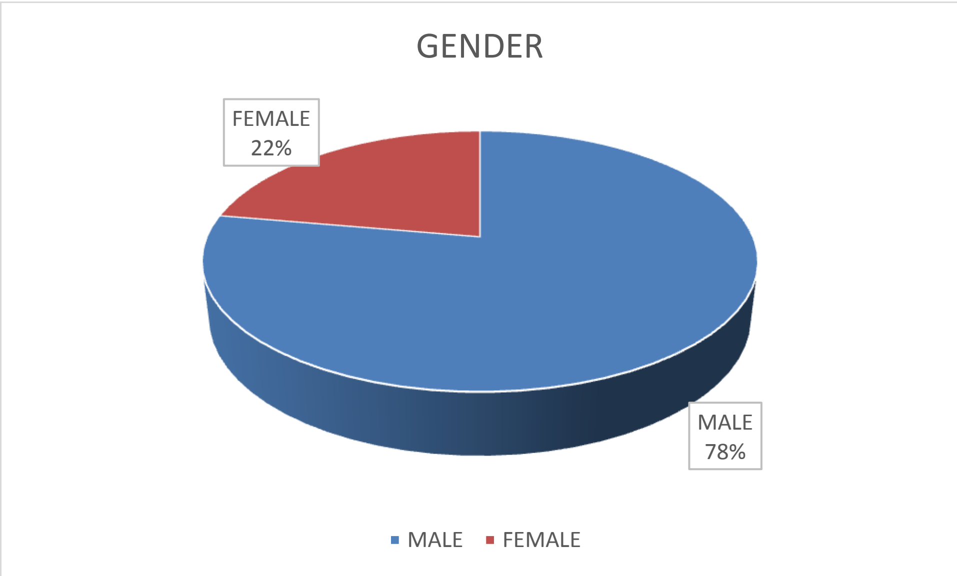

Figure 4.1: Indication of gender in terms of percentages

The study showed that there were more male teachers of Chemistry and laboratory technicians in secondary schools in the Sub-County. Majority of the respondents, 23(78%), indicated that in their institutions, including girls' schools, teachers and lab technicians were mostly male. This implies that most female students lacked role models to motivate them to aspire to efficiently utilize laboratory resources and positively impact on their achievement. It was thus possible girls were not motivated to perform tasks such as working as laboratory technicians in Chemistry laboratories. Kakonge (2000) argues that gender disparity exists in achievement of students in Chemistry as a subject, with females continuing to perform poorly than the boys.

4.3.2 Academic Qualification

The academic qualifications of teachers and laboratory technicians were as indicated in the bar graph below.

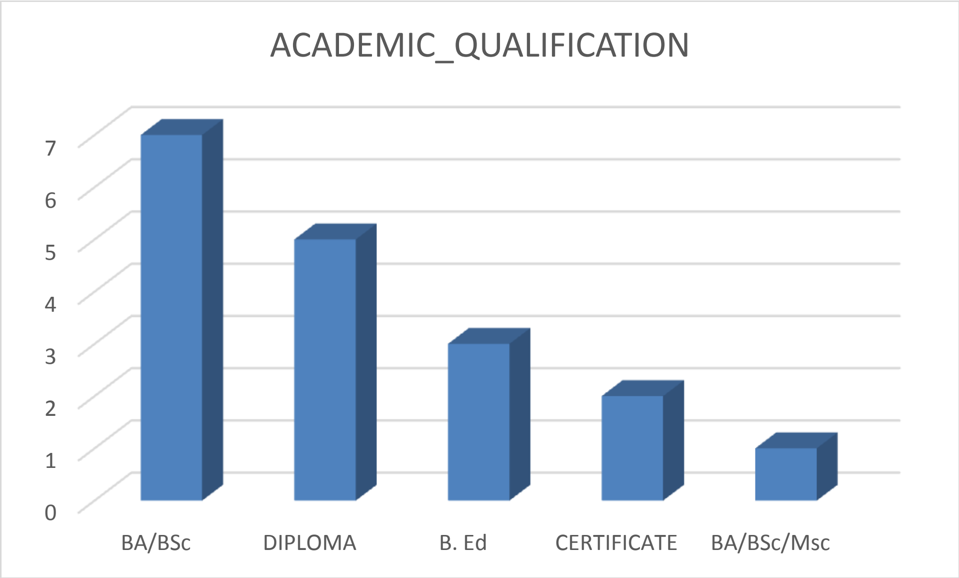

Figure 4.2: Academic qualifications of lab technicians and Chemistry teachers

From the study findings, 2(5.6%) of the lab technicians were MSc degree holders, 3(11%) were certificate holders, 5(16.7%) were B.Ed degree holders, 8(27.8%) were diploma holders and 12(38.9%) are BA/BSc holders. More qualified teachers have a greater propensity and confidence to use available instructional resources.

The higher the academic qualification, the greater the exposure to the laboratory resources and the better the teachers and lab technicians are in preparing laboratories and imparting knowledge (Ezeano & Ezeudu, 2013). As such, the fact that 17(56.7%) of Chemistry teachers and laboratory technicians were not trained in an education background could render them ineffective or inefficient in imparting Chemistry knowledge using laboratory resources.

Consequently, achievement is procedural and the attainment of efficiency in the utilization of laboratory resources requires training on how to handle and utilize the laboratory itself as well as the resources that are used in Chemistry laboratory. Njagi and Njagi (2015) posit that those teachers' and laboratory technicians' competence in Chemistry education is shaped by the foundational training they received at secondary school level.

4.3.3 Teaching Experience

From study findings, 8(27.8%) indicated experience of 11-20 years, 8(27.8%) had experience of 6-10 years and 17(44.4%) had experience of up to 5 years. Table 4.3 below illustrates these findings.

Table 4.3: Working experience of Chemistry Teachers and Laboratory Technicians

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Up to 5 yrs	14	46.6	46.6	46.6
	11-20 yrs	8	26.7	26.7	73.3
	6-10 yrs	8	26.7	26.7	100.0
	Total	**30**	**100.0**	**100.0**	

From the research findings, 16(53.4%) indicated experience of between 5 to 20 years. This implies that most of educators in the selected secondary schools had rich experience in the utilization of laboratory resources. This means their extensive interaction with resources in Chemistry laboratories had given them an edge of efficiency on utilization of laboratory Chemistry resources. Since experience is enormous, it is expected of Chemistry students to implement the acquired knowledge from experienced teachers beyond classroom level.

Furthermore, only 14(46.7%) of the respondents had work experience of less than 5 years and this may imply that the Sub-County had greater potential to achieve better results in KNEC Chemistry national examinations. Bukirwa (2011) has established that Chemistry teachers' with greater teaching experience have developed their own teaching practices and are subsequently more able to enhance students' understanding of subject concepts.

4.4 Availability of Resources for Teaching and Learning of Chemistry in Sotik Sub-County Secondary Schools

Basing on the data collected using Chemistry teachers and laboratory technicians' questionnaire and the Checklist, availability of teaching and learning resources in Chemistry was analysed and interpreted as described below. It is important to note that, satisfied and extremely satisfied implied availability while dissatisfied and extremely dissatisfied implied non-availability.

4.4.1 Availability of Consumables

4.4.1.1 Concentrated Acids

It was realized from the findings that most laboratories were well stocked with the required acids. The findings were as shown in the table below.

Table 4.4: Availability of Concentrated Acids

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Sulphuric Acid					
Valid	Available	24	77.8	77.8	77.8
	Insufficient	3	11.1	11.1	88.9
	Unavailable	3	11.1	11.1	100.0
	Total	**30**	**100.0**	**100.0**	
Nitric Acid					
Valid	Available	16	55.6	55.6	55.6
	Insufficient	7	22.2	22.2	77.8
	Unavailable	5	16.7	16.7	94.4
	Not sure	2	5.6	5.6	100.0
	Total	**30**	**100.0**	**100.0**	
Hydrochloric Acid					
Valid	Available	22	72.2	72.2	72.2
	Insufficient	3	11.1	11.1	83.3
	Excessive	3	11.1	11.1	94.4
	Unavailable	2	5.6	5.6	100.0
	Total	**30**	**100.0**	**100.0**	
Maleic Acid (Cis-butenedioic acid, Formula; $C_4H_4O_4$)					
Valid	Available	15	50.0	50.0	50.0
	Insufficient	6	16.7	16.7	66.7
	Excessive	3	11.1	11.1	77.8
	Unavailable	3	11.1	11.1	88.9
	Not sure	3	11.1	11.1	100.0
	Total	**30**	**100.0**	**100.0**	

Most participants were satisfied with presence of acids in their laboratories. Concentrated sulphuric acid was the most available, 24(77.8%), followed by concentrated hydrochloric acid, 22(72.2%), and concentrated nitric acid, 16(55.6%). Mineral acids should be availed right from the point when learners are introduced to basic Chemistry. Therefore, the study findings clearly show that since the acids were available there was a high probability that the students in the Sub-County were using them. The availability of the resources thus enables good introduction and mastery of basic scientific concepts for learners. Furthermore, empirical studies have shown that students achieve greater learning in both cognitive and psychomotor domain when

Chemistry laboratory resources are utilized efficiently in Chemistry instructional process and more so in their early stages of academic life (Ifeakor, 2006).

On the other hand, the respondents indicated that the available organic acids were enough. Specifically, 15(50%) of respondents were satisfied with the availability of Maleic acid **(Cis-butenedioic acid; its formula $C_4H_4O_4$; Molecular weight 116.07g/mol)**. This acid is useful in conducting qualitative analysis that involves organic compounds that are examinable by KNEC. Therefore, if learners in the Sub-County are made to efficiently utilize these resources during revision better achievements in Chemistry will be realized.

4.4.1.2 Alkalis and Bases

The findings of the study indicated that the respondents were all satisfied with availability of dilute sodium hydroxide at 21(70.0%), Copper (II) Sulphate at 22(72.2%) and Ammonium hydroxide at 22(72.2%). The findings were as shown in the tables below.

Table 4.5: Availability of Alkalis and Bases

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Sodium Hydroxide					
Valid	Available	21	70.0	70.0	70.0
	Excessive	5	16.6	16.6	86.6
	Insufficient	2	6.7	6.7	93.3
	Not sure	2	6.7	6.7	100.0
	Total	**30**	**100.0**	**100.0**	
Copper (II) Sulphate					
Valid	Available	22	72.2	72.2	72.2
	Excessive	3	11.1	11.1	83.3
	Not sure	3	11.1	11.1	94.4
	Insufficient	2	5.6	5.6	100.0
	Total	**30**	**100.0**	**100.0**	
Ammonium Hydroxide					
Valid	Available	22	72.2	72.2	72.2
	Excessive	5	16.7	16.7	88.9
	Insufficient	3	11.1	11.1	100.0
	Total	**30**	**100.0**	**100.0**	

From these findings, it is clear that the necessary alkalis and bases are available in secondary schools in Sotik Sub-County. Alkalis and bases are commonly used in the learning process in the laboratory in secondary school level Chemistry in conjunction with acids. They are used in teaching topics on acids, bases and indicators, salts and solubility, mole concept are among the few that utilize bases and alkalis in the process of knowledge acquisition. It implies therefore, if they are efficiently used, these laboratory resources can enhance student achievement (Ebong, 2006).

4.4.1.3 Availability of Measuring Cylinders and Volumetric Flasks

From the research findings, 18(61.1%) of the respondents were satisfied, 7(22.2%) were extremely satisfied while 5(16.7%) remained neutral with the presence of measuring cylinders and volumetric flasks in their Chemistry laboratories as indicated in the table below.

Table 4.6: Availability of Measuring Cylinders and Volumetric Flasks

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	18	61.1	61.1	61.1
	Excessive	7	22.2	22.2	83.3
	Not sure	5	16.7	16.7	100.0
	Total	**30**	**100.0**	**100.0**	

From the research results in Table 4.6, it is clear that the resources for measuring of liquids in most laboratories were available at 25(83.3%). This implies that using volumetric analysis (titration process), students get to practice and master measuring as a process skill provided the available measuring instruments are efficiently used. Measuring as a science process skill requires dedication, accuracy and precision. These skills may be efficiently learnt if students are constantly exposed to the use of measuring equipment. The study findings showed that students in Sotik Sub-County have access to the requisite resources for measuring volumes of liquids. Measuring instruments help learners to stay curious in Chemistry learning which increases their chances to learn more and achieve better grades. This will in turn help schools avoid having to expose students to measuring skills for the first time during national exams, as reported by Kenya National Examinations Council (KNEC, 2004).

4.4.1.4 Availability of Beakers, Pipette, Burette and Conical Flask

Of the respondents, 17(55.6%) were satisfied, 10(33.3%) were extremely satisfied while 3(11.1%) were neutral with availability of pipette, burette, beakers and conical flasks as shown in Table 4.7 below.

Table 4.7: Availability of Burette, Pipette, Beakers and Conical Flasks

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	17	55.6	55.6	55.6
	Excessive	10	33.3	33.3	88.9
	Not sure	3	11.1	11.1	100.0
	Total	**30**	**100.0**	**100.0**	

From the results in Table 4.7, 27(88.9%) of the respondents agreed that there are enough burettes, pipettes, beakers and conical flasks. These instruments are used to make accurate measurements of liquids for a wider range (up to 50ml) in high school level Chemistry in laboratories. Burettes are used when fairly accurate volumes are required. Beakers and conical flasks are used for heating substances or mixing chemical components for titration processes which is examinable in KNEC Chemistry examination. Its availability implies that during these examinations, the learners may undertake their practical process with ease.

