RELATIONSHIP BETWEEN CHEMISTRY PRACTICAL WORK AND STUDENTS’ ACADEMIC PERFORMANCE IN CHEMISTRY, IN PUBLIC SECONDARY SCHOOLS, IN KILIFI NORTH CONSTITUENCY, KENYA.

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A thesis submitted in partial fulfillment of the requirements for the Degree of Master of Education (Mathematics and Science Education) of Pwani University

May, 2017
Declaration

This thesis is my original work and has not been presented for a degree or any other award in any University or college. No part of it may be reproduced without prior permission of the author and/or Pwani University.

Signature

Date 21/9/2017

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Approval

I/We confirm that this thesis has been submitted with my/our approval as University supervisor/s.

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Dedication

This work is dedicated to my wonderful immediate family who supported me throughout my work.
Acknowledgement

I wish to acknowledge with appreciation the help of those who contributed to the completion of this work. First and foremost are my supervisors and mentors, Professor Helen Omondi Mondoh and Dr. Jacinta Aswani Kwena who, despite their busy schedules, gave me unlimited academic guidance in the course of writing my thesis. Secondly, I appreciate my entire family who were patient with me throughout the trying moments of undertaking this work. I also wish to acknowledge all my respondents, students and chemistry teachers for their sacrifice in participating in the research. Finally, I recognise the input of my colleagues whose positive criticisms helped me in shaping this work.

To all those who contributed in one way or another, God Bless you All.
Abstract

Despite the fact that Chemistry is a core subject, the general performance in Chemistry among secondary school students countrywide remains poor. Research evidence shows that poor performance in Chemistry not only results from intrinsic conceptual difficulties in the subject but also springs from poor Chemistry Practical work. However, Chemistry educationists seem to be in disagreement with respect to the relationship between Chemistry Laboratory work and students’ academic performance in Chemistry. This study, therefore, sought to find out the relationship between Chemistry Laboratory work and students’ academic performance in Chemistry. The study was guided by John Dewey’s Constructivist Learning theory. The study was conducted in Kilifi North Constituency. The research design was correlational survey and simple random sampling was used to select one girl school, six mixed schools, and Purposive sampling was used to select one boys’ school. Stratified random sampling and simple random sampling were used to select 80 students. Purposive sampling and simple random sampling were used to sample eight chemistry teachers. Data was collected by use of [1] Chemistry Teacher Questionnaire (CTQ) [2], Student Questionnaire (SQ), [3] Observation Checklist (OC) and through [4] analysis of documents and mark sheet form. Piloting was done in Kilifi North Constituency in which two schools, ten students and two teachers were involved. The pilot study results were used to enhance validity and reliability of the instruments. Statistical Package for Social Sciences (SPSS) was used to facilitate data analysis. Descriptive statistics including percentages, mean and frequency tables were used to describe the study variables. Inferential statistics (Pearson product moment of correlation coefficient and Spearman’s Rank order correlation) were used to test hypotheses at .05. The findings revealed that 75% of the schools had laboratories while 25% had modified science rooms used as laboratories. However, 12.5% of the schools had three laboratories for the three sciences, 25% had two laboratories and 37.5% had one laboratory shared among the three sciences. On use of laboratory, 27.5% of schools utilizes the expected 11-13 lessons per term, 33.75% utilizes 7-10 lessons and 38.75% utilizes 3-6 lessons. Finally, majority of teachers, 50% were degree holders while 25% were either diploma or masters holders. The findings emerging from this study also revealed that there was a significant positive relationship between; availability of laboratory materials, the use of chemistry laboratory (number of laboratory sessions functionally attended), teacher’s academic qualification and student’s academic performance in chemistry at corr. 0.819, sig.0.013; corr. 0.690, sig. 0.001 and corr. 0.926, sig. 0.001 respectively. The findings also supports the Constructivist Learning theory. Finally, the results of this study could serve as springboard for further studies in the same area.
**Abbreviations and Acronyms**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BOM</td>
<td>Board of Managers</td>
</tr>
<tr>
<td>C.E.O</td>
<td>County Education Officer</td>
</tr>
<tr>
<td>ERC</td>
<td>Ethical Review Committee</td>
</tr>
<tr>
<td>INSETs</td>
<td>In-service Education Trainings</td>
</tr>
<tr>
<td>KICD</td>
<td>Kenya Institute Curriculum Development</td>
</tr>
<tr>
<td>K.C.S.E</td>
<td>Kenya Certificate of Secondary Education</td>
</tr>
<tr>
<td>KNEC</td>
<td>Kenya National Examinations Council</td>
</tr>
<tr>
<td>NCST</td>
<td>National Council of Science and Technology</td>
</tr>
<tr>
<td>PA</td>
<td>Parents Association</td>
</tr>
<tr>
<td>SDGs</td>
<td>Sustainable Development Goals</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>SMASSE</td>
<td>Strengthening Mathematics and Science in Secondary Education</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organisation</td>
</tr>
</tbody>
</table>
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CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Factors that hinder good performance in Chemistry will always be of great concern to educational stakeholders, since Chemistry as a science is a field of knowledge concerned with ideas relating to the behaviour of matter. Although some of the concepts studied in Chemistry are abstract their application has had a concrete impact on human life and generally man’s environment (Hofstein, 2004).

Chemistry is commonly viewed as, the “central science” and mastery of its concepts regarding the structure of matter is essential to further coursework in all sciences. In essence, Chemistry performs the function of gatekeeper for future study in many sciences (Tai, Sadler & Loehr, 2005). Similarly, in the context of Science Education, Chemistry has been identified as a very important science subject. Its importance in scientific and technological developments of any Nation has been widely reported (Adesoji & Olatunbosun, 2008). The centrality of chemistry in the curriculum is evident from the concern shown in the policy reports such as in the Koech Commission Report of 1998, which noted that children should be exposed to scientific concepts from the early age.

Among the objectives of the Kenya’s 8-4-4 system of education, is to prepare pupils for the world of Science and Technology. In this regard, chemistry is very useful because of its vast application in daily life. The application of Chemistry has resulted in the development of chemical industries to manufacture a wide variety of goods, which are helpful to man. Common examples of such industries include: petroleum industry, iron and steel industries, pharmaceutical industries among others. People who specialise in Chemistry find employment in chemical industries, in medical laboratories and as teachers of Chemistry (Muchiri & Maina, 2006).
Practically, most things that we use has been transformed from a natural state of little or no utility to one of the very different appearances and much greater utility through a chemical process. Arguably common items in our environment such as iron sheets, steel products, Money, ceramics, cement, fertilizer, perfumes, glass, insecticides, paints, detergents and medicine just to mention but a few, are products of chemical processes. Chemistry education is a precursor of any factors that can boost Kenya’s effort toward industrialisation and thus foster economic growth and sustainable development guided by the Kenya Vision 2030. According to UNESCO (2005), there is need for Kenyan government to examine Chemistry Education alongside other science subjects to realise her vision 2030 and the Sustainable Development Goals (SDGs).

Faroumbi (1998) contends that students tend to understand and recall what they see more than what they hear, students can visualise concepts when they actually use laboratories in the teaching and learning of science. Even more, Prince (2011), argues that demonstrations and practical work have immense heuristic value, tremendous rhetorical power, an overwhelming persuasive force. He stated that, “if you don’t see it, you won’t believe it. And if you don’t believe it you won’t understand it. And if you don’t understand it, you won’t long remember it. The senses are important, not only for first discovering, but also for receiving knowledge”. Tobin (1990) emphasized that laboratory activities appeal as a way to learn with understanding and at the same time engage in a process of constructing knowledge by doing science. According to Dahar & Faize (2011), learning and the understanding level in science is improved when students are engaged in science laboratory for practical.

To emphasize the importance of laboratory work, Ngaruiya, Kimani & Mburu (2004) contented that through laboratory experiments chemists have discovered new materials and chemical processes that produce them in industries. It is with this understanding that
UNESCO (2005) reiterated that if school science is to be learned effectively, it must be experimented.

In Kenya, a lot of emphasis has been put on science. The eight years primary, four years secondary and four years university (8-4-4) curriculum involves preparing pupils for the world of Science and Technology. Chemistry is a practical subject, which equips students with concepts and skills that are handy in solving the day today problems in life. Chemistry aims at providing the learners with the day to day solutions to problems in life. Chemistry aims at providing the learners with the necessary knowledge for the benefits of an individual in their everyday life and for further education (Muange, Ogutu, Wambua, Omoru & Mango 2004).

In the (8.4.4) Secondary School curriculum, Chemistry is presented in the syllabus as a practical subject in which scientific concepts, principles and skills should be developed through experimental investigation. At the National examination level, namely the Kenya Certificate of Secondary Education (K.C.S.E), chemistry is examined through two theory papers; 233/1 and 233/2 and one practical paper; 233/3. According to the Kenya National Examinations Council (KNEC) report of 2007, for a candidate to acquire grade B – (minus) and above in overall chemistry examination, the candidate should have acquired grade D+ (plus) and above in Chemistry practical.

This requirement has an implication on the way Chemistry laboratory work is managed in secondary schools. The practical examination in Chemistry tests whether candidates have developed such skills and competencies as outlined by, KNEC (2005) that include: ability to follow a set of instructions to carry out experiments, manipulative skills like correct measurement of volume using a variety of measuring instruments, ability to record observations correctly and ability to make sound deductions.
These skills are in line with some of the general objectives of teaching and learning Chemistry as prescribed in the current Chemistry syllabus by the Kenya Institute of Education (K.I.E), 2002. Two objectives that emphasise practical are stated in the syllabus as follows: to select and handle appropriate apparatus for use in experimental work and to make the correct measurement, observation and logical conclusion in a given experiment.

To emphasise the importance of the chemistry practical paper, KNEC assigns it 40% of the total score. Statistics from KNEC (2011) indicate that a student total score in Chemistry is highly dependent on the score on the practical examination paper. According to KNEC (2011), reports for a student to score at least grade A (minus) the student must first score at least 28 out of the 40 % in practical. Earlier KNEC reports (2003; 2004) highlighted the following weaknesses in the Chemistry practical paper examinations that contribute to poor results in Chemistry as inability by candidates to: follow instructions and hence ended up with wrong observation, make correct inferences; this was partially so even in areas where they were able to make and record correct observations, read time correctly; some of those who read time correctly, some were unable to tell correct time in seconds, or any in other unit of time, or get the reciprocals of the time, draw and interpret graphs correctly and finally write correct ionic formulae.