Consequently, if pipettes, burettes, beakers and conical flasks are efficiently used in the Sub-County, students will learn to make accurate measurements among other laboratory processes skills such as boiling liquids of little volumes, undertaking experiments in qualitative analysis, titration and preparation of various gases. This calls for better achievements in Chemistry results in the Sub-County.

4.4.1.5 Materials that are locally available, produced or bought by the School

This question was asked by the researcher to find out the level of creativity given the fact that improvisation is given the fast priority in Chemistry laboratories these days.

The results in Table 4.8 below show that 13(44.4%) were satisfied, 5(16.7%) were dissatisfied, 5(16.7%) were neutral, 3(11.1%) were extremely dissatisfied and 2(5.6%) were extremely satisfied with the level of utilization of fruits in Chemistry laboratories in Sotik Sub-County.

Table 4.8: Availability of Fruits

		Frequency	**Per cent**	**Valid Per cent**	**Cumulative Per cent**
Valid	Available	13	44.4	47.1	47.1
	Insufficient	5	16.7	17.6	64.7
	Not sure	5	16.7	17.6	82.4
	Unavailable	3	11.1	11.8	94.1
	Excessive	2	5.6	5.9	100.0
	Total	**28**	**94.4**	**100.0**	
Missing	System	2	5.6		
Total		**30**	**100.0**		

The above results show that most experiments performed during laboratory processes probably required schools to buy new fruits after every lesson, which might not be economically efficient.

Nine (33.3%) of the respondents were satisfied with availability of palm oil, 7(22.2%) were dissatisfied, 3(11.1%) were neutral, 2(5.6%) were extremely satisfied and 4(22.2%) were extremely dissatisfied as shown in Table 4.9 below.

Table 4.9: Availability of Palm Oil

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	9	33.3	35.3	35.3
	Insufficient	7	22.2	23.5	58.8
	Unavailable	7	22.2	23.5	82.4
	Not sure	3	11.1	11.8	94.1
	Excessive	2	5.6	5.9	100.0
	Total	**28**	**94.4**	**100.0**	
Missing	System	2	5.6		
Total		**30**	**100.0**		

From the research findings in Table 4.9, 14(44.4%) agreed that palm oil were not supplied to their satisfaction in Chemistry laboratories while 11(38.9%) indicated that they were satisfied with the supply of palm oil in their Chemistry laboratories. Since almost half of the respondents were not satisfied, it is possible that palm oil is not frequently utilized in Chemistry laboratories in some schools in the Sub-County. This means that most schools might be handling preparation of soaps in organic Chemistry theoretically in the absence of other commercial oils. It may also imply that the level of improvisation is also lower.

Using locally available materials makes it easier to sensitize the learners on how to utilize the available laboratory resources for teaching and learning Chemistry. These resources make understanding easier since students are often more acquainted with them. Nevertheless, some educators argue that locally available resources are of sub-standard quality (London, as cited in Owoeye & Yara, 2011). However, to facilitate students' understanding in Chemistry concepts for better achievement, it is important for teachers to improvise and use the resources efficiently in the absence of the standardized resources.

4.4.2 Availability of Non-Consumables

4.4.2.1 Availability of Laboratory Tables, Shelves and Stools

The findings in Table 4.10 below show the state of availability of laboratory tables, shelves and stools in secondary schools in Sub-County.

Table 4.10: Availability of laboratory Tables, Shelves and Stools

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	18	61.1	61.1	61.1
	Not sure	5	16.7	16.7	77.8
	Insufficient	3	11.1	11.1	88.9
	Unavailable	2	5.6	5.6	94.4
	Excessive	2	5.6	5.6	100.0
	Total	**30**	**100.0**	**100.0**	

The findings indicate that 18(61.1%) were satisfied, 3(11.1%) were dissatisfied, 2(5.6%) were extremely dissatisfied, 5(16.7%) were neutral and 2(5.6%) extremely satisfied with the availability of laboratory tables, shelves and stools in their schools. Therefore, in most schools students were comfortable while undertaking Chemistry experiments in the laboratory. Chemistry laboratory shelves, stools and tables are strategic factors in a well-functioning Chemistry laboratory since these resources eases the stress of standing and writing for learners.

On the other hand, availability of shelves, stools and tables only is not enough for better achievement. The proper arrangement of consumables on shelves, and arrangement of stools and tables to create sufficient working space all play a vital role in enhancing teaching and learning of Chemistry. In Chemistry, alphabetical order of arrangement of chemicals in shelves is always encouraged for easy access.

4.4.2.2 Availability of Analytical Balance and Beam Balance

The findings on the availability of analytical and beam balance in secondary schools in Sub-County were as indicated in the table below.

Table 4.11: Availability of Analytical and beam balance

		Frequency	**Per cent**	**Valid Per cent**	**Cumulative Per cent**
Valid	Available	20	66.7	66.7	66.7
	Insufficient	6	22.2	22.2	88.9
	Excessive	2	5.6	5.6	94.4
	Not sure	2	5.6	5.6	100.0
	Total	**30**	**100.0**	**100.0**	

From the above research findings, most, 20(66.7%), of the respondents were satisfied, 2(5.6%) were extremely satisfied, 2(5.6%) were neutral while 6(22.2%) were dissatisfied by the presence of the weighing and beam balances. Considering the level of dissatisfaction, it is possible that in some schools such experiments that require accurate measurement are only conducted by learners during the national examinations (KNEC, 2004). Consequently, students, Chemistry teachers and laboratory technicians in the Sub-County may be performing laboratory experiments using rudimentary resources or poor approximation, and the only reason they may invest in standardized equipment is to enable students pass examinations. Unfortunately, students in such schools have no mastery of practical skills in Chemistry. Indeed, it is possible that some schools never undertake the required measuring of masses and weights of chemical components in qualitative analysis experiments.

4.4.2.3 Availability of Heat Source

Most, 17(55.6%), of the respondents were satisfied with availability of Bunsen burners, 5(16.7%) were extremely satisfied, 3(11.1%) were dissatisfied, 3(11.1%) were neutral and 2(5.6%) were extremely dissatisfied. These results were as indicated in Table 4.12 below.

Table 4.12: Availability of Bunsen Burners

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	17	55.6	55.6	55.6
	Excessive	5	16.7	16.7	72.2
	Insufficient	3	11.1	11.1	83.3
	Not sure	3	11.1	11.1	94.4
	Unavailable	2	5.6	5.6	100.0
	Total	**30**	**100.0**	**100.0**	

The research findings further showed that most, 18(61.1%), respondents were satisfied with the availability of portable burner, 3(11.1%) were dissatisfied, 2(5.6%) were extremely dissatisfied while 7(22.2%) were neutral. These results were as shown in Table 4.13 below.

Table 4.13: Availability of Portable Burner

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	18	61.1	61.1	61.1
	Not sure	7	22.2	22.2	83.3
	Insufficient	3	11.1	11.1	94.4
	Excessive	2	5.6	5.6	100.0
	Total	**30**	**100.0**	**100.0**	

The fact that 17(55.6%) and 18(61.1%) were satisfied with availability of Bunsen burners and portable burners, respectively, seemed to imply that Chemistry laboratory experiments that require heating were being conducted efficiently in the secondary schools under study. The respondents who were dissatisfied reported that they always improvised the sources of heating only, especially during national examinations. One respondent confided thus:

> It is difficult especially when it comes to use firewood to boil water when doing exams, since to reach the required temperatures takes time and time allocation for examination is not changed.

Even though Chemistry laboratories have the potential to develop students' abilities such as posing Chemistry oriented questions (Davis & Krajick, 2005) and heating, if the environment in which the experiments are conducted are challenging to the Chemistry teachers and laboratory technicians, they may opt for an easy way out, i.e. doing only a part of the experiment they feel capable of. This is a form of inefficiency in the use of the laboratory and the result is dismal achievement in Chemistry.

Unfortunately, dismal achievement has characterized Chemistry for a while since the chalk and talk method of imparting knowledge is the only remaining option to educators in the absence of laboratory resources (Wachira, 2005). This is made worse by the fact that most laboratory activities require apparatus and resources that may be expensive for schools (Carnduff & Reid, 2003).

4.4.2.4 Availability of Test Tubes and Test-Tube Racks

The research results in Table 4.14 below indicate that 21(70.0%) of respondents were satisfied with the availability of test-tube and test-tube racks, 5(16.6%) were extremely satisfied, 2(6.7%) were dissatisfied and 2(6.7%) were neutral.

Table 4.14: Availability of Test-Tube and Test-Tube Racks

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	21	70.0	70.0	70.0
	Excessive	5	16.6	16.6	86.6
	Insufficient	2	6.7	6.7	93.3
	Not sure	2	6.7	6.7	100.0
	Total	**30**	**100.0**	**100.0**	

The satisfactory level for the availability of test-tubes and test-tube racks indicates that a higher population of the students sampled in the Sub-County were comfortable undertaking Chemistry experiments that involve qualitative analysis in examinations. The researcher observed that students often assume that test-tubes are used for general Chemistry laboratory experiments. Specifically, test-tubes are used in Chemistry during qualitative analysis when identification of cations and anions are required. Efficient identification is attributed to the fact that visibility is always enhanced by the transparency of the glassware. Unfortunately, some students tend to use the test-tubes instead of boiling tubes to heat substances. The habit of misusing laboratory apparatus has created a scenario whereby students gather data that appear to contradict known scientific principles or concepts.

The availability of test-tube racks ensures that test tubes are not broken when they are utilized efficiently for the purpose they are intended to perform. As such, this is done by holding the test tubes and boiling tubes in an upright position. These are the factors that may assist in achievement in Chemistry laboratories if efficiently utilized.

4.4.2.5 Availability of Tripod and Retort Stands

Majority, 18(64.7%), of the respondents indicated that their institutions had enough tripod stands and 10(35.3%) said they had enough retort stands. The results were as indicated in Table 4.15 below.

Table 4.15: Availability of Tripod and Retort Stands

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	18	61.1	64.7	64.7
	Excessive	10	33.3	35.3	100.0
	Total	**28**	**94.4**	**100.0**	
Missing	System	2	5.6		
Total		**30**	**100.0**		

The findings in Table 4.15 show that most, 28(94.4%), schools in Sotik Sub-County possessed tripod stands and retort stands in their Chemistry laboratories to assist them in conducting experiments that require heating, and for holding burettes during volumetric analysis. It has been observed that heating sources engage the learners' creativity towards the process of acquisition of knowledge (Conrad & Donaldson, 2011) as such, creative learning in Chemistry may be enhanced when this apparatus are used well in the Sub-County.

4.4.2.6 Availability of Spatula and Crucible

From the results, 18(64.7%) were satisfied, 8(29.4%) were extremely satisfied and 2(5.9%) were neutral. Table 4.16 below presents these results.

Table 4.16: Availability of Spatula and Crucibles

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	18	60.0	64.7	64.7
	Excessive	8	26.6	29.4	94.1
	Not sure	2	6.7	5.9	100.0
	Total	**28**	**93.3**	**100.0**	
Missing	System	2	6.7		
Total		**30**	**100.0**		

According to majority, 26(86.6%), of Chemistry teachers and laboratory technicians, spatulas and crucibles were sufficiently available. With these resources, achievement in topics such as chromatography should be higher. However, achievement is not dependent only on availability but efficient utilization of these instruments.

4.4.3 Availability of Audio-Visual Aids in Chemistry Laboratories

This study sought to establish the availability of graphic materials, including maps, charts, non-projected still pictures, over-head projectors, video and audio-tapes and finally computers.

4.4.3.1 Availability of Graphic Materials (Maps and Charts)

The research findings on the availability of charts and maps in Chemistry laboratories to enhance easy learning were as shown in Table 4.17 below.

Table 4.17: Level of Satisfaction towards Availability of Maps and Charts

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	18	60.0	64.4	64.4
	Insufficient	3	10.0	10.7	75.1
	Not sure	3	10.0	10.7	85.8
	Unavailable	2	6.7	7.1	92.9
	Excessive	2	6.7	7.1	100.0
	Total	**28**	**93.3**	**100.0**	

Missing	System	2	6.7		
Total		**30**	**100.0**		

From the findings in Table 4.17, 18(64.4%) were satisfied, 3(10.7%) were dissatisfied, 3(10.7%) were neutral, 2(7.1%) were extremely satisfied and 2(7.1%) were extremely dissatisfied. These findings concur with those of Kahinde *et al.* (2011) that efficient teaching and learning processes are guaranteed when adequate graphic materials are available. This implies that practical lessons that involve industrial processes may not be attended to well in some of the schools as 5(17.8%) were dissatisfied. It is important to note that charts facilitate viable simulation of the industrial processes.

Efficient teaching learning process is guaranteed when adequate graphic materials are available (Ajayi, 2007). An understanding of the industrial process elicits positive attitudes towards the subject and encourages students to work harder to achieve better results.

4.4.3.2 Availability of Non-projected Still Pictures

The research sought to find out the level of satisfaction on availability of non-projected still pictures among the respondents in the Sub-County. The results were as shown in Table 4.18 below.

Table 4.18: Availability of Non-Projected Still Pictures

		Frequency	**Per cent**	**Valid Per**	**Cumulative cent**	**Per**

				cent	
Valid	Available	12	38.9	44.5	44.5
	Not sure	7	22.2	25.9	70.4
	Insufficient	5	16.7	18.5	88.9
	Unavailable	3	11.1	11.1	100.0
	Total	**27**	**88.9**	**100.0**	
Missing	System	3	11.1		
Total		**30**	**100.0**		

Most schools, 12(44.5%), were satisfied, 7(25.9%) were neutral, 5(18.5%) were dissatisfied while 3(11.1%) were extremely satisfied with the availability of non-projected still pictures.

Non-projected still pictures cost less compared to taking students on trips to various industries to learn from first-hand experience. As such, more schools, 12(44.5%), were in possession of these non-still pictures to facilitate improvement of achievement in Chemistry. Apart from improving achievement in Chemistry, these materials provide Chemistry teachers with an opportunity to vary their instructional techniques hence avoid the monotonous classroom environment in the Sub-County (Hofstein *et al.*, 2001).

4.4.3.3 Availability of Over-Head Projectors

The research sought to gather information on the level of satisfaction of laboratory technicians and Chemistry teachers on the availability of over-head projectors in the Sub-County. The results were as shown in the Table 4.19 below.

Table 4.19: Availability of Overhead Projectors

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Unavailable	12	40.0	40.0	40.0

Available	8	26.6	26.6	66.6
Insufficient	5	16.7	16.7	83.3
Not sure	3	10.0	10.0	93.3
Excessive	2	6.7	6.7	100.0
Total	**30**	**100.0**	**100.0**	

The results in Table 4.19 show that 12(40.0%) respondents were extremely dissatisfied, 8(26.6%) were satisfied, 5(16.7%) were dissatisfied, 3(10.0%) were neutral while 2(6.7%) were extremely satisfied. The fact that more than half, 17(56.7%), of the respondents were dissatisfied implies that most schools had not embraced over-head projector technology, even though reforms have called for integration of these technology in learning institutions.

On the other hand, the study sought to establish the availability of computers and its peripherals. From the study findings, 10(35.7%) of the respondents were extremely dissatisfied, 8(28.6%) were neutral, 5(17.9%) were dissatisfied, 3(10.7%) were satisfied and 2(7.1) were extremely satisfied. These results are shown in Table 4.20 below.

Table 4.20: Availability of Computers and its Peripherals

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Unavailable	10	33.3	35.7	35.7
	Not sure	8	26.6	28.6	64.3

	Insufficient	5	16.7	17.9	82.2
	Available	3	10.0	10.7	92.9
	Excessive	2	6.7	7.1	100.0
	Total	**28**	**93.3**	**100.0**	
Missing	System	2	6.7		
Total		**30**	**100.0**		

Since half, 15(50.0%), of the respondents were dissatisfied with availability of computers and its peripherals, it is possible that most schools in Sotik Sub-County have not integrated computer technology, hence traditional methods of imparting knowledge may still be the norm. Consequently, Taber (2001) argues that traditional methods lack deep conceptual understanding of key concepts and facts of Chemistry educators.

On the other hand, learning institutions constitute of various students from different backgrounds. Some of them have good background knowledge of computer technology. If efficient Chemistry teachers employ the "known to unknown" method of facilitating knowledge using these devices, better achievement may be realized. This is especially possible if enough computers and computer technology, over-head projectors included, are availed by the school. In such cases, learning is highly facilitated through curiosity.

4.4.3.4 Availability of Videos and Audio Tapes

The researcher intended to get views of Chemistry teachers and laboratory technicians on availability of video and audio tapes.

Table 4.21: Availability of Videos and Audiotapes

		Frequency	**Per cent**	**Valid Per cent**	**Cumulative Per cent**

Valid	Excessive	14	46.7	46.7	44.4
	Insufficient	7	23.3	23.3	70.0
	Excessive	3	10.0	10.0	80.0
	Not sure	3	10.0	10.0	90.0
	Available	3	10.0	10.0	100.0
	Total	**30**	**100.0**	**100.0**	

As shown in Table 4.21 above, 14(46.7%) respondents were extremely dissatisfied, 7(23.3%) were dissatisfied, 3(10.0%) were extremely satisfied, 3(10.0%) were neutral while 3(10.0%) were satisfied.

From Table 4.21, 21(70.0%) of the Chemistry teachers and laboratory technicians were dissatisfied with availability of video tapes and audiotapes. This could imply that video and audiotapes were eminently unavailable in the schools studied in Sotik Sub-County. These video and audiotapes are part of the environmental learning features under the control of the Chemistry teacher, laboratory technicians and Chemistry learners. They encourage interaction stimulation and feedback among Chemistry students and also with the Chemistry teacher.

As such, it is important to introduce new technology to the learners early enough to enable efficient laboratory use. Such technologies help learners create visual representations of the physical interactions among chemical elements; hence easily understand the concepts conveyed (Linn, 1992).

4.4.4 Laboratory Design

4.4.4.1 Presence of Preparation Room and Emerging Equipment

As indicated in Table 4.22(a) below, 17(55.6%) were satisfied, 5(16.7%) were extremely satisfied, 3(11.1%) were dissatisfied, 3(11.1%) were neutral and 2(5.6%) were extremely dissatisfied.

Table 4.22(a): Availability of Preparation Room

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	17	56.6	56.6	56.6
	Excessive	5	16.7	16.7	73.3
	Insufficient	3	10.0	10.0	83.3
	Not sure	3	10.0	10.0	93.3
	Unavailable	2	6.7	6.7	100.0
	Total	**30**	**100.0**	**100.0**	

The results in Table 4.22(a) above show that the level of satisfaction on availability of preparation room was at 22(73.3%). This implies that teachers of Chemistry in Sotik Sub-County find it easier to prepare for pre-testing of experiments. Moreover, since chemicals and basic laboratory equipment are available, the teachers and students are able to successfully conduct experiments in the laboratories. The preparation room helps the laboratory technicians and Chemistry teachers to identify the problems that may be encountered during the experimentation process and correct them in time.

From the results in Table 4.22(b) below, 22(72.2%) of the respondents agreed that the space was sufficient for performing experiments while 8(27.8%) disagreed.

Table 4.22(b): Sufficient Space for Performing Experiment in Chemistry Laboratories

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Yes	22	72.2	72.2	72.2
	No	8	27.8	27.8	100.0
	Total	**30**	**100.0**	**100.0**	

The findings in the table above indicate that most students are comfortable while undertaking practical processes in the laboratory. The sense of comfort and safety gives students peace of mind to properly observe what is going on and makes accurate inferences in the laboratory.

In addition, behaviour of various chemical components in the laboratory tends to change with either concentration or temperatures changes which may be caused by poor storage and congested laboratory spaces. With increased population per unit area, the temperature of a given environment might increase and this may affect the outcome of a chemical reaction. Therefore, for efficient utilization of a Chemistry laboratory, enough space is necessary.

4.4.4.2 Availability of Chemical and Graphical Storage Room

The results on the availability of chemical and graphical storage rooms in secondary schools in Sotik Sub-County were as shown in the table below.

Table 4.23: Availability of Chemical Storage Room

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	15	50.0	50.0	50.0
	Excessive	8	26.6	26.6	76.6
	Insufficient	5	16.7	16.7	93.3
	Unavailable	2	6.7	6.7	100.0
	Total	**30**	**100.0**	**100.0**	

The study revealed that 15(50%) of the respondents were satisfied, 8(26.6%) were extremely satisfied, 5(16.7%) were dissatisfied while 2(6.7%) were extremely dissatisfied on the availability of chemical storage room. This indicates that the percentage purity of the outcome of any Chemistry practical processes in the Sub-County is high as most chemicals are properly stored. Furthermore, it was observed that the storage bench units were utilized well since storage cupboards had various chemicals arranged on working tops. It may also mean that the chemicals can easily be accessed saving time during the Chemistry practical processes. Such levels of effectiveness in the Chemistry laboratory engender better experimental learning outcomes and overall performance in the subject.

4.4.4.3 Availability of Fume Board Chamber and Safe Waste Disposal

The research sought to ascertain the availability of fume board chambers in various schools and the results obtained were as shown in Table 4.24(a) below.

Table 4.24(a): Availability of Fume Board Chamber

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Available	12	40.0	40.0	40.0
	Insufficient	10	33.3	33.3	73.3
	Excessive	3	10.0	10.0	83.3
	Not sure	3	10.0	10.0	93.3
	Insufficient	2	6.7	6.7	100.0
	Total	**30**	**100.0**	**100.0**	

As shown in Table 4.24(a) above, 12(40.0%) of the respondents were satisfied, 10(33.3%) were extremely dissatisfied, 3(10.0%) were extremely satisfied, 3(10.0%) were neutral while 2(6.7%) were dissatisfied. Some schools in the Sub-County did not have fume board chambers. This implies that experiments that result in emission of toxic gaseous compounds are either not performed in these schools or are done at the expense of students' and teachers' safety. Alternatively, such schools may resort to conducting these experiments in open air.

Performing toxic experiments in open air may pose great health risks to both the environment and Chemistry students. In worst case scenario, such effects may include genetic disorders, ecological impact, global warming and drug resistance diseases and pests (Munishi *et al.*, 2004).

Some Chemistry educators said they avoided such experiments despite their importance to students' academics and lives. When was asked to state why they avoided them, one teacher argued: "This is only an entity in the ocean of the syllabus". These are some of the attitudinal factors that negatively affect the achievement in Chemistry in the Sub-County due to wanton inefficiency in Chemistry laboratory. In addition, the study revealed that the methods utilized in waste disposal in the Sub-County are wanting in some schools as indicated in the table below.

Table 4.24(b): Availability of Safe Waste Disposal

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Yes	15	50.0	53.6	53.6
	No	13	44.4	46.4	100.0
	Total	**28**	**94.4**	**100.0**	
Missing	System	2	5.6		
Total		**30**	**100.0**		

From the analysis in Table 4.24(b) above, 15(53.6%) agreed that the methods of waste disposal in their various schools were okay but 13(46.4%) disagreed. Poor waste disposal in and around the laboratory may interfere with the efficiency in Chemistry practical process being administered to Chemistry learners.

4.4.4.4 Availability of Semi-circular Demonstration Table

The study sought the opinion of the respondents on the availability and design of the demonstration table and the following were obtained.

Table 4.25: Space Provided during Demonstration

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Unavailable	12	40.0	40.0	40.0
	Insufficient	6	20.0	20.0	60.0
	Not sure	5	16.7	16.7	76.7
	Available	5	16.7	16.7	93.4
	Excessive	2	6.6	6.6	100.0
	Total	**30**	**100.0**	**100.0**	

The study found that 12(40.0%) of the respondents were extremely dissatisfied, 6(20.0%) were dissatisfied, 5(16.7%) were neutral, 5(16.7%) were satisfied while 2(6.6%) were extremely satisfied. It was observed that the demonstration tables in the Sub-County were rectangular in shape. The rectangular shape poses a problem to learners in terms of the viewing angle and do not provide a greater chance to a higher population of Chemistry learners to observe the experimental proceedings.

Consequently, the greater number of enrolments of students in high school due to the introduction of FPE in Kenya in 2003 and the subsidized secondary education programmes, continue to put greater pressure on the available Chemistry laboratory resources. This challenge will also affect the Chemistry experimental resources leading to achievement in high school level Chemistry.

Moreover, from observation, it was noticed that some classes had more than seventy students against the recommended number of 40 by the Ministry of Education in the Sub-County. These numbers may not fit adequately in the Chemistry laboratory for demonstration experiments.

Congestion as a result of having too many students at once in a laboratory constitutes a form of inefficient laboratory use. This is because large numbers make it difficult for Chemistry teachers to monitor students’ acquisition of experimental skills. In such cases, students who sit at the back in the laboratory will most likely not even be pay attention or make clear observations of what is being done by the teacher. The end result of all this would be poor achievements in the subject.

4.4.5 Availability of Safety Equipment

The safety equipment plays a crucial sub-ordinate role of improving the working conditions of the Chemistry laboratory. The working conditions should be safe and appealing for laboratory technicians, Chemistry teacher and students. The safety equipment includes fire extinguishers, gas masks and first aid kit.

4.4.5.1 Availability of Gas Masks

The research sought to establish the availability of gas masks in secondary school chemistry laboratories in Sotik Sub-County. The findings were as shown in Table 4.26 below.

Table 4.26: Availability of Gas Masks

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Yes	17	55.6	55.6	55.6
	No	13	44.4	44.4	100.0
	Total	**30**	**100.0**	**100.0**	

From the analysis in the table above, 17(55.6%) of the respondents agreed that gas masks were available in their Chemistry laboratories while 13(44.4%) disagreed. Gas masks are part of the necessary precautionary wear in the preparation of Hydrogen Sulphide, Sulphur (IV) Oxide and Carbon (II) Oxide in Chemistry laboratories as stipulated by the Chemistry Syllabus. Since a greater number agreed that gas masks were available in their schools' Chemistry laboratories, it is possible that, given they are efficiently used, these apparatus give students courage to perform these experiments and achieve better from what was learnt.

4.4.5.2 Availability of Models

The research sought to find out if the Chemistry laboratories in the selected schools in Sotik Sub-County had Sodium Chloride, Graphite and Diamond models. The findings were as shown in Table 4.27 below.

Table 4.27: Models of Sodium Chloride, Graphite and Diamond in Sotik Sub-County

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Yes	20	66.7	66.7	66.7
	No	10	33.3	33.3	100.0
	Total	**30**	**100.0**	**100.0**	

Table 4.32 above indicate that 20(66.7%) of the respondents agreed that Sodium Chloride, Graphite and Diamond models were available in their Chemistry laboratories while 10(33.3%) indicated that their Chemistry laboratories lacked these models. This implies that models were available in the schools' Chemistry laboratories. This may be attributed to the fact that most often teacher-students on teaching practice supplement the schools with their projects after their learning process. It was observed that most of the models were made from locally available materials and were attached to some given registration numbers. These models are the ones that Chemistry teachers are trying to create meaning from them on what they are teaching to efficiently convey knowledge to learners.

Consequently, even though some educators may argue that chemical and molecular representations have no meaning by themselves and they only come from a group of individuals (Chamizo, 2011), Chemistry teachers have an obligation to ensure that the level of understanding of various Chemistry learners is achieved in the Sub-County.