While most people in our society recognize and appreciate the essential role of Chemistry in everyday life, it remains one of the poorly performed subjects in K.C.S.E (Ongeri, 2012). Statistics from Kilifi County Quality Assurance Office indicate performance in K.C.S.E Chemistry in Kilifi North constituency to be declining from 2007 a year before the launch of vision 2030 (see Table 1).
### Table 1

*Trends in KCSE Performance in Chemistry at the national level (2007-2011)*

<table>
<thead>
<tr>
<th>Year</th>
<th>Performance Index</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>4.3434</td>
<td>D+</td>
</tr>
<tr>
<td>2008</td>
<td>2.8044</td>
<td>D-</td>
</tr>
<tr>
<td>2009</td>
<td>2.7894</td>
<td>D-</td>
</tr>
<tr>
<td>2010</td>
<td>2.6696</td>
<td>D-</td>
</tr>
<tr>
<td>2011</td>
<td>2.6673</td>
<td>D-</td>
</tr>
</tbody>
</table>


The Kenya National Examinations Council (KNEC), test the following topics in Chemistry paper III; titration, qualitative analysis, rate of reaction, solubility of salts or enthalpy change. The basic apparatus required for the experiments include; stands/clamps, burettes, pipettes, conical flasks, volumetric flasks for titration, test tubes, boiling tubes and beakers for qualitative analysis, stop watches, thermometers and source of heat for both rate of reaction, solubility of salts and enthalpy change. The following chemicals are needed for the above experiments to be carried out; acids, base, sulphate, chloride, carbonate, nitrate, hydrogen carbonate, sulphite, an oxidizing agent and a metal (KNEC, 2003).

### 1.2 Statement of the Problem

In Kenya, Chemistry is an optional subject in Form 3 and Form 4. However, due to insufficiency of Physics teachers and resources to support all science subjects, many schools when faced with pressure to make a choice, opt for chemistry (K.I.C.D, 2002). In addition, its application in economic, scientific, technological and industrial development in Kenya has influenced many schools to make it a compulsory subject. Consequently, many schools commit a lot of input in terms of time, human and material resources into practical work in chemistry with the hope of improving performance in it. The question is, does the heavy investment yield fruits?
Similarly, the government of Kenya has invested heavily in In-service Education Trainings (INSETs) for serving science and mathematics teachers in Strengthening Mathematics and Science in Secondary Education (SMASSE) training. This is mainly because of the role that science and mathematics are expected to play towards the realization of Vision 2030 (GoK, 2009). Schools have been charged with the responsibility of providing laboratory facilities through their Board of Managers (BOM) and Parents Associations (PAs).

Despite all the above efforts, low achievements in Chemistry at KCSE examinations have continued to be witnessed in many schools Kilifi included. Although, SMASSE has been in existence since 2001, hundreds of teachers have attended these courses but the problem of underperformance persists. If this is left unattended, Kenya may not achieve its vision of 2030. Chemistry educationist appear to be in disagreement with respect to the relationship between Chemistry Laboratory Work and Student’s Academic Performance in Chemistry. For example, Owoeye & Yara (2010) declare that laboratory work is a strong predictor of success in Chemistry, while Sofeme & Andy (2012) asserts that Laboratory work does not guarantee success in Chemistry. Most of the studies related to this issue have been carried out in western countries. Studies carried out in Africa, particularly in Nigeria and in Kenya do not clearly point out how Laboratory work affects performance in Chemistry. To date there is no study conducted in Kenya coast region, particularly in Kilifi North Constituency that has looked at the relationship between Chemistry Practical Work and Student’s Academic Performance in Chemistry. It is in this regard that this study sought to assess the relationship between Chemistry Laboratory Work and Student’s Academic Performance in Chemistry.

1.3 Purpose of the Study

The purpose of this study was to find out the relationship between chemistry laboratory work and students’ academic performance in chemistry.
1.4 Objectives of the Study

The objectives included:

1. To determine the relationship between availability of laboratory materials and students’ academic performance in chemistry.

2. To determine the relationship between use of chemistry laboratories and students’ academic performance in chemistry.

3. To determine the relationship between teacher academic qualification and students’ academic performance in chemistry.

1.5 Research Hypotheses

The study was guided by the following alternate hypotheses;

$H_{a1}$: There is a relationship between the availability of laboratory materials and students’ academic performance in chemistry.

$H_{a2}$: There is a relationship between the use of chemistry laboratory and students’ academic performance in chemistry.

$H_{a3}$: There is a relationship between teacher academic qualification and students’ academic performance in chemistry.

1.6 Significance of the Study

Chemistry provides a foundation for career in the related fields and is a precursor to technological advancement. It is also one of the stepping-stones in the Kenya’s Vision 2030 industrial and economic transformation. Chemistry concepts have concrete impact on human life and generally man’s environment.
Policy makers, Curriculum developers, BOM, PA and other school stakeholders may use the findings of this study to come up with appropriate ways of improving chemistry performance in the schools.

1.7 Scope and Limitations of the Study

1.7.1 Scope of the Study

The study was restricted to public secondary schools in Kilifi North Constituency, Kilifi County. The researcher only dealt with Form Four students and Form Four Chemistry teachers and was also limited to the relationship between Chemistry Practical Work and Students’ Academic performance in Chemistry.

1.7.2 Limitation of the Study

In every social research there are errors caused by diverse type of data. There is also inescapably sampling errors. The researcher could not assume ability to control all the confounding factors in the study. It may also be difficult to say that the instruments that were used collected a hundred percent of all the desired data. The fact that, this study dealt with Form Four Students from public schools in Kilifi North Constituency and that the results were to be generalised to other settings is a limitation.

The students chosen for this study were a small sample of population and come from different background. This small population may be very different from population in other parts of Kilifi County.

1.8 Assumption of the Study

This study made three basic assumptions:

1. All respondents gave honest and accurate information

2. Sampled schools had done end of Term Two Kilifi District joint examination chemistry practical
3. The sampled students had similar background of Chemistry practical knowledge

1.9 Theoretical and Conceptual Framework

1.9.1 Theoretical Framework

Constructivism learning Theory by John Dewey

This study was based on John Dewey’s (1896) constructivist theory. Constructivism theory was used to show relationship between the various variables. Constructivism is based on participatory learning starting from real life experience to construct knowledge. It is problem based adaptive learning strategy that challenges faulty schema, integrates new knowledge, and allows for creation of original work or innovative procedures. The focus of constructivism approach in learning is to help learners become creative and innovative through analysis, conceptualisations, and synthesis of prior experience to create knowledge. A person’s prior knowledge comes from the past experience, culture, and their environment. Generally prior knowledge is good but sometimes misconceptions and wrong information can be a hindrance. Sometimes time must be spent correcting prior knowledge before new learning can occur.

Scientific observation has established that education is not what the teacher gives, but a natural process spontaneously carried out by the human individuals and is acquired not by listening to words but by experiences upon the environment (Woolnough & Alsop, 1985). The task of the teacher becomes that of preparing a series of motives of activities spreading over a prepared environment. Active learning conditionalises knowledge through experimental learning. The method of instruction used to learners must provide for exploration, thinking and reflection, and that interactions with the environment is necessary for learning.

Constructivism does not dismiss the active role of the teacher or the value of expert’s knowledge. Constructivism modifies the role so that teachers help the students to construct
knowledge rather than reproduce a series of facts. The constructivist teacher provides tools such as problem solving and inquiry based learning activities with which students formulate and test their ideas, draw conclusions and inferences and pool and convey their knowledge in a collaborative environment. Constructivism transforms the students from a passive recipient of information to an active participant in the learning process. Always guided by the teacher, students construct their own knowledge actively rather than just mechanically ingesting knowledge from the teacher or the textbook. For example, a group of students in a science class are discussing a problem in Chemistry. Though the teacher knows the ‘answer’ to the problem he/she focusses on helping the students restate their questions in useful ways. He/she prompt each student to reflect on and examine his/her current knowledge when one student comes up with the relevant concept, the teacher seizes up on it, and indicates to the group that this might be a fruitful avenue for them to explore. They design and perform relevant experiments. Afterwards, the students and teachers talk about what they have learned, and how their observations and experiments helped (or did not help) them to better understand the concept. In the same faith, the theory postulates that discovery, hands-on, experiential, collaborative, project-based, and task-based learning are a number of applications that enhance students’ abilities to master scientific concepts. Similarly Smith (1997), contents that John Dewey believed education must engage with and expand experience. Those methods used to educate must provide for exploration, thinking, and reflection and that interaction with the environment is necessary for learning. Dewey advocates the learning process of experiential learning through real life experience to construct and condition knowledge.

Constructivism has implication on learning and instruction. Emphasizing this Kolb (1984), proved the importance of conditioned knowledge through experiential learning. Kolb created a Model out of concrete experience, observation and reflection, the formation of abstract concepts, and testing in new situations. Kolb’s beliefs are consistent with the
Constructivists in that he includes Concrete Experience as part of the learning process and requires a student to test knowledge by acting upon the environment, thereby giving the student reliable, trust-worthy and conditioned knowledge.

Hmelo (2007) cite several studies supporting the success of the constructivist problem-based and inquiry learning methods. For example, they describe a project called GenScope, an inquiry-based science software application. Students using the GenScope software showed significant gains over the control groups, with the largest gains shown in students from basic courses.

Guthrie (2004) compared third-grade reading: a traditional approach, a strategies instruction only approach, and an approach with strategies instruction and constructivist motivation techniques including student choices, collaboration, and hands-on activities. The constructivist approach, called CORI (Concept-Oriented Reading Instruction), resulted in better student reading comprehension, cognitive strategies, and motivation.

Doğru (2007) compared science classrooms using traditional teacher-centered approaches to those using student-centered, constructivist methods. In their initial test of student performance immediately following the lessons, they found no significant difference between traditional and constructivist methods. However, in the follow-up assessment later, students who learned through constructivist methods showed better retention of knowledge than those who learned through traditional teacher centered methods.