The research results further showed that 10(33.3%) of schools in Sotik Sub-County did not have these models. Teachers and lab technicians in these schools need to construct these models to help students in efficiently conceptualising abstract and theoretical concepts. The process of constructing these models includes ascertaining how the microscopic elements and structures look like, choosing and integrating a set of items to be utilized in the construction process, imaging and creatively constructing or designing the model itself.

In summary, the findings showed that most schools in Sotik Sub-County scored highly on the availability of basic learning resources in Chemistry. It, however, emerged that a number of schools lacked the requisite visual and audio-visual aids, semi-circular demonstration tables, sufficient spaces for experimentation due to overcrowding and palm oil. For better achievement to be realized, provision and efficient use of the Chemistry teaching and learning resources is required.

4.5 Extent of Use of the Available Resources in Teaching and Learning of Chemistry in Sotik Sub-County

Based on the data collected using Chemistry students' questionnaire during the study, the results were analysed and discussed as below.

4.5.1 Weekly Attendance of Laboratory Sessions

The Kenya Secondary School Chemistry Syllabus advocates for four 40 minutes lessons in Forms One and Two and five 40 minutes lessons in Forms Three and Four. It is anticipated in the Syllabus that the workload in these two upper classes is enormous. Due to this allocation, two (2) of these lessons are set aside for Chemistry practical exercises while the remaining two are for theoretical work. The research, therefore, sought to find out from Chemistry learners' if laboratory sessions were well attended to. The responses were as presented in the table below.

Table 4.28: Weekly Laboratory Sessions

		Frequency	**Per cent**	**Valid Per cent**	**Cumulative Per cent**
Valid	Strongly Agree	110	38.6	38.6	38.6
	Agree	92	32.3	32.3	70.9
	Disagree	37	12.9	12.9	83.8
	Neutral	27	9.5	9.5	93.3
	Strongly Disagree	19	6.7	6.7	100.0
	Total	**285**	**100.0**	**100.0**	

From Table 4.28 above, 110(38.6%) strongly agreed that they normally attend to Chemistry laboratory sessions, 92(32.3%) agreed, 37(12.9%) disagreed, 27(9.5%) were neutral while 19(6.7%) strongly disagreed with weekly attendance of laboratory sessions. This seems to imply that most Chemistry teachers, laboratory technicians and students appreciated the presence of practical work in teaching Chemistry as a subject.

However, 56(19.6%) of respondents indicated that they have not been attending weekly laboratory sessions. As such, it is an indication that they have not changed from the traditional approach of imparting Chemistry knowledge, where the teacher is the supreme source of knowledge. The teaching approach of Chemistry in these stations may still be through the chalk and talk method with little or no practice (Wachira, 2005). This implies that understanding knowledge from the abstract chemical reactions is not facilitated by practical sessions which involve the efficient use of the laboratory resources.

4.5.2 Performing Demonstration Experiments

The researcher sought to find out if demonstrations were used in Chemistry laboratories. The findings from the study were as shown in Table 4.29 below.

Table 4.29: Performance of Demonstration Experiments

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Strongly agree	110	38.6	38.6	38.6
	Agree	83	29.1	29.1	67.7
	Disagree	37	12.9	12.9	80.6
	Strongly disagree	37	12.9	12.9	93.5
	Neutral	18	6.5	6.5	100.0
	Total	**285**	**100.0**	**100.0**	

From the results in Table 4.29 above, 110(38.6%) of the respondents strongly agreed that demonstration experiments were done, 83(29.1%) agreed, 37(12.9%) disagreed, 37(12.9%) strongly disagreed while 18(6.5%) remained neutral.

Since 193(67.7%) agreed that demonstrations were done in the Chemistry classes, it is possible that students learnt by seeing without doing the experiments themselves. This makes teachers the central participants in manipulating laboratory resources which deprives learners the opportunity to interact with the resources. If learners are given a chance to manipulate the Chemistry laboratory resources, it will positively transform their achievements in Chemistry in the Sub-County. As such, since skills are acquired through a process (Saat, 2004), Chemistry learners should be encouraged to practically manipulate Chemistry laboratory resources themselves.

Considering the challenges experienced in achievement in Chemistry in Sotik Sub-County, the use of demonstration experiments has its own advantages. First, they are much useful where there are not enough laboratory resources but in this case, there are enough laboratory learning resources. They may also be used when the products emitted during chemical reactions are poisonous. Moreover, they are important when time is limited and cannot allow for performance of class experiment, which is the most efficient method of utilizing laboratory resources, to improve Chemistry manipulative skills.

4.5.3 Performance of Experiments Individually

The researcher intended to find out the level of satisfaction of Chemistry students on weekly performance of class experiments and the following results were obtained.

Table 4.30: Chemistry Learners' Performance of Class Experiments Individually in Chemistry Laboratory

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Disagree	110	38.8	38.8	38.8
	Agree	46	16.1	16.1	54.9
	Strongly agree	46	16.1	16.1	71.0
	Strongly disagree	46	16.1	16.1	87.1
	Neutral	37	12.9	12.9	100.0
	Total	**285**	**100.0**	**100.0**	

From the above analysis, 110(38.8%) of the respondents were dissatisfied that they had been performing experiments individually, 46(16.1%) were strongly dissatisfied, 46(16.1%) were satisfied, 46(16.1%) were strongly satisfied and 37(12.9%) remained neutral. Chemistry process skills cannot be achieved by learners if they are not given the opportunity to interact with laboratory apparatus. This interaction ensures that learners gain confidence during Chemistry practical examinations.

From the analysis in Table 4.30 above, the extent dissatisfaction of the utilization of the Chemistry equipment in secondary schools in the Sub-County is worrying. This is the greatest contributor to the dismal performance in Chemistry practical in the Sub-County. One reason for this is the failure of Chemistry teachers to maximally utilize the available laboratory resources. Effective and efficient utilization of available laboratory resources lies in the teachers' professional and skilful abilities. Moreover, teachers must be dedicated and motivated to guide individual students to undertake classroom experiments on their own.

4.5.4 Using Chemistry Laboratory Apparatus at the Learners Own Pace

The researcher intended to investigate the extent to which available resources are utilized in Sotik Sub-County on Chemistry learners, 'own pace' and the following were the findings.

Table 4.31: Extent of Learning Chemistry at, 'Own Pace' outside Chemistry Laboratory with Laboratory Resources

		Frequency	Per cent	Valid Per cent	Cumulative Per cent
Valid	Strongly disagree	175	61.3	61.3	61.3
	Disagree	92	32.3	32.3	93.5
	Agree	9	3.2	3.2	96.8
	Strongly agree	9	3.2	3.2	100.0
	Total	**285**	**100.0**	**100.0**	

From the above analysis, 175(61.3%) respondents strongly disagreed, 92(32.3%) disagreed, 9(3.2%) agreed while 9(3.2%) strongly agreed that they were given time to interact with apparatus at their own pace in school. These findings seemed to imply that the learning resources in the Sub-County were not provided by laboratory technicians and Chemistry teachers to the learners to work on their own pace. As a result, Chemistry students, especially slow-learners, may have difficulty understanding some of the Chemistry content that is conveyed through the use of the laboratory.

In addition, achievement in Chemistry is always a "stepping stone" towards innovation of various scientific concepts that assists in continuity of knowledge. These may be realized, if the laboratory technicians and Chemistry teachers in the Sub-County level of educational system will equip Chemistry learners with the much needed skills using efficiently used resources (Anekwe, 2010) and giving Chemistry learners' a longer time to learn at their own pace.

4.5.5 End of Term Practical Examinations

The researcher wanted to ascertain if Chemistry practical were being administered as examination in a formative manner and the following were the findings as in the Table 4.32 below.

Table 4.32: Extent of Inclusion of Chemistry Practical in End of Term Exams

		Frequency	**Per cent**	**Valid Per cent**	**Cumulative Per cent**
Valid	Strongly disagree	165	57.9	57.9	57.9
	Agree	46	16.1	16.1	74.0
	Strongly agree	46	16.1	16.1	90.1
	Disagree	28	9.9	9.9	100.0
	Total	**285**	**100.0**	**100.0**	

From the findings in Table 4.32 above, 165(57.9%) of the respondents strongly disagreed, 46(16.1%) agreed, 46(16.1%) strongly agreed while 28(9.9%) disagreed.

These findings seemed to imply that in most schools, Chemistry practical were not included in end of term exams in most schools. The core purpose of formative evaluation in Chemistry laboratories is to encourage students to adopt good study habits. These include performing regular experiments to attain and master Chemistry process skills, provide feedback on their strengths and weakness in learning and applying Chemistry laboratory processes, and communicate their achievements.

Nonetheless, it is clear that in most secondary schools in Sotik Sub-County, these core objectives may not be realized since, from the data presented above, most students only use the laboratory resources when sitting for KNEC Chemistry practical (KNEC, 2004).

4.6 Relationship between the Use of Chemistry Learning Resources and the Academic Achievement in Chemistry

To apply the notion of efficiency in the utilization of Chemistry laboratory to the resources in this study, quasi-experimental design was utilized. As described in Chapter Three, the sample was divided into two experimental groups and two control groups to test the following null hypothesis:

> $\mathbf{H_{O1}}$: There is no significant difference between the control and experimental group in terms of performance.

The results of the hypothesis test were as presented in the sub-section below.

4.6.1 Relationship between the Experimental Group and Control Groups

The research sought to establish the relationship between the experimental group and control groups. From the percentages scored in the CAT administered to various

Chemistry learners in the sampled Schools in the Sub-County, the findings were as shown below.

Table 4.33: Overall Experimental and Control groups' Percentage Scores from CAT

Group				Statistic	Std. Error
Percentage Score	Control	**Mean**		22.58	1.348
		95% Confidence Interval for Mean	Lower Bound	19.91	
			Upper Bound	25.26	
		5% Trimmed Mean		20.87	
		Median		17.00	
		Variance		183.485	
		Std. Deviation		13.546	
		Minimum		7	
		Maximum		80	
		Range		73	
		Interquartile Range		6	
		Skewness		2.308	.240
		Kurtosis		5.650	.476
	Experimental	Mean		40.89	1.056
		95% Confidence Interval for Mean	Lower Bound	38.81	
			Upper Bound	42.98	
		5% Trimmed Mean		40.73	
		Median		42.00	
		Variance		217.530	
		Std. Deviation		14.749	
		Minimum		12	
		Maximum		82	
		Range		70	
		Interquartile Range		20	
		Skewness		.042	.174
		Kurtosis		-.428	.346

It is noted from the results in Table 4.33 above that the mean of the experimental group in Chemistry was relatively higher compared to that of the control group when the analysis was done at 95% confidence interval for lower and upper limits.

Moreover, the maximum score in the control group was recorded as 80 per cent while the minimum score was 7 per cent. In the experimental group, the maximum score was 82 per cent while the minimum score was at 12 per cent. This indicates that there was a slight statistical difference in the maximum and minimum scores for both the control and experimental group. In terms of variance and standard deviation, the experimental group recorded a greater value than that of control group. Consequently, the range between the control groups was at 73 per cent while that of experimental group was at 70 per cent. Interquartile range of the control group recorded a 6 while that of experimental group recorded a 20.

From the results, the achievements of those students who were treated during experiments were better than those who were not treated. This means greater utilization of Chemistry laboratory resources in imparting Chemistry knowledge should be done to enhance students' achievements in the subject. The desired achievements in Chemistry are obtained when accepted scientific concepts and ideas are not simply experienced (Millar, 2004) through demonstration of well documented procedures for the learner to follow in an enclosed room, but more so through learning in an environment where knowledge can be practically transmitted and attained.

The Chemistry practical process requires Chemistry teachers to effectively and efficiently utilize laboratory resources to guide students from the "known to unknown" concepts and experiences. Therefore, this study strongly advocates the optimal use of available Chemistry laboratory resources by teachers in Sotik Sub-County secondary schools.

In addition to the above tests, the researcher conducted a test for normalcy between the control and the experimental groups using Shapiro Wilk and Kolmogorov-Smirnov test. The findings were as shown in the table below.

Table 4.34: Test of Normality between the Experimental and Control Groups

Group		**Kolmogorov-Smirnov[a]**			**Shapiro-Wilk**		
		Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
PERCENTAGE	Control	.290	101	.000	.710	101	.000
SCORE	Experimental	.060	195	.087	.986	195	.049

The p-values of 0.000 and 0.049 from Shapiro-Wilk test of normality are both less than 0.05 which implies that the score distribution for the control group and the experimental group was not normal. The graph below further illustrates the above observation.

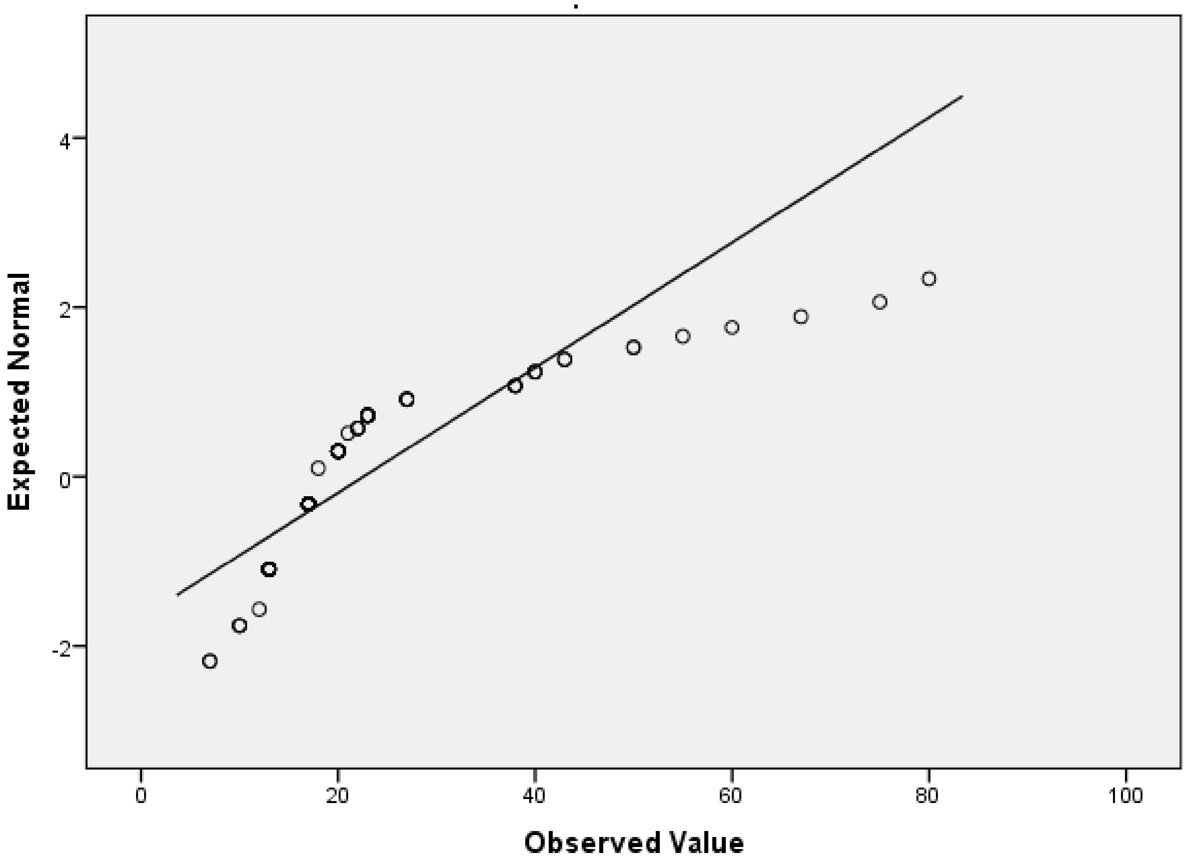

Figure 4.3(a): A normal Q-Q plot of percentage score for control group

This curve indicates that the value scored did not conform to normality test since it did not fall within the line of best fit. In the case of the experimental group, the graph below shows the results obtained.

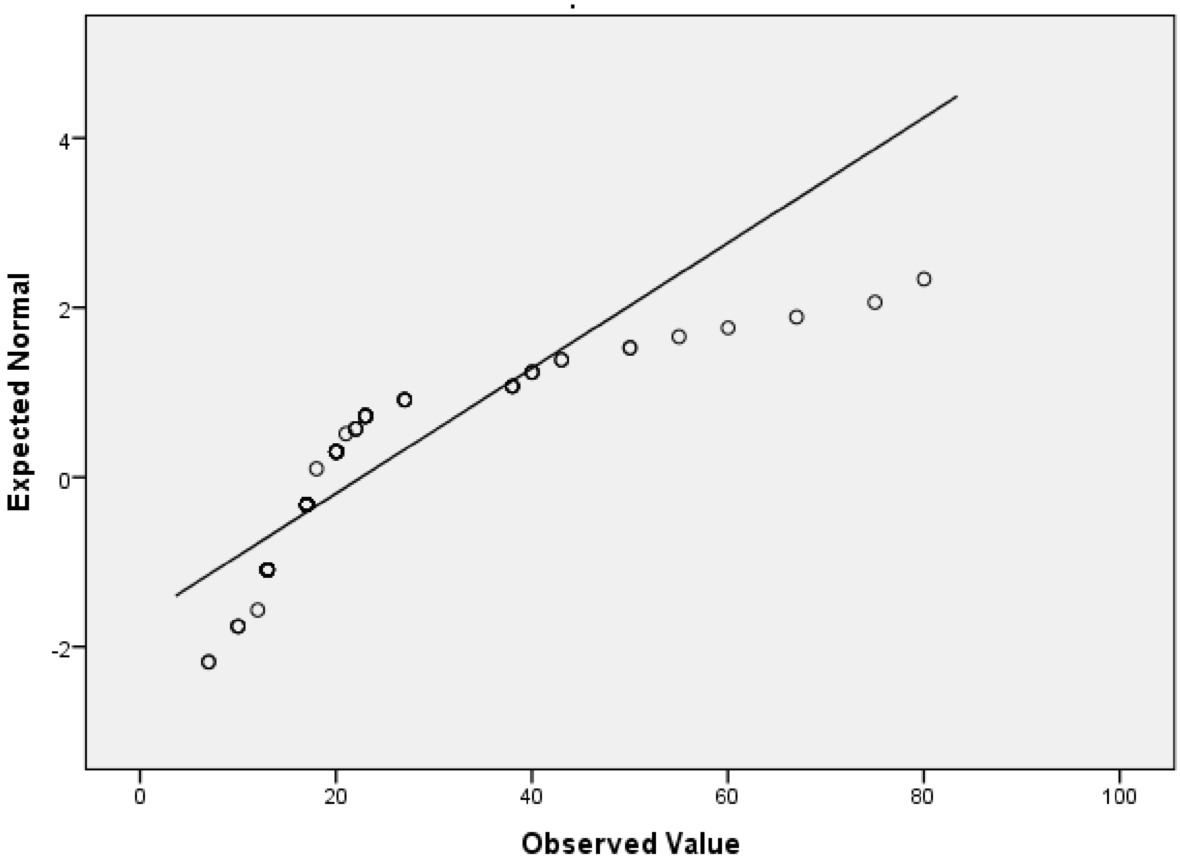

Figure 4.3(b): A normal Q-Q plot of percentage score for experimental group

Even though some of the observed values fell within the line of best fit, the normality test was not achieved since the P value of 0.049 was less than 0.05 as indicated in Table 4.34 above. Therefore, the researcher went further to use Mann-Whitney U-test which is a non-parametric test and an alternative to the two independent samples T-test. The findings were as shown in the table below.

Table 4.35: Mann-Whitney U-Test for Normality

	Percentage Score
Mann-Whitney U	3202.500
Wilcoxon W	8353.500
Z	-9.537
Asymp. Sig. (2-tailed)	.000

From the table above, the P-value of 0.000 implies that at 95% confidence intervals, there is a significant difference between the control group and the experimental groups and hence the null hypothesis is not accepted. The difference realized was due to the fact that the experimental group during post testing had already undergone treatment and, therefore, most of Chemistry process skills had been attained. This positively impacted the achievement of Chemistry results in experimental group. Apart from being better, the results realized in the experimental group also indicate a minimum level of skewness compared to those of the control group, as shown in the figure below.

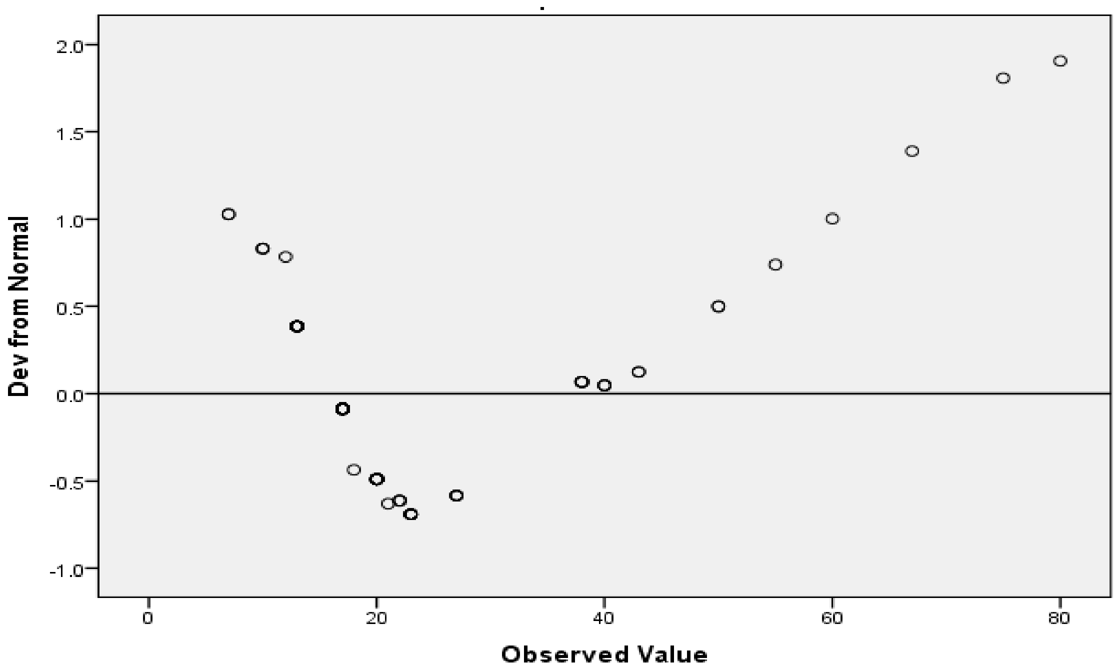

Figure 4.4(a): Deviation from normality score by various control group candidates

The above figure indicates that most of the student scores in the control groups were positively deviated from the normal while a few were negatively deviated from the normal. In addition, most students scored less than 40 per cent among those in the control group. On the other hand, the findings on the experimental group were as shown in the figure below.

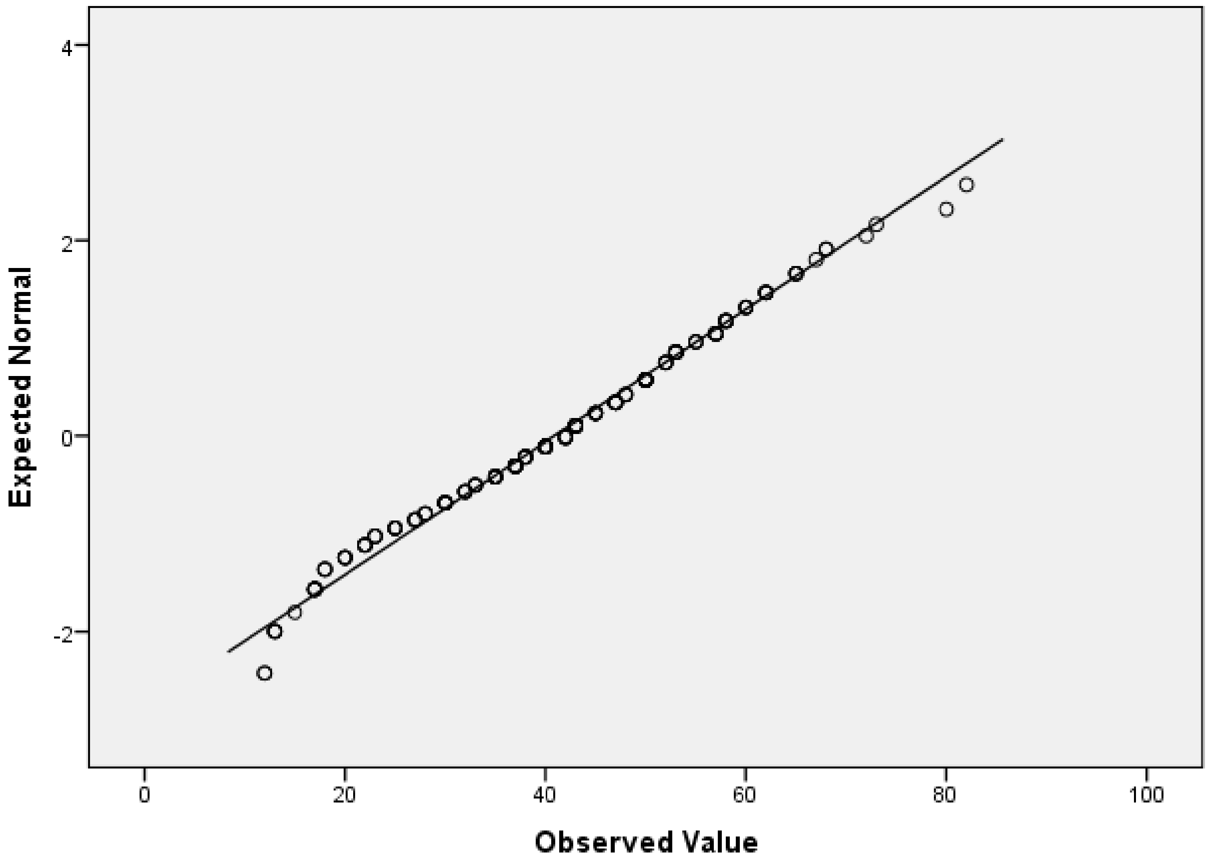

Figure 4.4(b): Deviation from normal score by various experimental group candidates

The figure above indicates that the candidates were equally deviated from normal in the negative side and positive side. This ensures that the performance of students is good and it explains why most students in experimental group performed well.

4.6.2 Relationship between the Two Pre-tests and Two Post-tests for Experimental and Control Groups

In order to determine the degree of internal efficiency in an actual Chemistry cycle, one needs an analytical device that may help to simplify the usage of various resources that are within the disposal of the learner, laboratory technicians and Chemistry teachers. In this study, pre-test-post-test control group design without randomization was used to test the null hypothesis.

The study intended to establish the relationship between the two pre-tests and two post-tests for the experimental and control groups. The findings of the study were as shown in the table below.