1.9.2 Conceptual Framework

Teaching and learning has inputs and outputs (Ellis, 2012). Consequently, in order to obtain a new product which according to this study is performance, there is need to impress Chemistry Practical work as used in Chemistry teaching and learning process. The intervening variable such as syllabus coverage was controlled through sampling procedures. The interaction between the dependent and independent variables was presented
diagrammatically as a Conceptual Framework in (Figure 1) and presents the relationship between Chemistry Practical work and students’ academic performance in Chemistry.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Intervening Variable</th>
<th>Dependent Variables</th>
</tr>
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<tbody>
<tr>
<td>Chemistry Practical Work</td>
<td>Syllabus coverage of Chemistry content</td>
<td>Students’ Academic Performance in Chemistry</td>
</tr>
<tr>
<td>1. Availability of laboratory materials</td>
<td></td>
<td>Scores in chemistry practical examination</td>
</tr>
<tr>
<td>2. Use of chemistry laboratory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Teacher academic qualification</td>
<td></td>
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</tr>
</tbody>
</table>

*Figure 1. Conceptual Framework.*

1.10 Operational Definitions of Terms

**Availability of materials:** Refers to the presence of basic laboratory chemicals such as; sodium chloride, sodium hydroxide, barium nitrate, sodium carbonate which should be 2 kilograms per year for a single stream school, hydrochloric acid, sulphuric acid, nitric acid which should be 5 litres per year for a single stream school based on the number of Chemistry practical lessons per year (Muange, Wambua & Mango, 2011). Basic laboratory equipment’s and apparatus such as burettes, pipettes, test-tubes, stands and flasks which are necessary in carrying out essential chemistry experiments. The standard ratio of students to apparatus during laboratory sessions as recommended by K.I.E (2002) is 3:1, and during examination is 1:1.

**Chemistry Practical Work:** Is an umbrella term connoting availability of laboratory materials, use of chemistry laboratory and teacher academic qualification.

**Practical:** Refers to teaching and learning approaches that stresses the importance of observation and use of data in obtaining scientific knowledge. In this method, learners are active participants in the learning process. They manipulate the learning materials and equipment.
**SMASSE:** Strengthening Mathematics and Science in Secondary Education.

**Use of Laboratory:** Refers to the frequency with which teachers and students carry out experiments in the laboratory as per the standards set out in the Chemistry syllabus.

**Students’ Academic Performance:** Students’ Score in Chemistry was the Score in end of Term Two 2014 Kilifi District Joint Examination Chemistry Paper III.

**Teacher Academic Qualification:** Teacher training level eg S1, Diploma, Degree, Masters and above.
CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Students’ performance in all subjects is mainly measured by achievement in tests and examinations. An evaluation of scores on such tests leads to the categorisations: poor, fair, good or excellent. Students’ performance can therefore be said to be poor or excellent depending on the evaluation of scores obtained. In their studies, Merisotis & Phipps (2000), Waudo & Wawire (2004) concluded that performance in Chemistry, whether poor, fair, good or excellent, can be attributed to syllabus coverage in Chemistry. According to Merisotis & Phipps (2000), Waudo & Wawire (2004), schools which cover syllabi early had enough time to put into place a series of measures that will ensure good performance. Arguably, adequacy or inadequacy in this factor would lead to excellent or poor grades in Chemistry. However, there is a possibility that this may not be the only factor.

Dahar & Faize (2011) assert that poor performance in Science springs from inadequacy of laboratory materials and deficiency in the use of science resources, rather than from inherent conceptual difficulties in the subject. In line with this argument Francisca and Oluyemisi (2007), argue that science is developed and contested through laboratory work. This argument emphasises the role of laboratory work in teaching and learning science. It highlights laboratory work as a resource for teaching and learning science, Chemistry included.

However, studies by (Hodson, 1998; Hofstein & Lunetta, 1982; Lazarowitz & Tamir, 1994) on the effect of laboratory work on performance in Chemistry have been inconclusive. This chapter reviews literature directly related to how Chemistry laboratory work affects performance in Chemistry.
2.1 Availability of Laboratory Materials and Students’ Academic Performance in Chemistry

Eloebhose & Imhanlahimi (2000) argue that learning resources are those devices like human and material employed during the teaching and learning process to ensure that the predetermined specific learning objectives of the lesson are achieved. Earlier Balogun (1985), asserted that no meaningful science education programme could exist without laboratory facilities since they were indispensable to good science teaching and learning.

In line with this argument Lewin (2000), argued that despite efforts to address the quality of education, many African countries and developing countries in general often had difficulties providing satisfactory conditions and material resources especially laboratories and equipment. Further Jegede, Fraser & Okebukola (1992), posit that inadequate facilities and close ended laboratory investigation were responsible for student poor performance in chemistry in the seventies and eighties.

This was strongly supported by Cirfat & Zumyil (2000), when they observed that lack of science equipment and laboratory were the major causes of poor performance in the science subject in secondary schools. Similarly Jebson (2012), reported that five percent of the post-primary schools in Lagos State had no laboratory and were ill equipped with material resources. These factors were found to affect students’ achievement in chemistry. Their results were consistent with the findings of Aguisiobo (1998), who explained that poor capital investment in terms of provision of science learning resources contributed to students’ low level of academic performance in chemistry. In support Kinuthia (2009), Kiveu & Maiyo (2009), Kippra (2003), among others argued that, availability of educational resources in Kenya were elusive since independence.

Ogunniyi (1993) in his study to determine how science laboratories material environment affects students learning outcomes in Nigeria, found that the science laboratory materials environment positively correlated with the student’s academic performance.
A similar study carried out by Owoeye & Yara (2010), on school facilities and academic achievement of secondary schools Agricultural science in Ekiti State, Nigeria, revealed that facilities are potent to high academic achievement of students. Earlier Orodho (1996), in his study on factors determining achievement in science subject at secondary level in Kenya noted inadequate laboratory and laboratory equipment as one of the variables. His findings support those of Kizito (1986), whose study on factors contributing to poor performance in physical sciences in Busia district, Kenya also noted inadequate laboratory use of materials as one of the causes.

Arguably, the laboratory is essential to the teaching of sciences and success of any science course is much dependent on the laboratory provision made for it. This is supported by Ogunniyi (1993), who concluded that there was general consensus among science educators that laboratories occupy a central position in science instruction. This position was evidenced by the research done by Asiabaka (2008), on affective management of schools in Nigeria; where he noted that the government’s failure to establish policy directive on minimum standards in relation to school facilities led to disparities in resources. Arguably, while some schools had well equipped laboratories, libraries and other facilities for effective teaching and learning others had none and where they existed, such facilities were poorly equipped and this lead to poor performance.

On the same Jebson (2012), observed that lack or inadequate or total absence of laboratory space and or facilities contributed to poor performance in examinations in science subjects. In a related study emphasising the importance of learning resources in science teaching Ango (1990), argued that a teacher could only achieve his aspiration if enough resources for teaching and learning were available. Lamenting on students’ poor performance in chemistry, Dan-Azumi (1998) reiterated that one of the most repeatedly mentioned problem causing poor performance in the subject was lack of equipment and materials to conduct practicals. Similarly Chiriswa (2002), emphasised that effective teaching and learning
depended on the availability of suitable adequate resources such as laboratories which, enhanced good performance at National examinations.

The importance of learning resources in teaching and learning of science cannot be overemphasized. Asiabaka (2008) insisted that material resources were very important to effectively teach and learn sciences. Chiriswa (2002) was of the view that the global changes in science curriculum were due to knowledge explosion and technological development demands for qualitative science teaching. Arguably, these changes called for the provision of standard resources at the school where the foundation of science learning is lay.

Contrary to the above argument, Lawal (2006) reported no significant correlation between adequacy of laboratory equipment and academic achievement of students’ in Chemistry in senior secondary education. Explainably, Secondary School Laboratory was an important component of learning science subjects but it depended upon the degree to which it was efficiently used. Ostensible is that the mere availability of science laboratory according to Lewin (2000) is not a guarantee of students’ performance until both the students and teachers actually use laboratories efficiently. This argument was supported by Hanushek (2006), who clarified that if the resources used were inefficient; the relationship between added resources and outcome would be unclear. This simple observation led to identification of the need for direct investigation of the relationship between the availability of laboratory materials in schools and student’s academic performance in Chemistry.

2.2 Use of Chemistry Laboratory and Students’ Academic Performance in Chemistry

Hofstein (2004) described the concept of the use of science laboratory as the experiences in school settings where students interact with materials to observe and understand the natural world. Earlier studies by Asunta & Tuula (2003) revealed that school laboratory has many different purposes: acquisition of specific techniques, learning to use different equipment,
such as pipettes and pH-meters, and learning to read them correctly as well as learning how to design an investigation to solve a scientific problem; gaining knowledge through investigations and learning to apply it. This was strongly supported by White (1996) who argued that the main purpose of laboratories is to help pupils’ learning and understanding of the scientific facts and explanations.

Secondary school laboratory is an important component of learning science subject but it depends upon the degree to which it is efficiently used (Lewin, 2000). The mere availability of science laboratory according to Lewin is not a guarantee of students’ performance until both the students and teachers actually use laboratories efficiently. Besides this, Lewin (2000) argued that if science laboratories are provided to schools, three possibilities may arise: they may remain unused, used inefficiently or used efficiently. Conversely, science laboratory may contribute to higher level of academic achievement if used efficiently and properly (Lewin, 2000). This reiterates his earlier stand (Lewin, 2000) on the same, stated that the science laboratory is an important component in learning science subjects but it depends upon the degree to which it is efficiently used. Accordingly, only the availability of science laboratory is not a guarantee for students’ performance until both the student and teachers actually use science laboratory facilities efficiently.

Laboratory adequacy was reported to affect the performance of students in chemistry (Adeyegbe, 2005; Raimi, 2002). On same, Adoseji & Olatanbosun (2008) reported that laboratory adequacy was found to enhance achievement through attendance at chemistry workshop. Hofstein, Shore & Kipnis (2004) argued that laboratory activities have long had a distinctive and central role in the science curriculum, and science educators have suggested that many benefit accrue from engaging students in science laboratory activities. Earlier on and in line with this argument, Faroumbi (1998) contended that students tend to understand and recall what they see more than what they hear; student can visualise concepts when they actually use laboratories in the teaching and learning of science.
Further Prince (2011), argued that demonstrations and practical work had immense heuristic value, tremendous rhetorical power, an overwhelming persuasive force. He stated that, “if you don’t see it, you won’t believe it. And if you don’t believe it you won’t understand it. And if you don’t understands it, you won’t long remember it. The senses are important, not only for first discovering, but for receiving knowledge…”

Tobin (1990) emphasised that laboratory activities appealed as a way to learn with understanding and at the same time engaged in a process of constructing knowledge by doing science. Dahar & Faize (2011) are also in agreement that learning and the understanding level in science was improved when students were engaged in science laboratory for practical experiments. Further Hofstein et al. (2004), suggested that if designed properly the science laboratory has the potential to play an important role in attaining cognitive skills such as scientific thinking, inquiry skills as well as understanding the process of scientific protocols. Ostensibly, when properly developed, laboratory has the potential to enhance students’ achievement, conceptual understanding and understanding of the nature of science as well as their positive attitudes and cognitive growth (Kurbanoglu, Izzet, Akim, & Ahmet, 2010). In support Keys, Hand, Vaughin & Collins (1999), in their studies found that the use of science writing heuristic facilitated students to generate meaning from experimental data and make connections among procedures, evidence, and claims, and engage in meaningful learning. According to Millar (2004), one of the specificity of the experimental sciences courses, that is, biology, chemistry and physics is the need for the students to interact with both the domain of real objects and observable things and the domain.

Chemistry is essentially a practical oriented subject which demands proper exhibition of good study behaviours for effective interpretation of existing phenomena (Byee, 2000). If used properly, the laboratory has the potential to be an important medium for introducing students to central conceptual and procedural knowledge and science (Byee, 2000). Since
chemistry is a science based on experimentation, doing an experiment in a laboratory is an important part of chemistry learning (Kurbanoglu, et al., 2010).

In a similar argument Millar (2004), emphasised that use of laboratories was essential in order to develop interest, curiosity, positive attitudes toward chemistry, creativity and problem solving ability in science, and also improved students’ understanding of science concepts and scientific process. As if to support Sabric & Emuas (2006), revealed that there was a strong relationship between the total number of secondary science laboratory experiments in school and the academic performance achievement. Similarly Liu (2006), argued that, combined computer modelling or hands-on laboratories were more effective than either computer simulations or hands-on laboratory students’ conceptual understanding of the particulate model of gases.

More recently Prince (2011), posits that the teacher who does not take advantage of demonstrations is doing his students a disservice by failing to stimulate excitement in the audience. The foregone arguments imply the existence of valid reasons for including demonstrations in introductory science courses. Swanson (1999) highlighted one ostensible benefit to learners and pointed out that, “just as an artist uses a paintbrush to reveal an underlying concept, a science educator uses demonstration as his or her tool to illustrate scientific principles”.

While laying emphasis on the same Prince (2011), asserted that demonstrations provide teachers with a way to motivate students to learn and retain knowledge of chemistry. According to Tobin (1990), meaningful learning is possible in the laboratory if the students are given opportunities to manipulate equipment and materials in an environment suitable for them to construct their knowledge of phenomena and related scientific concepts. It has been found that achievement and skills improved when students were taught science in an activity based curriculum (Tobin, 1990). Adeyegbe (2005) observed that teaching practical skills has often been a neglected aspect of science teaching by teachers in Nigeria and makes
chemistry difficult for learners and consequently they perceive it as a difficult and abstract subject. Emphasising on use of laboratory, Drayton & Falk (2002) reiterated that inquiry-based learning could facilitate the development of chemistry understanding. Obviously, inquiry provides opportunities for students to investigate phenomena of their own interest and thus, develop their higher-order thinking skills (Roth, 1995). Well-designed, inquiry-type laboratory activities, in particular, can provide learning opportunities to help students build higher-level learning skills and meta-cognitive abilities (Hofstein et al., 2004).

In later work Tai, Sadier & Loehr (2005), uncovered several interesting high school pedagogical experience that appeared to be linked with varying laboratory activities for understanding, and were associated with higher students grades. Students reporting more instances of attending laboratory work to enhance their understanding earned higher chemistry grades than their peers who reported few or no instance of attending laboratory work for understanding (Tai et al., 2005). To help students understand chemistry, Jonhstone & Letton (1990) suggest integrating laboratory activities into classroom instruction.

In similar work, Krajcik, Mamlok, & Hug (2001) revealed that students who performed the various phases of inquiry were challenged by asking appropriate questions, finding and synthesising information, monitoring scientific information, designing investigations, and drawing conclusions. This supports (Hodson, 1998; Lazarowitz & Tamir, 1994; Millar, 2004) who concluded that for student success in scientific inquiry, their direct experience with laboratory apparatus and materials was a necessary precursor. Similarly, Hofstein et al. (2004) suggested that laboratory instruction was an effective and efficient teaching strategy to attain some science learning goals. Appropriate activities according to Hofstein et al. (2004) help students to construct their chemistry knowledge, develop different skills such as- cooperation, communication, psychomotor, and thinking, and promote positive attitudes. In particular, inquiry-type practical experiences develop positive attitudes toward learning
chemistry in general and toward learning about chemistry phenomena (Hofstein, et al., 2004).

Adeyegbe (2005) contends that practical work provides experience with phenomena giving concrete meaning to, for example, ideas of chemical reactions by using real reactants and tools. On the same, Millar (2004) reported the importance of practical work, especially for acquiring scientific knowledge, skills and motivation. Uganda National Council of Science and Technology (UNCST) (2007) noted that experiments have been observed to be central to the teaching of science in that they help develop scientific investigation, motivate and create curiosity, spur objectivity and willingness to evaluate evidence. Ostensibly, this is the reason why availability and utilisation of laboratory cannot be over emphasised.

Kitheka (2005) noted that schools with abundant resources like laboratory materials did not always utilise them efficiently and consequently failed to raise student’s level of performance. Conversely, schools with limited resources like laboratory materials may utilise what they have efficiently and this may boost learning and consequently achieve educational objectives. In the same vein, Obwacha (2005, October 6) describes a certain school as “the sick man of the National schools in Kenya Certificate of Secondary Education (K.C.S.E)” inspite of possessing adequate facilities and 74 teachers. Similarly, Munyori (2006, March 6) concluded that some National schools are a National shame. This was in reference to the poor performance of the three schools that tailed in the 2005 Kenya Certificate of Secondary Education (K.C.S.E) examination in the National school category, according to the results published in the Daily Nation and the Standard newspapers of March 2, 2006. The two scenarios exemplify of the importance of utilisation of resources.

The literature so far reviewed reveals that whereas the science laboratory has been given a distinctive role in science education, research has failed to show simplistic relationship between laboratory experience and students performance in chemistry. Studies were conducted to investigate the educational effectiveness of science laboratory and whether
they facilitate the students’ achievements. However, these studies did not show any relationship between laboratory experience and students learning (Hodson, 1998; Hofstein & Lunetta, 1982, 2004; Lazarowitz & Tamir, 1994).

Although practical work or laboratory work is used widely in science lessons, its role in effectively promoting the learning of scientific knowledge and process is questioned (Lunetta, 1998). Gustone (1991) suggested that using the laboratory to have student restructure the knowledge is straight forward, but he also claimed that this view was naive. On the same, Dahar & Faize (2011) criticised laboratory work and claimed that it was unproductive and confusing. Finally, The National Science Education Standards (National Research Council, 1996) emphasise the importance of rethinking the role and practice of laboratory work in science teaching in general and in the context of chemistry education in particular. This simple observation motivates a direct investigation of the relationship between the use of Chemistry laboratory and student’s academic performance in Chemistry.

2.3 Teacher academic qualification and Students’ Performance in chemistry

There is growing interest in the professional development of educators as demands, expectations, and requirements of teacher education increasingly come under scrutiny (Loughran, 2014). What the teacher does influences the whole process of learning. Effective teachers produce better performing students (Akiri, 2013). In line with this argument (Fuller, 1985) contends that teachers play an important role in determining the climate of their classroom. According to Kwale SMASSE (2004), teachers are the most important agents that can influence change in student’s performance in Mathematics and Sciences. Arguably, they are in contact with the students most of the time. Through such contacts they communicate their view point and expectations to students and the students are likely to faithfully believe them hence improving their performance. The study by Fuller (1985), on factors influencing performance revealed that 80% of studies confirmed in-servicing of teachers as positively correlated to achievement. In addition 70% of the studies showed a
positive correlation between years of tertiary education and teacher training, to achievement. This brings in the idea that the teacher himself/herself might be a determinant of performance.

In the discussion about student’s performance, teachers are especially likely target criticism. They would be better effective, it is charged, if they were better educated (Stevenson & Stigler, 1992). According to Comber and Keeves (1973), teaching experience does not necessarily cause higher achievement in science, but knowledgeable teachers are less likely to pass misconceptions, are more confident in imparting information, use less time for preparation and are able to present a wider range of examples and analogies which, helps the students to comprehend concepts more easily. Emphasising on the same, Udofot (2010) posited that the nation places importance on quality of its teachers, and the education they receive is predicated on the high social demand that society is making on education. Accordingly, the teacher prerequisite qualification requirements need to be given priority attention. Arguably, if quality Chemistry education is to be realised, appropriate qualification is needed by teachers to impart skills for productive and engaging practical activities in the learners.

On the same issue, The Education and Training Commission of Europe (2010) posited that teacher qualification was an essential factor that provides learners with personal fulfilment, better social skills and more diverse employment opportunities. Forging the same argument, Afangideh (2011) observed that professional preparation was needed by science teachers and Chemistry teachers in particular, through adequate and informed exposure to courses, for teaching effectiveness, as it influences student’s performance. Further, Afangideh (2011) observed that adequately exposed teachers who employed probing questions, problem based solving skills, discussions and feedback during interaction performed significantly higher than teachers who lacked exposure. Similarly, (Akpa, 2012) argued that teacher cannot teach the students well if he/she is not well trained and grounded in the subject he is teaching due
to poor qualifications. He further posited that, if a teacher is not well trained, the learning process will not be effective no matter how carefully a curriculum has been marked out, how detailed and scientifically accurate the textbooks, worksheets, equipment and operating instructions are and how adequate the physical facilities are.

In a related study, Adedayo (2012) examined the effects of teacher’s qualifications on the performance of senior secondary school students in physics. The results revealed that students taught by teachers with higher qualifications performed better than those taught by teachers with lower qualifications. It was also shown that students performed better in physics when taught by professional teachers. This argument compliments Darling-Hammond (1998) who defines a well qualified teacher as one who was fully is certified and holds the equivalent of a major in the field being taught. Dunlap & Frank (1996) maintained that all teachers must possess instructional/intervention skills to maximise the learner’s outcomes, and policies adopted by states, regarding teacher education, licensing, hiring and professional development. He argued that this might make an important difference in the learning and teaching and capacities that teachers bring to the work.