Table 4.36: Relationship between the Two Pre-tests and the Two Post-tests Percentage Scores for Experimental and Control Groups

Test				Statistic	Std. Error
PERCENTAGE-SCORE	Post-test one	Mean		43.94	2.156
		95% Confidence Interval for Mean	Lower Bound	39.64	
			Upper Bound	48.24	
		5% Trimmed Mean		43.85	
		Median		43.00	
		Variance		320.761	
		Std. Deviation		17.910	
		Minimum		10	
		Maximum		80	
		Range		70	
		Interquartile Range		28	
		Skewness		-.072	.289
		Kurtosis		-.753	.570
	Post-test two	Mean		34.62	2.021
		95% Confidence Interval for Mean	Lower Bound	30.59	
			Upper Bound	38.65	
		5% Trimmed Mean		33.98	
		Median		37.00	
		Variance		298.240	
		Std. Deviation		17.270	
		Minimum		7	
		Maximum		82	
		Range		75	
		Interquartile Range		30	
		Skewness		.377	.281
		Kurtosis		-.665	.555
	Pre-test one	Mean		42.25	1.302
		95% Confidence Interval for Mean	Lower Bound	39.65	
			Upper Bound	44.84	
		5% Trimmed Mean		42.70	
		Median		43.00	

	Variance		123.688	
	Std. Deviation		11.122	
	Minimum		13	
	Maximum		62	
	Range		49	
	Interquartile Range		13	
	Skewness		-.498	.281
	Kurtosis		.137	.555
Pre-test two	Mean		19.90	.666
	95% Confidence Interval for Mean	Lower Bound	18.58	
		Upper Bound	21.23	
	5% Trimmed Mean		19.59	
	Median		18.00	
	Variance		35.890	
	Std. Deviation		5.991	
	Minimum		7	
	Maximum		38	
	Range		31	
	Interquartile Range		6	
	Skewness		.832	.267
	Kurtosis		.497	.529

KEY:

Pre-test one, Post-test one } Control group

Pre-test two, Post-test two } Experimental group

From the above analysis, the experimental group performed better than the control group. For the control group, the pre-test one recorded a mean of 42.25 while the post-test one recorded a mean of 43.94. These values indicate that the improvement index is at +1.69. On the other hand, the experimental group pre-test one, before administering an intervening variable, recorded a mean of 19.90 but the post-test intervention recorded a mean of 34.62 which is a positive deviation of +14.72. The power of intervention while using Chemistry laboratory resources is realized in these two groups. This has also indicated that without using basic laboratory resources, the outcome that may be felt will be minimal.

Indeed, the quality of Chemistry education is greatly determined by the relevance of the availability of resources in the laboratory (Maduagwu & Nwogu, 2006). This plays a prime role in national technological, sociological and economic developments. The economies of the world grow when well-trained people are given opportunities to play various roles in its growth. Proper training, on the other hand, is achieved when educators utilize the available resources in institutions of learning.

The research also sought to test for normality in the four groups using Kolmogorov-Smirnov and Shapiro-Wilk tests. The findings were as shown in the table below.

Table 4.37: Test of Normality between the Two Experimental and the Two Control Groups

Test		**Kolmogorov-Smirnov[a]**			**Shapiro-Wilk**		
		Statistic	Df	Sig.	Statistic	Df	Sig.
PERCENTAGE SCORE	Post-test one	.096	69	.188	.976	69	.199
	Post-test two	.147	73	.001	.940	73	.002
	Pre-test one	.093	73	.194	.967	73	.055
	Pre-test two	.185	81	.000	.921	81	.000

The p-values of 0.199, 0.002, 0.055 and 0.000 from Shapiro-Wilk test of normality indicate that only the data of the post-test one followed a normal distribution (since P-value is greater than 0.05) as shown in the figures below.

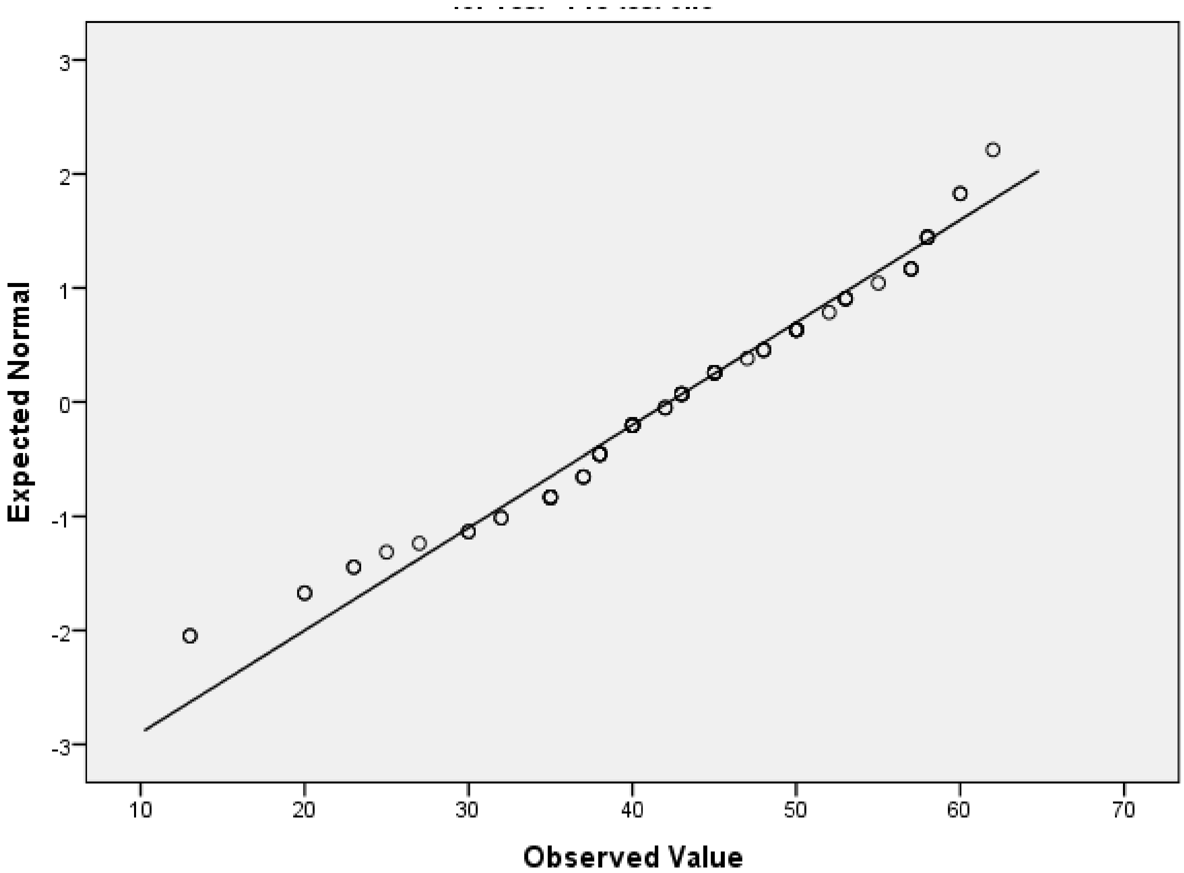

Figure 4.5(a): A normal Q-Q plot of percentage score for pre-test one

From the findings in Figure 4.5(a), most of the percentage scores were not within the line of best fit meaning they could not satisfy Shapiro-Wilk test.

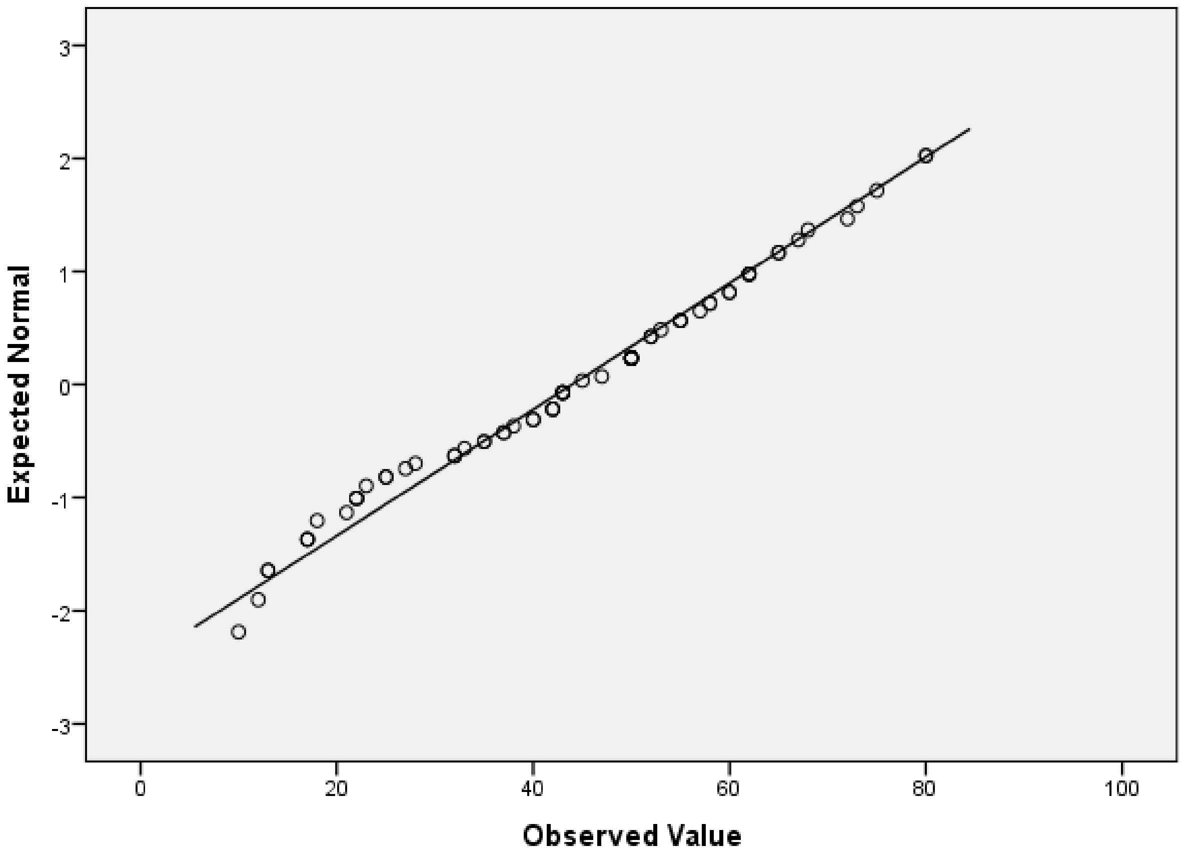

Figure 4.5(b): A normal Q-Q plot of percentage score for post-test one

From the findings in Figure 4.5(b), most of the percentage scores were within the line of the best fit meaning they satisfied Shapiro-Wilk test.

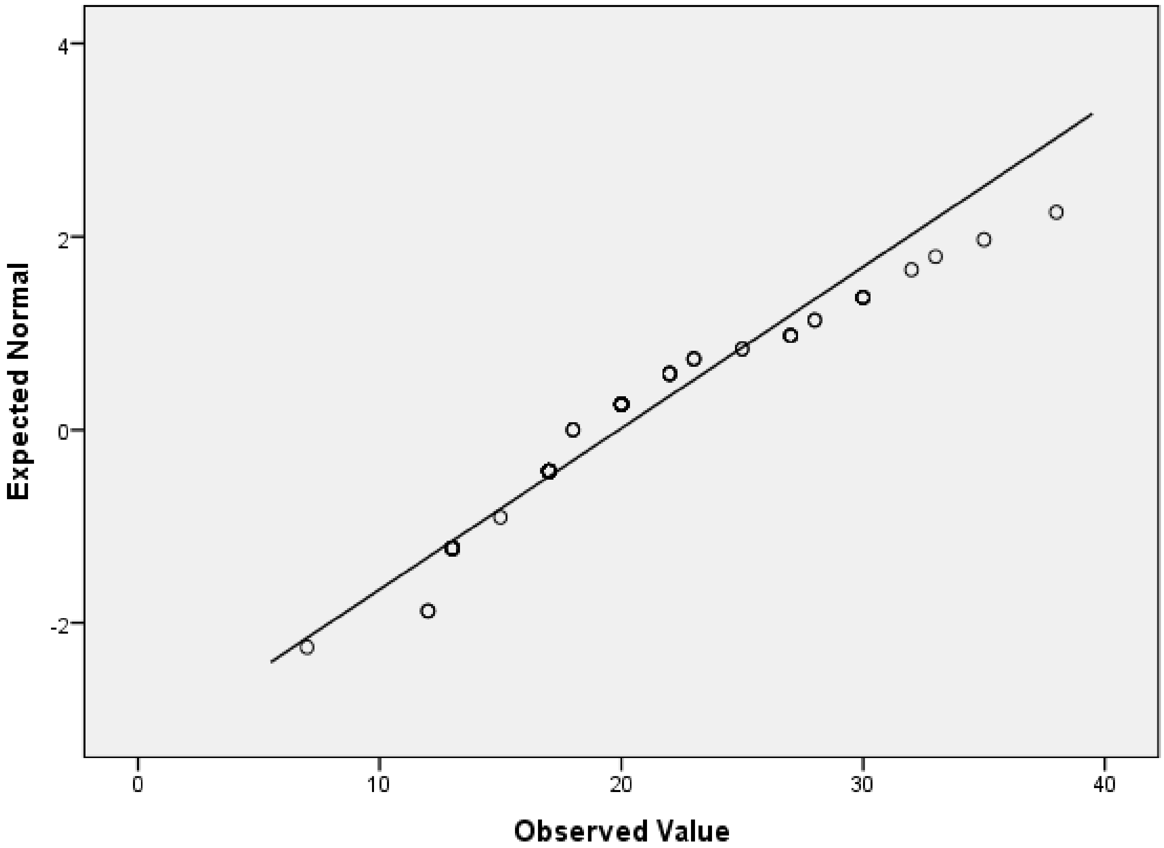

Figure 4.6(a): A normal Q-Q plot of percentage score for pre-test two

From the results in Figure 4.6(a), only two percentage scores were within the line of the best fit. This implies that the data could not satisfy Shapiro-Wilk test.