With regard to teacher’s knowledge and attitude towards science, Cherian (1996) maintained that there was a significant correlation between teacher’s knowledge and attitude towards Science. This finding was supported later by Unanma, Abugu, Dike & Umeobika (2013), who examined the relationship between teacher’s academic qualification and academic achievement of senior secondary school students in Chemistry and discovered that there was a positive relationship between the variables. This was endorsed by the findings of Adeyemi (2014) in the reports to analyse the performance of the English Language Teachers (ELTs) and Teachers with Formal Education (TFE) at secondary level in public high schools in Nigeria. Adeyemi’s (2014) results show that those students who receive instructions from ELTs show better results in the final examinations as compared to those who receive input from the TFEs.
In a related study, Ogbonnaya (2009) suggested that if all Mathematic teachers had a degree, were specialised in Mathematics or Mathematics education, the students’ achievement in Mathematics would likely improve. This reaffirms Richardson (2008) conclusion that if the teacher has a traditional secondary Mathematic certification, then students would tend to score higher in examination, compared to teachers with alternative certifications. In support, Huang & Moon (2009) documented that teacher qualification accounted for approximately 40 to 60 percent of the variance in average of student’s achievement in assessment. This was endorsed by, Ekuri, Etta & Iserome (2011) who assert that teacher qualification significantly influences the performance in assessment practices needs of social studies students.

In related study, Richardson (2008) reveals that students in urban areas performed better than those in rural areas. The researcher suggested that the availability of enough qualified teachers must have been a determinant for student’s performance. Building on the same argument, Wahling (2014) encouraged parents to send their children to boarding schools because boarding schools offered unique teaching opportunities that came with particular advantages over more traditional school settings such as public or private. One of the obvious advantages is the qualification or the quality of the teachers they employ. Wahling (2014) remarked that boarding schools were rigorous in their selection of staff and that most boarding schools required their teachers to hold degrees in their specialist subject, and that they had to go through a strict interview process to make sure they would fit in the school. Notably, some of the teachers even had post graduate degrees in their specialised field and that they were selected for the role because they were clearly passionate about what they taught.

However, in Kenya some schools in the rural areas have performed better than their urban counterparts (Owoeye & Yara, 2010). Maundu (1986) argued that there was significant correlation between teacher qualification and pupil performance in Kenya. The good
performance was attributed to excellent instructions given by qualified teachers in addition to other inputs.

However, while hiring of qualified teachers is encouraged for improvement of academic performance, theories from the study of Firestone (2014) cautions that policies to remove ineffective teachers should not reduce autonomy or trust among effective teachers, and that evaluation should provide teachers with useful feedback and policy makers with information on the conditions that facilitate good teaching. Maundu (1986) established that teachers who had graduated from Kenya Science Teacher College were more practical-oriented than those who had degrees from public universities.

On the issue of teacher qualification vis-à-vis academic achievement the reviewed literature does not make obvious the effect of the former on the latter. This was evidenced in the work of Koedel (2007) whose study shows that teacher’s qualifications are almost entirely unable to predict value-added to learner’s performance. Kimani, Augustine, Kara and Njagi (2013) concurred with the Koedel’s findings as they discovered that teacher’s professional qualification was not significantly related to academic achievement of students. In an earlier study to investigate the effect of teacher academic qualification on pupil’s achievement, in Social Studies in primary schools in Nigeria, Adeyemi and Babatunde (2011), found no significant relationship between teacher academic qualification and pupil’s achievement in social studies. This simple observation motivates a direct investigation of the relationship between the teacher academic qualification and student’s academic performance in Chemistry.

2.4 Summary

The literature presented in the preceding sections suggests that the issue of Chemistry Laboratory work and students’ academic performance in Chemistry has not been
exhaustively researched. The related studies presented, although not exhaustive are of great
significant as they have filled some critical gaps in Literature.

In all cases, the literature provided contradicting results, hence the present study sought to
fill the gaps.
CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

The chapter presents a description of methodological procedure that were used in this study namely; location of the study, research design, variables, population, sampling techniques and sample size, research instruments, pilot study, reliability and validity of research instruments, data collection procedures, data analysis, logistical and ethical considerations and summary of the chapter.

3.1 Location of Study

The study was carried out in secondary schools in Kilifi North Constituency, Kilifi County, Kenya. Generally, there has been poor performance in chemistry in the whole country (Ongeri, 2012). In Kilifi North constituency, Chemistry is offered in all schools as a compulsory science subject (Kilifi County Quality Assurance - KCQA, 2013). It was, however, observed with concern that the performance of Chemistry in K.C.S.E in the Constituency has continued to diminish (see Table 1, in Chapter 1). This informed the choice of the County. Also the accessibility and proximity of the locale to the university.

3.2 Research Design

The study employed a correlational survey design to investigate the relationship among; use of Chemistry laboratory, availability of laboratory materials, teacher academic qualification and students’ academic performance in Chemistry. Cohen, Manion and Morrison (2011) assert that the design involves collecting data in order to determine whether and to what degree a relationship exists between two or more quantifiable variables. Emphasizing the same, Kothari (2004) noted that correlation studies typically study a number of variables believed to be related to a major, complex variable, such as performance.
3.3 Variables of the Study

Being a correlational study of the ex-post facto nature the variables could not be literally manipulated and also causal effect may not be inferred. However, for the purpose of this study; availability of laboratory materials, use of chemistry laboratory, and teacher’s academic qualification were treated as independent variables. Availability of chemistry materials was categorised as: 1- not available, 2- sparingly available, 3- moderately available, 4- highly available. Use of chemistry laboratory was categorised as: 1- poor, 2- fair, 3- good, 4- very good. Finally, teacher’s academic qualification was categorised as: 1- S1, 2- diploma, 3- graduate, 4 -masters and above.

The dependent variable was academic performance score in chemistry. This was a raw score for the individual student in chemistry practical end of term two Kilifi district joint examinations 2014 in Kilifi district results obtained from the school documents. This paper was marked out of 40 and therefore the scores a student obtained ranged between 0-40 on a continuous scale.

The intervening variable was Chemistry content coverage. The researcher tried to control this by purposive sampling method.

3.4 Population of the Study

Kilifi North Constituency comprises 17 public secondary schools, 39 Chemistry teachers and 719 Form Four students (KCQA, 2013).

The target population comprised all public secondary schools, all Form Four Chemistry teachers in public schools and all Form Four students in public secondary schools in Kilifi County. The accessible population comprised 17 public secondary schools (one boy school, three girls’ schools and 13 mixed schools), 39 form four chemistry teachers and 719 Form Four students in Kilifi North Constituency. Public schools only were chosen for this study.
because of the uniformity in the curriculum offered and relatively comparable school learning environments.

Form Four teachers participated in this study because they had the necessary information and records concerning laboratory work in Chemistry needed by the researcher. Form Four students were selected because they took a common mock examination that made comparison of scores possible.

3.5 Sampling Techniques and Sample Size

3.5.1 Sampling Techniques

Purposive sampling was used to select only the schools which had completed the Chemistry syllabus by the time of data collection. Since there was Only One Boys’ school in Kilifi North constituency, it was selected purposively. Simple random sampling through lottery technique was used to select one girls’ school from the three schools and six mixed schools from the 13 schools. In schools with more than one stream of Form 4, simple random sampling was used to select only one stream to participate with their Chemistry teacher. Similarly, simple random sampling through lottery technique was used to select ten students each from the one boys’ school and one girls’ school. Stratified random sampling was used in mixed schools to select girls and Boys from the sampled classes of Form 4 to ensure sex representation.

Purposive sampling was used to select Form Four chemistry teachers for the classes selected to participate in the study.

3.5.2 Sample size

The school sample comprised; One Boys’ School, One Girls’ School and Six Mixed Schools making a total Sample of Eight Secondary Schools out of the 17 Schools forming 47%. Eighty (80) Form Four students were sampled from a population of 719 students forming 11.13%. Finally, 8 Chemistry teachers were selected from a population of 39 Chemistry
teachers from the sampled schools forming 20%. According to Gatara, (2010) a minimum of 10% sample of a population is sufficient.

Table 2

*Sampling Frame*

<table>
<thead>
<tr>
<th>Population (N)</th>
<th>Sample Size</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>719</td>
<td>80</td>
</tr>
<tr>
<td>Teachers</td>
<td>39</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>758</td>
<td>88</td>
</tr>
</tbody>
</table>

3.6 Instruments

Data was collected by use of Three main instruments; questionnaires, observation checklist and document analysis.

3.6.1 Research Instruments

3.6.1.1 Questionnaires

Two sets of questionnaires were used: The Chemistry teacher questionnaire (CTQ) and Student’s questionnaire (SQ).

Chemistry teacher questionnaire (CTQ) was used to collect information from teachers (see Appendix 1). The questionnaire consisted of three sections A, B and C. Section A contained four items on demographic information of the teacher. Section B contained two items on the teacher academic qualification measured as: 1- S1, 2- diploma, 3- degree, 4- masters and above. Use of Chemistry laboratory was scored on a three point likert scale as: 1- not at all, 2- sometimes, 3- always. Section C contained two items on general information on laboratory work, on adequacy of working space and stools. This was scored on a Four point Likert Scale as: 1- strongly disagree, 2- disagree, 3- agree, 4- strongly agree.
Student’s questionnaire (SQ) was used to gather information from students on second objective in the sampled schools (see Appendix 20. The questionnaire consisted of two sections A and B. Section A contained four items on demographic information of the student. Section B contained two items on the use of Chemistry laboratory based on a Four Point Likert scale as: 1-poor, 2-fair, 3-good 4-very good. The second item on attending practical lessons was scored on a Three point Likert Scale: as 1- not at all, 2- sometimes, 3- always (See Appendix 2).

3.6.1.2 Observation checklist

An observation checklist was used to gather information on availability of laboratory materials. It consisted of four items; the first two items were on background information about the school; the third item was about the availability of a laboratory in the school as present, not present, others; the fourth item was about the availability of laboratory materials which was scored on a Four Point Likert scale as: 1- not available, 2- sparingly available, 3- moderately available, 4- highly available for apparatus; 1- available, 2- not available for the permanent facilities in the laboratory; 1- not available, 2- insufficient, 3- sufficient, 4- highly sufficient for chemicals. (See observation checklist in Appendix 3).

3.6.1.3 Document Analysis

Students’ performance was obtained from the school records for end of term two (July-August) Chemistry Paper III (practical) examinations of 2014 Kilifi District Mock Examination and were filled in Students’ Score Sheet form (See Appendix 4).

3.6.2 Pilot study

A pilot study was conducted prior to the main study from two schools that were not included in the main study but had similar characteristics with the schools in the study and the schools that had taken the same mock examination. Neuman (2003), views piloting of instrument on a small representative sample that is identical to, but not including the group to be studied as
important. Ten (10) students and One Chemistry teacher were randomly selected from each of the two schools. After piloting, the researcher discovered that the time allocated for filling questionnaires was insufficient; consequently, the time assigned was increased from 30 minutes to 40 minutes. Secondly, some of the wording of the items had to be reconstructed, because it gave different and unintended meaning that was not in line with the objectives of the study. Therefore the information gathered was vital in addressing logistical challenges like time allocated for filling the questionnaires. In addition, the information collected helped the researcher to assess if the information yielded the type of the anticipated responses and familiarization with the administration process. Pilot study also helped the researcher to check on the analyzability of the data collected as well as establishing the reliability and validity of the research instruments.

3.6.3 Reliability of Questionnaire

Pilot study was done prior to the main research to ascertain reliability of the instruments. During data collection, clear instructions were given to participants to ensure they understood the procedure. This helped to reduce random error thereby improving reliability. The questionnaires and observation schedule were tested for reliability by use of test-retest method. These instruments were administered to the pilot group twice within two weeks’ time interval. Obtained responses were then correlated by use of Spearman rank order (rho) as per the formula:

\[ \rho = 1 - \frac{\sum (d)^2}{N (N^2 - 1)} \]

Where: \( d \) is the difference between the ranks and \( N \) is number of pairs.

A correlation coefficient of 0.94 was obtained. According to Cohen, Manion and Morrison (2011) a coefficient of stability of 0.8 and above is considered to be acceptable. As such, obtained coefficient of stability of 0.94 was considered to be good enough.
3.6.4 Validity of the Questionnaire

Content validity of piloted questionnaires and observation schedule was ascertained with assistance of supervisors and other experts from the Pwani University School of Education. It was also ensured through cross checking of items against the respective study objectives. According to Mugenda & Mugenda (2003), experts can be used to validate research instruments. Random sampling of participants helped in increasing internal and external validity of the study. In addition, triangulation through various data collection methods served to increase the validity of the research findings.

3.7 Data Collection Procedures

The researcher had an introduction letter from Pwani University Ethics Review Committee accredited by the National Commission for Science, Technology and Innovation (NACOSTI) allowing him to conduct the research (See Appendix 5). In addition, permission was sought from the principals of sampled schools before administering the questionnaire (See Appendix 6). Chemistry teachers and students from the selected schools were informed about the research and given the consent form. The respondents read and signed the consent form hence participation in the study was voluntarily, (See Appendix 7). The sampled teachers and students were assembled in the laboratory and were taken through necessary instructions by the researcher and allowed to fill the Questionnaires.

In order to fill the Observation Checklist, the researcher personally filled the Observation Checklist assisted by either the Laboratory Technician or Chemistry teachers. Finally, the researcher obtained Chemistry practical mock results from the existing school documents from the head of Science department and recorded in the student’s score sheet form (See Appendix 4).
3.8 Data Analysis and Presentation Methods

Responses from the Chemistry Teacher Questionnaire (CTQ) and Students Questionnaire (SQ) were coded appropriately. Both descriptive and inferential statistics were used in data analysis. Descriptive statistics; percentages, frequencies and weighted mean were used to describe the participants, schools and use of laboratories. Inferential statistics; Pearson Product Moment Correlation of Coefficient and Spearman’s Rank Order Correlation were used to test hypothesis. Both Pearson Product Moment Correlation of Coefficient and Spearman’s Rank Order Correlation are suitable in measuring the degree of relationship between variables (Kothari, 2004)

The hypotheses tested included:

H$_{01}$: There is no relationship between availability of laboratory materials and student’ academic performance in chemistry. Test: Pearson Product Moment Correlation of Coefficient as per the following formulae;

\[
r = \frac{\sum d_x d_y}{\frac{n}{\sigma_x \cdot \sigma_y}}
\]

Where: $d_x$ is the deviations of mean from values of x series, $d_y$ is deviations of mean from values of y series, n is the number of pairs, $\sigma_x$ is the standard deviation of x series, $\sigma_y$ is the standard deviation of y series

H$_{02}$: There is no relationship between use of chemistry laboratories and students’ academic performance in chemistry. Test: Pearson Product Moment Correlation of Coefficient as per the above formulae.

H$_{03}$: There is no relationship between teacher academic qualification and students’ academic performance in chemistry. Test: Spearman’s Rank Order Correlation as per the following formulae:

\[
R = 1 - \frac{\sum 6 (d)^2}{N (N^2 - 1)}
\]
Where: \( d \) is the difference between the ranks and \( N \) is number of pairs

All hypotheses were tested at \( \alpha = .05 \)

### 3.9 Logical and Ethical considerations

In order to ensure high ethical standards, strict confidentiality, respect and willingness of respondents' participation was paramount. The researcher sought permission from the principals of the sampled schools (refer to Appendix 6). The researcher also sought informed consent from the respondent (refer to Appendix 7).

The researcher sought permission from the heads of science department to access student chemistry practical mock results. All information collected from them was kept confidential. In addition, ethical approval to conduct the research was sought from the Ethics Review Committee of Pwani University before commencement on data collection, (Refer to appendix 5).

In order to protect the schools and respondents' identity, all questionnaires were assigned unique codes that were only known to the researcher alone. Study findings were presented in summary form and the names of the schools or respondents were not used in anywhere in the report. Finally, the researcher acknowledged all the authors cited.

### 3.10 Summary

This chapter focused on the research methodology used in this study. A correlation research design was used for the purpose of this study. The research was conducted in Kilifi North Constituency, Kilifi County. The target population constituted of form four chemistry teachers and all form four students in all public schools in Kilifi County, while the accessible population consisted of 39 Form Four Chemistry teachers and 719 Form Four students from 17 public schools from Kilifi North Constituency.

The sample was selected using simple random sampling, stratified sampling and purposive method, and data was collected by use of two sets of questionnaires; CTQ and SQ,
observation checklist as well as student’s score sheet. Finally, data was analysed using descriptive and inferential statistics. Out of the inferential statistics; Pearson product moment correlation of coefficient and Spearman’s Rank Order correlation were employed in order to measure the relationship between variables.
CHAPTER FOUR: RESULTS, INTERPRETATION AND DISCUSSION

4.0 Introduction

This chapter presents and interprets the results of the study. Further, discussions of the findings linking this study to other scientific work are done. The data was obtained from a sample of 8 secondary schools, 8 Chemistry teachers and 80 Form Four students from Kilifi North Constituency through questionnaires and an observation schedule. The data obtained were analysed descriptively and inferentially with the aid of Statistical Package for Social Sciences (SPSS). The findings of the study are presented objective by objective and discussions done in relation to the Theoretical Framework of the study and previous relevant empirical researches.

The findings of the study are discussed under the headings: demographic information of respondents; relationship between availability of laboratory materials and students’ academic performance in Chemistry, relationship between use of Chemistry laboratories and students’ academic performance in chemistry and relationship between teacher academic qualification and students’ academic performance in Chemistry and conclusion.

4.1 General and Demographic information of the Respondents

Student’s sex was cross tabulated with school category to determine the percentage of student’s sex against school category. Table 3, shows that in mixed schools majority were boys (60%) while 40% were girls. In general majority of the participants were boys (57.5%) while 42.5% were girls.
Table 3

_Students’ Sex and School Category_

<table>
<thead>
<tr>
<th>Student’s Sex</th>
<th>Boys’ School</th>
<th>Girls School</th>
<th>Mixed School</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boy</td>
<td>10 (100%)</td>
<td>0 (0%)</td>
<td>36 (60%)</td>
<td>46 (57.5%)</td>
</tr>
<tr>
<td>Girl</td>
<td>0 (0%)</td>
<td>10 (100%)</td>
<td>24 (40%)</td>
<td>34 (42.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>10 (100%)</td>
<td>10 (100%)</td>
<td>60 (100%)</td>
<td>80 (100%)</td>
</tr>
</tbody>
</table>

n = 80

The participants’ age and sex were cross tabulated to determine the percentage of student’s age against their sex. Table 4, shows that most of the boys’ age ranged between 20-21 years (45.6%). Similarly, majority of girls’ age ranged between 18-19 years and 20-21 years which were both at 35.3%. In general 41.3% of the participants were 20-21 years while 10% of the participants were 16-17 years.

Table 4

_Participant’s Age and Sex_

<table>
<thead>
<tr>
<th>Students’ Age (Years)</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-17</td>
<td>1 (2.2%)</td>
<td>7 (20.6%)</td>
<td>8 (10%)</td>
</tr>
<tr>
<td>18-19</td>
<td>16 (34.8%)</td>
<td>12 (35.3%)</td>
<td>28 (35%)</td>
</tr>
<tr>
<td>20-21</td>
<td>21 (45.6%)</td>
<td>12 (35.3%)</td>
<td>33 (41.3%)</td>
</tr>
<tr>
<td>22 and above</td>
<td>8 (17.4%)</td>
<td>3 (8.8%)</td>
<td>11 (13.7%)</td>
</tr>
<tr>
<td>Total</td>
<td>46 (100%)</td>
<td>34 (100%)</td>
<td>80 (100%)</td>
</tr>
</tbody>
</table>

n = 80

The researcher was interested in knowing the teacher’s working experience against sex. Table 5, shows that majority of male teachers had teaching experience of 5 years and below or 11-15 years both at 42.86%, while 14.29% of male teachers had teaching experience of 6-10 years. Additionally, all female teachers (100%) had teaching experience of 6-10 years. In
general, majority of teachers had teaching experience of 5 years and below or 11-15 years both at 37.5%, while 25% of teachers had a teaching experience of 6-10 years.

Table 5

*Teacher’s Teaching Experience and Teacher’s Sex*

<table>
<thead>
<tr>
<th>Teaching Experience (Years)</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 and below</td>
<td>3 (42.86%)</td>
<td>0 (0%)</td>
<td>3 (37.5%)</td>
</tr>
<tr>
<td>6-10</td>
<td>1 (14.29%)</td>
<td>1 (100%)</td>
<td>2 (25%)</td>
</tr>
<tr>
<td>11-15</td>
<td>3 (42.86%)</td>
<td>0 (0%)</td>
<td>3 (37.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>7 (100%)</td>
<td>1 (100%)</td>
<td>8 (100%)</td>
</tr>
</tbody>
</table>

*n = 8*

4.2 Research Findings

The findings of this research was discussed as per the research objectives in the order of: Relationship between Availability of Laboratory Materials and Student’s Academic Performance in Chemistry; Relationship between Use of Chemistry Laboratory and Student’s Academic Performance; and Relationship between Teachers’ Academic Qualification and Student’s Academic Performance in Chemistry.