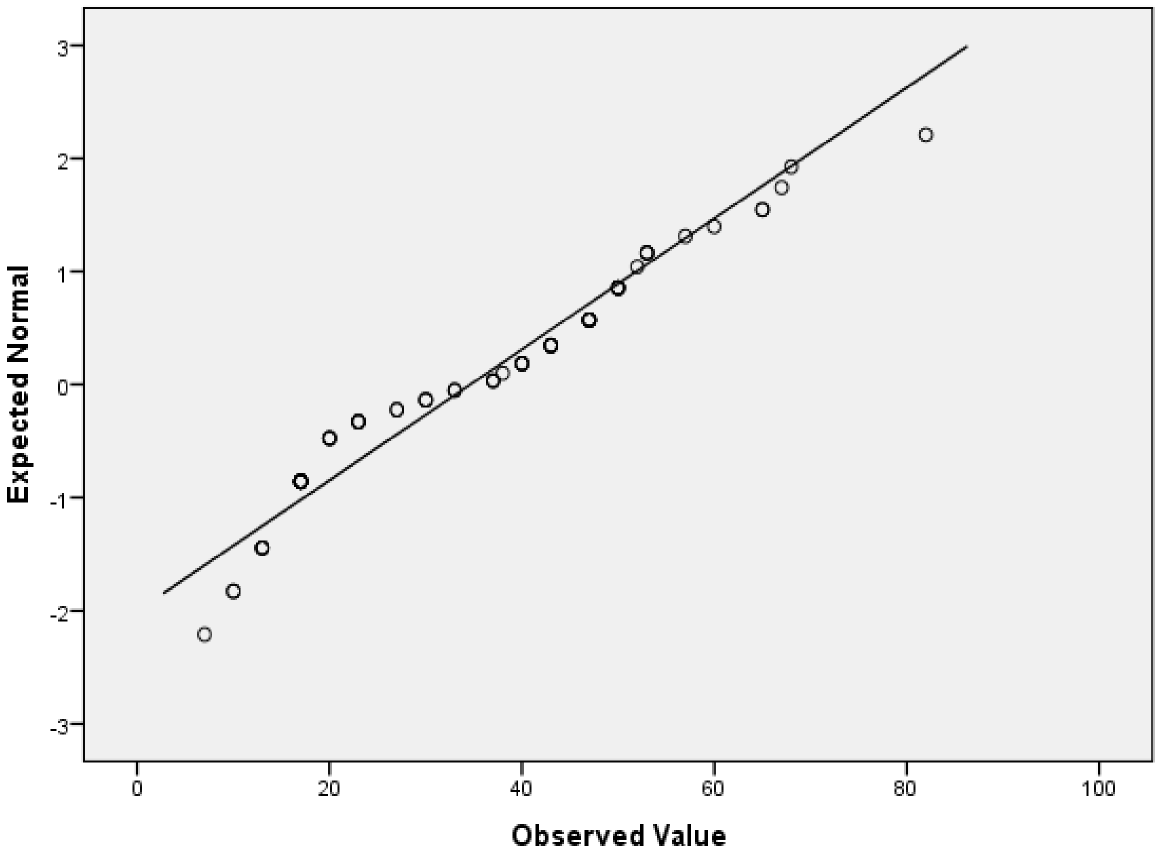

Figure 4.6(b): Normal Q-Q plot of percentage score for post – test two

Only five percentage scores fell within the line of best fit and as such could not satisfy Shapiro-Wilk test. Therefore, Kruskal Wallis test which is a non-parametric test and an alternative to one-way analysis of variance was used as below.

Table 4.38(a): Kruskal Wallis Test

Test		**N**	**Mean Rank**
Percentage Score	Post-test one	69	192.81
	Post-test two	73	147.34
	Pre-test one	73	192.27
	Pre-test two	81	72.35
	Total	**296**	

Table 4.38(b): Grouping Variable Test

	Percentage Score
Chi-Square	102.136
Df	3
Asymp. Sig.	.000

From the results in Table 4.38(b), the P-value of 0.000 implies that at 95% confidence intervals, there is a significant difference in the tests scores. Therefore, the null hypothesis was not accepted since there was a significant difference between the two control and the two experimental groups in terms of performance.

From the above discussion, the use of laboratory resources has been cited as a core factor that assists in students' achievements. Therefore, embracing the use of resources that are available in the Chemistry laboratory may assist in achievement of positive results in Sotik Sub-County. Consequently, strategic planning by Chemistry students, laboratory technicians and Chemistry teachers will assist in the attainment of better results. It will also reduce the time wasted in the preparation of the laboratory resources instead of planning for their application in laboratory sessions. Planning should also focus on ensuring that every individual learner gets a chance to utilize the Chemistry laboratory resources.

4.7 Chapter Summary

The findings of the study revealed that there are enough Chemistry laboratory learning resources in secondary schools in Sotik Sub-County. However, other resources were unavailable including some visual and audio-visual aids which include computers and its peripherals, video and audio-tapes, over-head projectors and non-projected still pictures, semi-circular demonstration tables, enough space for performing experiments and palm oil.

Moreover, it emerged that most schools used rectangular demonstration tables instead of semi-circular ones. Despite undergoing SMASSE INSET programmes, most teachers of Chemistry laboratories still undertook demonstration experiments instead of class experiments that can develop Chemistry learners' manipulative skills.

The findings also showed that most Chemistry laboratories in the selected schools had not adapted to the changes in Chemistry education. The extent of usage of various Chemistry laboratory resources was low in the Sub-County since most teachers dwelt a lot on demonstration experiments while others did not use Chemistry resources at all. There was no formative assessment that embraced the use of Chemistry practical at the end of the term, exception for pre-mock and mock examinations at Form 4 levels. In addition, there was a strong relationship between efficient use of laboratory resources and achievement in Chemistry in the study.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of the findings, conclusion and recommendations. It also gives suggestions for further research. The summary of the findings, conclusion and recommendations in the chapter are based on the objectives of the study.

5.2 Summary

The main purpose of this study was to determine the availability and use of laboratory resources and how this influences the achievement of the secondary school Chemistry students in Sotik Sub-County. The study was based on the Chemistry performance in the years 2010 and 2011 in which Sotik Sub-County recorded poor results. This propelled the researcher to investigate the availability of Chemistry learning resources in the Sub-County, the extent to which they were being used and finally the relationship between the use of Chemistry learning resources and the academic achievement of students. The study was based on the assumption that poor performance in Chemistry is an indication of lack inadequate practical work in schools since greater preference is given to practical (Obuong, 2007).

The target population of the study was drawn from members of Sotik Sub-County while the accessible population was sampled using Fisher's formula which was then done through simple random sampling. Purposive sampling was used to select the four (4) other secondary schools for quasi-experiments. The study adopted a triangulation of methods to enable the researcher to collect information, analyse and interpret the data. The instruments of data collection used in the study included an administered CAT, observation checklist and self-administered questionnaire. Data was collected and analysed descriptively using frequencies, means and percentages while the hypothesis was tested using Mann-Whitney U-Test and Kruskal Wallis test. The study revealed that most schools in the Sub-County were in possession of basic laboratory resources that may be used during KNEC Chemistry practical examinations. However, they were not being utilized effectively and efficiently in the process of imparting knowledge. The study also established that there is a strong relationship between using resources in teaching Chemistry and achievement by students.

5.3 Conclusion

5.3.1 Availability of Chemistry Laboratory Learning Resources

The study established that most secondary schools in Sotik Sub-County have enough basic laboratory learning resources necessary for better learning and improved achievement in the national examination. On the other hand, a majority of the schools lack visual and audio-visual aids. These materials included computers and their peripherals, video and audio-tapes and over-head projectors, semi-circular demonstration tables, enough space for demonstrations and palm oil that could be used in preparation of soaps.

5.3.2 Extent of Use of the Available Learning Resources in Chemistry Laboratory

It was realized that most Chemistry educators did not employ the resources available in the Chemistry laboratory during class experiments. Moreover, the teachers never gave room for students to use these resources and learn at their own pace. The demonstration method was teachers' favourite way of imparting knowledge.

5.3.3 Relationship between using Chemistry Learning Resources and the Academic Achievement

The study revealed that there is a positive relationship between using Chemistry laboratory learning resources and students' achievements in Chemistry.

5.4 Recommendations

From the study findings and the conclusions drawn, the following recommendations were made:

i. The government, education stakeholders, principals and the BOM members should equip Chemistry laboratories in Sotik Sub-County, especially the new schools. This should be done by making a financial allocation to enable these schools to purchase laboratory equipment once they have been established.
ii. Computers and projectors should be made available to Chemistry teachers to enable them to vary their methodological approach in imparting Chemistry knowledge.
iii. Building of ultra-modern laboratories should be encouraged to prevent environmental pollution by performing Chemistry experiments in the open.
iv. Chemistry teachers should use class experiments instead of group work laboratory experiments to enable every student to develop their Chemistry process skills. As such, INSET programmes should be organized for teachers who have not undergone education training programmes.

v. Principals, Chemistry teachers and laboratory technicians should allow students to take out some of the laboratory resources that are durable and safe to enable students to learn at their own pace.

vi. Since there is a positive relationship between the use of Chemistry learning resources and academic achievement, Chemistry teachers should be encouraged employ laboratory resources and not merely through chalk to talk method.

5.5 Suggestions for Further Research

1. A study should be conducted on teachers' in Sotik Sub-County to check on their competency and preparedness to use modern technologies in the teaching and learning of Chemistry in Schools.
2. A study should be conducted to explore the impact of new technologies, such as application of computers, tablets and related technologies in instruction, on students' achievement in Chemistry.
3. A study should be conducted to determine the socio-economic factors that determine schools' ability to acquire resources for teaching and learning of Chemistry.

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APPENDICES

APPENDIX I: CHEMISTRY TEACHERS AND LABORATORY TECHNICIANS' QUESTIONNAIRE

INTRODUCTION:

This questionnaire seeks your opinion on availability and use of laboratory resources on students' achievement in practical Chemistry in Sotik Sub-County, Kenya. Any information given will be handled with a greater level of confidentiality.

SECTION A: PERSONAL DETAILS

Instructions: Please don't indicate your name and tick where applicable.

1. Indicate your gender
   Male ☐
   Female ☐

2. Indicate your academic qualifications.
   Certificate ☐ BSc ☐
   Diploma ☐ PGDE ☐
   M.Phil ☐
   If any other specify………………………………

3. Indicate your age bracket.
   18-30yrs ☐
   31-40yrs ☐
   41-50yrs ☐
   51-60yrs ☐

4. What is your working experience?
   None ☐
   Up to 5 yrs ☐
   6-10yrs ☐
   11-20yrs ☐
   20-29yrs ☐
   30yrs and above ☐

SECTION B: GENERAL QUESTION ON YOUR SCHOOLS

5. How many students do you have in one stream taking chemistry?

   1 - 10 ☐
   11 - 20 ☐
   21 - 30 ☐
   31 – 40 ☐
   Over 40 ☐

If any other, specify ………………………………..

6. How many streams do you have in your school?

   One ☐
   Two ☐
   Three ☐
   Four ☐

   If any other, specify ………………………………..

7. How many Chemistry teachers do you have in your school?

   One ☐
   Two ☐
   Three ☐
   Four ☐

   If any other, specify ………………………………..

SECTION C: GENERAL QUESTIONS ON LABORATORY

Rate the following elements by putting a tick on the appropriate response for each item.

N/B. **U**-Unavailable **I**-Insufficient **N**-Not Sure **S**-Available **E**-Excessive

Statement	**U**	**I**	**N**	**A**	**E**
1. How satisfied are you with your laboratory possessing the following Consumables.					
a) i) Concentrated sulphuric acid					
ii) Concentrated nitric acid					
iii) Concentrated hydrochloric acid					
iv) Maleic acid					
b) Alkalis and bases					
i) Dilute sodium hydroxide					
ii) Copper (II) Sulphate					
iii) Ammonium hydroxide					
c) Measuring cylinders and Volumetric flask					
d) Burette, pipette, beakers and conical flasks					
e) Locally available materials produced or bought by the school					
i) Fruits					
ii) Palm Oil					
2. How satisfied are you with your laboratory possessing the following non-consumables					
a) Laboratory tables, Shelve and Stools					
b) Analytical balance and beam balance					
c) Bunsen burner					
d) Portable burner					
e) Test tube and racks					
f) Tripod and retort stand					
g) Spatula and crucible					
3. Does your laboratory satisfy you with visual and audio-visual aids as below.					
a) Graphic materials i.e. Charts and maps					
b) Non projected still pictures					
c) Overhead projectors					
d) Video and audiotapes					
e) Computers and its peripherals					
4. Are you satisfied with the designs of the following sections of your laboratory					
a) Preparation room					
b) Chemical storage room					
c) Fume board chamber					
d) Electricity sources					
e) Required semi-circular demonstration table					

5. Do you use the above materials in teaching and learning process?

6. If yes, indicate the topic in which each of the above consumables and non-consumables are applied in Chemistry

APPENDIX II: CHEMISTRY STUDENTS' QUESTIONNAIRE

INTRODUCTION:

This questionnaire seeks your opinion on availability and use of laboratory resources on students' achievement in practical Chemistry in Sotik Sub-County, Kenya. Any information given will be handled with a greater level of confidentiality.

SECTION A: PERSONAL DETAILS

INSTRUCTION

Please DON'T indicate your name and indicate where applicable.

1. Indicate your gender.

   Male ☐

   Female ☐

2. Indicate your age bracket

   10-14yrs ☐

   15-18yrs ☐

   19-22yrs ☐

3. In which class do you belong in?

   Form 1 ☐

   Form 2 ☐

   Form 3 ☐

   Form 4 ☐

4. What was your KCPE marks?

   Between 101-200 mks ☐

   Between 201-300 mks ☐

   Between 301-400 mks ☐

   Between 401-500 mks ☐

SECTION B

Rate the following elements by putting a tick on the appropriate response for each item below.

N/B: SA-Strongly Agree; A-Agree; N-Neutral; D-Disagree; SD-Strongly Disagree

Statement	**SA**	**A**	**N**	**D**	**SD**
a) You weekly attend laboratory sessions in Chemistry					
b) The number of students in your stream fits in the laboratory					
c) You perform experiments individually in your stream					
d) There are enough laboratory stools to sit on while performing experiments in the laboratory					
e) In your end of term exams, you always perform an experiment which is included in your report forms					
f) The class has tackled the topic salts and solubility of salt one.					
g) Test for cations and anions is not a problem to you					
h) Your teacher performs demonstration experiments while teaching in class					
i) Laboratory technician allows you to carry apparatus and stay with them in class to learn at your own pace					

APPENDIX III: OBSERVATION CHECKLIST

ACTIVITY	WHAT TO CHECK	YES	NO
Are there availability of the following in the laboratory			
a) Consumables			
i) Chemicals			
Copper (II) Chloride	Ledger book, Inventory & Chemical containers		
Sodium chloride	Ledger book, Inventory & Chemical containers		
Lead (II) bromide	Ledger book, Inventory & Chemical containers		
Cells	Ledger book, Inventory & box carrier		
Magnesium ribbon	Ledger book, Inventory & Chemical containers		
Potassium permanganate	Ledger book, Inventory & Chemical containers		
Bulb	Ledger book, Inventory & Bulb box		
Sodium metal	Ledger book, Inventory & Chemical containers		
ii) Apparatus			
Deflagrating spoon	Ledger book, Inventory & Apparatus		
Bunsen burner	Ledger book, Inventory & Apparatus		
Gas Jar	Ledger book, Inventory & Apparatus		
Connecting wires	Ledger book, Inventory & Apparatus		
Crocodile clips	Ledger book, Inventory & Apparatus		
Switch	Ledger book, Inventory & Apparatus		
Cell holder	Ledger book, Inventory & Apparatus		
Trough	Ledger book, Inventory & Apparatus		
Delivery tube	Ledger book, Inventory & Apparatus		
Bee hive shelves	Ledger book, Inventory & Apparatus		
Boiling tube	Ledger book, Inventory & Apparatus		
Round bottomed flask	Ledger book, Inventory & Apparatus		
Measuring cylinder	Ledger book, Inventory & Apparatus		
Desiccators	Ledger book, Inventory & Apparatus		
Evaporating dish	Ledger book, Inventory & Apparatus		
Measuring cylinder	Ledger book, Inventory & Apparatus		

Watch glass	Ledger book, Inventory & Apparatus		
Clamp, boss and stand	Ledger book, Inventory & Apparatus		
Pair of tong	Ledger book, Inventory & Apparatus		
iii) Bulletin Boards and sign	Are they readable?		
	Are materials changed frequently?		
b) Non- consumables			
i) Emerging equipment	Are all fire control equipment regularly tested and certified?		
	Is the fire control equipment appropriate for the type of the fire it must control (check CO_2 if in strategic position and presence of sand in the laboratory)?		
	Presence of gas mask		
	Availability of first aid kit in a strategic point		
ii) Laboratory Building			
• **Preparation room**	Sufficient space for performing preparation experiment		
	Presence of basic requirement for preparation		
• **Laboratory Benches**	Storage cupboards under bench unit and are they used		
	Are chemicals resting on the work top?		
• **Fume board chamber**	Number and placing of outlet		
• **Stools**	The number of stools in the laboratory		
• **Electricity source**	Number and placing of socket outlet		
	Battery or accumulator supply		
• **Demonstration table**	Gas taps are they present		
	Is it semi-circular in nature		
• **Graphical materials storage**	Is the room present and is it used to models and graphics		

room			
• **Water**	Is there presence of hot and cold water?		
	Presence of sinks, there length and depth		
	Presence of distilled water		
• **Drainage**	Are there drainage points on the floor?		
	Are there presence of dilution pots and problem of corrosive waste materials?		
• **Gas**	Number of placing of outlet		
	Types of outlets, e.g. one way, two way etc		
• **Waste disposal**	Are the methods created for disposal safe?		
• **Electricity mains**	Does it have a three pin socket?		
Is there existence of the following in the laboratory			
• **Graphic Materials i.e. Charts**	Check on Solvay process, Contact process, and Ostwald process charts.		
• **Non-projected still pictures**	Any real picture taken for Chemistry?		
• **Models**	Check on model of sodium chloride, Graphite and Diamond		

APPENDIX IV: CHEMISTRY ASSESSMENT TEST

Instructions

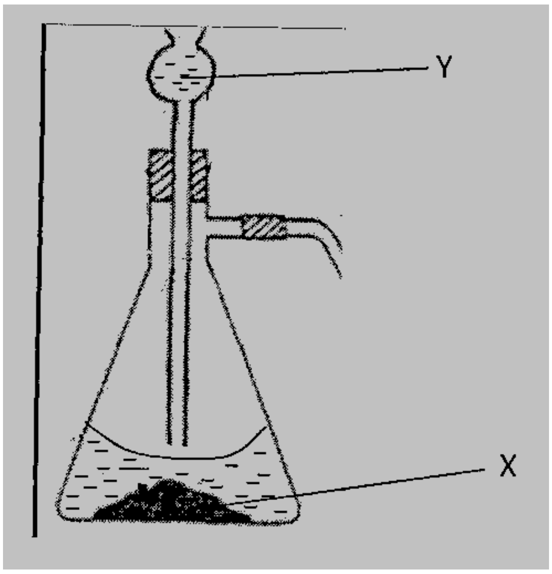
Attempt the following questions

SECTION A:

1a) Apart from volumetric flask, name three apparatus used to measure volume (3mks)

b) What is the function of volumetric flask? (1mk)

2. The set up below is used in the laboratory preparation of oxygen.



a) Complete the diagram to show how dry oxygen can be collected (2mks)

b) Name the substance labelled X (1 mk)

c) Write the chemical equation for the reaction above that produced oxygen gas (1mk)

d) Apart from apparatus marked Y, name the other apparatus that can perform similar function (1mk)

e) Apart from solid X, state other two substances that may be used to produce oxygen gas (2 mks)

f) Name five drying agents that can be used to dry oxygen gas (5mks)

SECTION B (PRACTICAL QUESTIONS)

3. You are provided with solid S. Carry out the test below. Write your observation and inferences in the spaces provided.

   Place all of Solid S in a boiling tube. Add about 10 cm^3 of distilled water and shake until all the solid dissolves. Use the solution for the test below.

a) To about $1cm^3$ of the solution in a test tube, add aqueous sodium hydroxide solution drop wise until in excess.

OBSERVATION	INFERENCE
(1mk)	(1mk)

b) To about $1cm^3$ of the solution in a test tube add 2M ammonia solution dropwise until in exces

OBSERVATION	INFERENCE
(1mk)	(1mk)

c) To about $2cm^3$ of the solution in the test tube, add 2-3 drops of aqueous potassium iodide solution.

OBSERVATION	INFERENCE
(1mk)	(1mk)

d) To about $1cm^3$ of solution in a test tube, add 2-3 drops of sodium sulphate solution.

OBSERVATION	INFERENCE
(1mk)	(1mk)

e) To about $1cm^3$ of solution in a test tube, add 2-3 drops of barium nitrate solution.

OBSERVATION	INFERENCE
(1mk)	(1mk)

f) To about $1cm^3$ of the solution in a test tube, add 2-3 drops of lead (II) nitrate solution and warm.

OBSERVATION	INFERENCE
(1mk)	(1mk)

g) To about $1cm^3$ of the solution in the test tube, add 2-3 drops of silver nitrate solution.

OBSERVATION	INFERENCE
(1mk)	(1mk)

APPENDIX V: SOTIK DISTRICT SECONDARY SCHOOL 2010 AND 2011 CHEMISTRY RESULTS ANALYSIS

POS	SCHOOL	2011	2010	DEVIATION	ENTRY
1	Kaplong Girls Sec. School	7.814	8.5366	-0.7226	97
2	Kaplong Boys. School	7.4733	7.0098	0.4635	161
3	Chebilat Sec. School	6.147	5.593	0.554	
4	Kamureito Sec. School	6.0888			45
5	Ndanai Sec. School	5.403			77
6	Muiywek Sec. School	5.395	5.429	-0.034	43
7	Moi Minaret Boys Sec.	4.79	5.682	-0.892	101
8	Kiptulwo Sec. School	4.54	4.772	-0.232	
9	Tarakwa Sec. School	4.457	4.241	0.216	36
10	Kanusin Sec. School	4.3261	3.8125	0.5136	
11	Kimolwet Sec. School	4.306	5.24	-0.934	49
12	Kapkelei Sec. School	4.14	4.48	-0.34	52
13	Solyot Sec. School	3.823	5.377	-1.554	63
14	Kamirai Sec. School	3.756	2.848	0.908	41
15	Gelegele Sec. School	3.698	3.241	0.457	74
16	Kamungei Sec. School	3.6559			93
17	Kapkures Sec. School	3.5714	3.75	-0.1786	28
18	Gorgor Sec. School	3.5607	4.725	-1.1643	108
19	Moi Minariet Girls Sec.	3.371	4.285	-0.914	35
20	Tembwo Sec. School	3.19	3.38	-0.19	36
21	Motiret School	3.15	2.529	0.621	20
22	Chesilyot Sec. School	2.98	2.927	0.053	
23	Rotik Sec. School	2.976	3.625	-0.649	41
24	Ngariet Sec. School	2.894	3.549	-0.655	254
25	Kipsingei Sec. School	2.891	3.5	-0.609	
26	Oldebesi Sec. School	2.61			18
27	Chebirbelek Sec. School	2.558	3.5	0.942	77
28	Sigorian Sec. School	2.444	3	-0.556	36
29	Kipsimbol Sec. School	2.264	3.151	-0.887	34
30	Kipsonoi Sec. School	2.0154	2.9912	-0.8966	65

Source: SSCEO Office (Sotik Sub-County, 2011)

APPENDIX VI: LETTER OF RESEARCH AUTHORIZATION FROM NACOSTI

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349, 254-020-2673550
Mobile: 0713 788 787 , 0735 404 245
Fax: 254-020-2213215
When replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RCD/14/013/1014**

Date: **13th June 2013**

Patrick Otieno Masime
University of Eldoret
P.O Box 1125-30100
Eldoret.

RE: RESEARCH AUTHORIZATION

Following your application dated **6th June, 2013** for authority to carry out research on "***Efficient laboratory use as correlate to students' achievement in chemistry.***" I am pleased to inform you that you have been authorized to undertake research in **Sotik District** for a period ending **30th September, 2013.**

You are advised to report to **the District Commissioner and District Education Officer, Sotik District** before embarking on the research project.

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

DR. M. K. RUGUTT, PhD, HSC.
DEPUTY COUNCIL SECRETARY

Copy to:
The District Commissioner
The District Education Officer
Sotik District.

"The National Council for Science and Technology is Committed to the Promotion of Science and Technology for National Development".

APPENDIX VII: LETTER OF RESEARCH AUTHORIZATION FROM SUB-COUNTY COMMISSIONER

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

PROVINCIAL ADMINISTRATION AND INTERNAL SECURITY

Telegrams: *"Districter" Sotik*
Telephone: 052-532172
Fax: 052-532172
e-mail:dcsotik@yahoo.com

District Commissioner
Sotik District
P.O Box 828,
SOTIK
Date: 28/06/2013

***When replying please quote*;**

REF: CORR.3/2 VOL.1I1/23

RE: RESEARCH AUTHOPRIZATION-PATRICK OTIENO MASIME.

The above named has been allowed to undertake research in the District on **"Efficient laboratory use as correlate to student's achievement in Chemistry"**

Any assistance accorded to him is highly appreciated.

DISTRICT COMMISSIONER
SOTIK DISTRICT.

Japhet K Sigilai,
For: District Commissioner,
SOTIK DISTRICT

Cc

DEO - Sotik

APPENDIX VIII: RESEARCH PERMIT

PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Patrick Otieno Masime
of (Address) University of Eldoret
P.O Box 1125-30100, Eldoret.
has been permitted to conduct research in

	Location
Sotik	District
Rift Valley	Province

on the topic: Efficient laboratory use as correlate to students' achievement in chemistry.

for a period ending: 30th September, 2013.

PAGE 3

Research Permit No. *NCST/RCD/14/013/1014*
Date of issue *13th June, 2013*
Fee received *KSH. 1000*

Applicant's Signature

For Secretary
National Council for Science &Technology

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed with-out prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

GPK6055t3mt10/2011

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

(CONDITIONS—see back page)

APPENDIX IX: KAM EXPERIMENTAL GROUP UNDERTAKING THE CAT

APPENDIX X: CHOL CONTROL GROUP UNDERTAKING THE CAT

APPENDIX XI: AKSH CONTROL GROUP UNDERTAKING THE CAT

APPENDIX XII: KAP CONTROL GROUP UNDERTAKING THE CAT