4.2.1 Relationship between Availability of Laboratory Materials and Student’s Academic Performance in Chemistry

One of the main aims of the study was to determine the availability of laboratory and laboratory materials; apparatus, chemicals and permanent laboratory facilities. Table 6, shows that majority (75%) of schools in the study had laboratories, while 25% of schools had modified rooms being used as laboratories.
Table 6

*Availability of Laboratory*

<table>
<thead>
<tr>
<th>Availability of Laboratory</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>6</td>
<td>75.0</td>
</tr>
<tr>
<td>Modified rooms</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

*n = 8*

The number of laboratories in schools was also determined. Table 7, shows the number of Laboratories in schools, majority (37.5%) of schools had one laboratory being shared among three sciences; chemistry, biology and physics, 25% of schools had two Laboratories, similarly 25% of schools had modified rooms, while 12.5% of schools had three laboratories with each science having its own Laboratory.

Table 7

*Number of Laboratories in School*

<table>
<thead>
<tr>
<th>Number of Laboratories</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>37.5</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>Modified room</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

*n = 8*

The availability of chemistry apparatus was determined. This was established through physical observation by the researcher. The scoring was as explained in chapter 3, section 3.6.1.2. Table 8, summarises the availability of chemistry apparatus. It was observed that, Stands and Clamps in most schools were moderately available (MA) that is, 50%, sparingly available (SA) was 37.5%, highly available(HA) was 12.5% and finally the weighted mean of availability of Stands and Clamps was 2.75 (68.75%). In most schools, 50ml Burettes were moderately available (MA) that is, 75%, highly available (HA) was 12.5% while sparingly available (SA) was 12.5%. The weighted average availability of 50ml Burettes was 3.13 (78.25%).
Third, availability of 250ml volumetric flasks was; 62.5% moderately available, 25% highly available, 12.5% sparingly available. The weighted mean availability of 250ml volumetric flasks was 3.00 (75%). The availability of 25ml pipettes was; 62.5% highly available, 37.5% moderately available and the weighted mean availability was 3.63 (90.75%). In most schools, 250ml conical flasks were moderately available 75%, highly available was 25 % with weighted average of 3.25 (81.25%). For 100ml beakers, the availability were; 75% moderately available, 25% highly available and the weighted mean was 3.25 (81.25%). Boiling tubes were; 62.5% highly available, 37.5% moderately available with a weighted mean availability of 3.63 (90.75%). Test tubes were; 75% highly available, 25% moderately available and the weighted mean availability was 3.75 (93.75%). Stopwatches were; 50% moderately available, 50% highly available with a weighted mean availability of 3.5 (87.5%). Finally, the availability of Thermometers were; 62.5% highly available, 37.5% moderately available and weighted average availability of 3.63 (90.75%).
Table 8

**Availability of Chemistry Apparatus**

<table>
<thead>
<tr>
<th>Apparatus</th>
<th>SA</th>
<th>MA</th>
<th>HA</th>
<th>Total</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stands and clamps</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>8</td>
<td>2.75 (68.75%)</td>
</tr>
<tr>
<td>50ml burettes</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>8</td>
<td>3.13 (78.25%)</td>
</tr>
<tr>
<td>250ml volumetric</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>8</td>
<td>3.00 (75.00%)</td>
</tr>
<tr>
<td>25ml pipettes</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>3.63 (90.75%)</td>
</tr>
<tr>
<td>250ml conical flasks</td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>3.25 (81.25%)</td>
</tr>
<tr>
<td>100ml beakers</td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>3.25 (81.25%)</td>
</tr>
<tr>
<td>Boiling tubes</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>3.63 (90.75%)</td>
</tr>
<tr>
<td>Tests tubes</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>3.75 (93.75%)</td>
</tr>
<tr>
<td>Stop watches</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>3.50 (87.5%)</td>
</tr>
<tr>
<td>Thermometer</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>3.63 (90.75%)</td>
</tr>
</tbody>
</table>

**Key;** SA=Sparingly Available (2), MA= Moderately Available (3), HA= Highly Available (4)

The researcher was also interested in finding out the sufficiency of chemicals in laboratory. The observation was mainly focused on the commonly used chemicals in the laboratory. This was also established through observation by the researcher and scoring done as per chapter 3, section 3.6.1.2. Table 9, summarizes the availability of chemicals in school laboratories. It was observed that: the availability of Sodium hydroxide was; 87.5% sufficient, 12.5% highly sufficient. The weighted mean availability of Sodium hydroxide was 3.13 (78.25%) which was sufficient. Sodium chloride the availability was; 62.5% sufficient, 37.5% highly sufficient while the weighted average availability of Sodium chloride was 3.38 (84.5%) which was sufficient. The availability of Barium nitrate was; 50% sufficient, 50% highly...
sufficient and the weighted mean availability was 3.5 (87.5%) which was both sufficient and highly sufficient. For Sodium carbonate the availability was; 62.5% highly sufficient, 37.5% sufficient while the weighted mean availability was 3.63 (90.75%) which was highly sufficient. Sodium hydrogen carbonate the availability was; 50% highly sufficient, 25% sufficient, 25% insufficient and the weighted mean availability was 3.25 (81.25%) which was highly available. The availability of Lead chloride was; 50% highly sufficient, 50% sufficient and the weighted mean availability was 3.5 (87.5%) which was both sufficient and highly sufficient. For Zinc sulphate, the availability was; 62.5% sufficient, 37.5% highly sufficient and the weighted mean availability was 3.38 (84.5%) which was sufficient. The availability of Iron sulphate was; 37.5% highly sufficient, 37.5% insufficient, 25% sufficient and the weighted mean availability was 3.00 (75%) which was both insufficient and highly sufficient. Iron III sulphate, the availability was; 50% sufficient, 37.5% highly sufficient, 12.5% insufficient with a weighted mean of 3.25 (81.25%) which was sufficient. For Sodium thiosulphate, the availability was; 62.5% sufficient, 25% highly sufficient, 12.5% not available and the weighted mean availability was 3.00 (75%) which was sufficient. Copper sulphate, the availability was; 75% sufficient, 25% highly sufficient with a weighted average availability of 3.25 (81.25%) which was sufficient. For magnesium ribbon, the availability was; 75% highly sufficient, 25% sufficient with the weighted mean availability of 3.75 (93.75%) which was highly sufficient. The availability of Potassium permanganate was; 50% sufficient, 37.5% highly sufficient, 12.5% not available and the weighted mean availability was 3.25 (81.25%) which was sufficient. For hydrochloric acid, the availability was; 75% highly sufficient, 25% sufficient and the weighted mean availability of 3.75 (93.75%) which was highly sufficient. Last but not least, availability of Sulphuric acid was; 62.5% highly sufficient, 37.5% sufficient with the weighted mean availability of 3.63 (90.75%) which was highly sufficient. Finally, the availability of Nitric acid was; 75% highly sufficient, 25% sufficient with weighted mean availability of 3.75 (93.75%) which was highly available.
### Table 9

**Sufficiency of Chemicals in Laboratory**

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>NA</th>
<th>IS</th>
<th>S</th>
<th>HS</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium hydroxide</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>7(87.5%)</td>
<td>1(12.5%)</td>
<td>3.13(78.25%)</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>5(62.5%)</td>
<td>3(37.5%)</td>
<td>3.38(84.5%)</td>
</tr>
<tr>
<td>Barium nitrate</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>4(50.0%)</td>
<td>4(50.0%)</td>
<td>3.50(87.5%)</td>
</tr>
<tr>
<td>Sodium carbonate</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>3(37.5%)</td>
<td>5(62.5%)</td>
<td>3.63(90.75%)</td>
</tr>
<tr>
<td>Sodium hydrogen carbonate</td>
<td>0(0%)</td>
<td>2(25.0%)</td>
<td>2(25.0%)</td>
<td>4(50.0%)</td>
<td>3.25(81.25%)</td>
</tr>
<tr>
<td>Lead chloride</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>4(50.0%)</td>
<td>4(50.0%)</td>
<td>3.50(87.5%)</td>
</tr>
<tr>
<td>Zinc sulphate</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>5(62.5%)</td>
<td>3(37.5%)</td>
<td>3.38(84.5%)</td>
</tr>
<tr>
<td>Iron sulphate</td>
<td>0(0%)</td>
<td>3(37.5%)</td>
<td>2(25.0%)</td>
<td>3(37.5%)</td>
<td>3.00(75.00%)</td>
</tr>
<tr>
<td>Iron III sulphate</td>
<td>0(0%)</td>
<td>1(12.5%)</td>
<td>4(50.0%)</td>
<td>3(37.5%)</td>
<td>3.25(81.25%)</td>
</tr>
<tr>
<td>Sodium thiosulphate</td>
<td>1(12.5%)</td>
<td>0(0%)</td>
<td>5(62.5%)</td>
<td>2(25.0%)</td>
<td>3.00(75.00%)</td>
</tr>
<tr>
<td>Copper sulphate</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>6(75.0%)</td>
<td>2(25.0%)</td>
<td>3.25(81.25%)</td>
</tr>
<tr>
<td>Magnesium ribbon</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>2(25.0%)</td>
<td>6(75.0%)</td>
<td>3.75(93.75%)</td>
</tr>
<tr>
<td>Potassium permanganate</td>
<td>1(12.5%)</td>
<td>0(0%)</td>
<td>4(50.0%)</td>
<td>3(37.5%)</td>
<td>3.25(81.25%)</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>2(25.0%)</td>
<td>6(75.0%)</td>
<td>3.75(93.75%)</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>3(37.5%)</td>
<td>5(62.5%)</td>
<td>3.63(90.75%)</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>2(25.0%)</td>
<td>6(75.0%)</td>
<td>3.75(93.75%)</td>
</tr>
</tbody>
</table>

Key; NA=Not Available (1), IS=Insufficient (2), S=Sufficient (3), HS=Highly Sufficient (4)

The researcher was also interested in determining the availability of laboratory facilities considered crucial for a functional laboratory. Tables 10, shows that; 62.5% of schools had fume cupboards, 37.5% of schools did not have. Secondly, all schools (100%) had weighing balances and Bunsen burners. Majority of the schools (75%) had chemical and apparatus store while 25% of the schools had no chemicals and apparatus store. Similarly, 75% of the schools had piping system; tap water and sink and 25% of the schools lacked.
Table 10

*Availability of Laboratory Facilities*

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Availability of Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Available</td>
</tr>
<tr>
<td>Fume cupboard</td>
<td>5(62.5%)</td>
</tr>
<tr>
<td>Weighing balance</td>
<td>8(100%)</td>
</tr>
<tr>
<td>Chemical and apparatus store</td>
<td>6(75%)</td>
</tr>
<tr>
<td>Bunsen burner</td>
<td>8(100%)</td>
</tr>
<tr>
<td>Piping system; tap water &amp; sink</td>
<td>6(75%)</td>
</tr>
</tbody>
</table>

n = 8

The researcher also cross tabulated adequacy of laboratory working space by the adequacy of seating space which was measured in terms of adequacy of stools from teacher’s point of view. Table 11, shows that majority of the participants (50%) agreed that the laboratory space was adequate, 37.5% of the participants disagreed while 12.5% of the participants strongly disagreed. In addition, majority of the participants (50%) agreed that sitting space was adequate, 37.5% of the participants disagreed and 12.5% of the participants strongly agreed. In general, majority of the participants (50%) agreed that both laboratory working space and stools were adequate.

Table 11

*Cross tabulation of Adequacy of Laboratory Space and Laboratory Stools*

<table>
<thead>
<tr>
<th>Adequacy of Laboratory Space</th>
<th>Adequacy of Laboratory Stools</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Agree</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Disagree</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Agree</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>3(37.5%)</td>
<td>4(50%)</td>
</tr>
</tbody>
</table>

n = 8
One of the hypotheses of the study set out to test stated that; “There is no relationship between availability of laboratory materials and students’ academic performance in Chemistry”. The hypothesis was tested using Pearson Product Moment Correlation of Coefficient. Table 12, shows the correlation between the mean availability of laboratory materials data obtained from observation checklist in every school and the school mean scores of students’ academic performance in chemistry mock practical examination. Information in the table shows that, there was a strong positive correlation ($r = 0.819, \alpha = 0.013$) at $\alpha = .05$, indicating a significant linear relationship between availability of laboratory materials and performance in chemistry practical. The coefficient of determination of $r^2$ of 0.6708 reveals that schools that have well equipped laboratories have relatively high mean scores in practical. Hence, 67.08% of performance in chemistry practical can be explained by the availability of laboratory materials and that, 32.92% of remaining part is attributed to other variables that this study did not consider. Hence the null hypothesis, $H_{01}$; there is no relationship between availability of laboratory materials and student’s academic performance in chemistry was rejected.

Table 12

*Correlation between Availability of Laboratory Materials and Students’ Academic Performance*

<table>
<thead>
<tr>
<th>Paired Variable</th>
<th>Correlation</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of Laboratory Materials and School Mean Score in Chemistry Practical</td>
<td>0.819</td>
<td>0.013</td>
</tr>
</tbody>
</table>

*n=8*

The figure 2 below shows a scatter diagram between the mean availability of Laboratory materials and means score in Chemistry practical. Its show a strong positive between the two variables.
4.2.2 Relationship between Use of Chemistry Laboratory and Student’s Academic Performance

The second objective of this study was to establish the extent to which students use the chemistry laboratory, this was measured by the number of chemistry practical lessons attended by students per term. Data was obtained from a students’ questionnaire. Table 13, summarizes the responses from the students on the use of laboratory, it shows that majority of students (38.75%) attended 3-6 chemistry practical lessons per term out of the total expected 13 lessons per term (assuming that an average term has 13 weeks), 33.75% of students attended 7-10 chemistry practical lessons per term and 27.5% of the students reported that they attended 11-13 chemistry practical lessons in a te
Table 13

Use of Chemistry Laboratory

<table>
<thead>
<tr>
<th>Number of Lessons Attended</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3-6</td>
<td>31</td>
<td>38.75</td>
</tr>
<tr>
<td>7-10</td>
<td>27</td>
<td>33.75</td>
</tr>
<tr>
<td>11-13</td>
<td>22</td>
<td>27.5</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>100.0</td>
</tr>
</tbody>
</table>

n = 80

A similar question asked the teachers to say how often they took students to the laboratory for practical lessons. Results are presented in Table 14. Majority (62.5%) of teachers sometimes took students for chemistry practical lessons while few (37.5%) of teachers always took students for practical lessons.

Table 14

Teacher Taking Students for Practical Lessons

<table>
<thead>
<tr>
<th>Teacher Taking Students for Practical Lessons</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sometimes</td>
<td>5</td>
<td>62.5</td>
</tr>
<tr>
<td>Always</td>
<td>3</td>
<td>37.5</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

n = 8

The second hypothesis of the study stated that; there is no relationship between use of Chemistry laboratories and students’ academic performance in chemistry. The hypothesis was tested using Pearson Product Moment Correlation of Coefficient. Table 15, shows the correlation between use of laboratory and students’ academic performance in chemistry practical. Information in the Table 15 shows that, there was a highly significant correlation (r = 0.690, \( \alpha = 0.001 \)) at \( \alpha = .05 \). The coefficient of determination of \( r^2 \) of 0.4761 reveals that 47.61% of performance in chemistry practical is explained by use of laboratory and that, 52.39% remaining part is attributed to other variables that this study did not consider. Hence the null hypothesis \( H_{02} \), which stated that, there is no relationship between use of Chemistry
laboratory and students’ performance in Chemistry, was rejected in favor of the alternative hypothesis.

Table 15

<table>
<thead>
<tr>
<th>Paired Variable</th>
<th>Correlation</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of Laboratory and School Mean Score in Chemistry Practical</td>
<td>0.690</td>
<td>0.001</td>
</tr>
</tbody>
</table>

n=80

The figure 3 below shows a scatter diagram between the mean attendances to practical lessons and means score in Chemistry practical. It show a strong positive between the two variables.

![Figure 3. Scatter Diagram of Mean Attendance to Practical Lessons against Mean Scores in Practical Examination](image)
4.2.3 Relationship between Teachers’ Academic Qualification and Student’s Academic Performance in Chemistry

The final objective in this study was to determine the teachers’ academic qualification. Table 16, summarizes teachers’ academic qualification. Information shows that most teachers (37.5%) were both diploma and degree holders while 25% were masters holders and above.

Table 16

Teachers’ Highest Academic Qualification

<table>
<thead>
<tr>
<th>Teachers’ Qualification</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Diploma</td>
<td>3</td>
<td>37.5</td>
</tr>
<tr>
<td>Degree</td>
<td>3</td>
<td>37.5</td>
</tr>
<tr>
<td>Masters and above</td>
<td>2</td>
<td>25.0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The final hypothesis of this study stated that; there is no relationship between teacher academic qualification and students’ academic performance in Chemistry. The hypothesis was tested using Spearman’s Rank Order Correlation at $\alpha = .05$. Table 17, shows correlation between teachers’ academic qualification and student’s mean scores in Chemistry practical examination, a strong positive correlation was found ($r = 0.926$, $\alpha = 0.001$) at $\alpha = .05$, indicating a significant linear relationship between teachers’ academic qualification and student’s mean scores in Chemistry practical examination. The coefficient of determination $r^2$ of 0.857476 shows that about 85.75% of performance of Chemistry practical is attributed to the teacher’s academic qualification. This means that 85.25% of performance in Chemistry practical can be predicted from the teachers’ academic qualification. This signifies that 14.25% of performance in Chemistry is attributed to other factors. Therefore, the null hypothesis $H_0$, which stated that there is no relationship between teachers’ academic qualification and students’ academic performance in Chemistry, was rejected in favor of the alternative hypothesis.
Table 17

Correlation between Teachers’ Academic Qualification and Student’s Academic Performance

<table>
<thead>
<tr>
<th>Paired Variables</th>
<th>Correlation</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Academic Qualification and School Mean Score</td>
<td>0.926</td>
<td>0.001</td>
</tr>
<tr>
<td>in Chemistry Practical</td>
<td></td>
<td>n=8</td>
</tr>
</tbody>
</table>

The figure 4 below shows a scatter diagram between the teacher’s academic qualification and means score in Chemistry practical. Its show a strong positive between the two variables.

![Scatter Diagram](image)

*Figure 4. Scatter Diagram of Teacher Academic Qualification against Mean Score in Practical Examination*
4.3 Interpretations and Discussions of Results

This section interprets and discusses the results of the study in the order of objectives: availability of laboratory materials, use of laboratory and teachers’ academic qualification and students’ performance in chemistry. In general, schools with adequate laboratory materials had better performance in chemistry practical, while those with inadequate laboratory materials performed poorly. The findings of this study revealed that there was a relationship between availability of laboratory materials and student’s academic performance in chemistry. The findings of this research were consistent with those in previous studies. Ogunniyi (1993) in his study to determine how science laboratories material environment affects students learning outcomes in Nigeria, the study found that the science laboratory materials environment positively correlated with the student’s academic performance. On the same vein, Owoeye & Yara (2010) carried out a study on school facilities and academic achievement of secondary schools Agricultural science in Ekiti state, Nigeria, the study revealed that facilities are potent to high academic achievement of students. Further, Orodho (1996) in his study on factors determining achievement in science subject at secondary level in Kenya noted inadequate laboratory and laboratory equipment as one of the variables. In addition, Kizito (1986) in his study on factors contributing to poor performance in physical sciences in Busia district, Kenya also noted inadequate laboratory as one of the causes. The laboratory is essential to the teaching of sciences and success of any science course is much dependent on the laboratory provision made for it. This is supported by Ogunniyi (1993) who said that there is a general consensus among science educators that laboratories occupy a central position in science instruction. Further, Asiabaka (2008) on affective management of schools in Nigeria noted that the government’s failure to establish policy directive on minimum standards in relation to schools facilities has let to disparities in acquisition. This is because while some have well equipped laboratories, libraries and other facilities for effective teaching and learning others have none and where they exist, such facilities are poorly equipped leading to poor performance. Lamenting on students’ poor performance in
chemistry, Dan-Azumi (1998) reiterated that one of the most repeatedly mentioned problem causing poor performance in the subject is lack of equipment and materials to conduct practical. Similarly, Chiriswa (2002) noted that effective teaching and learning depends on the availability of suitable adequate resources such as laboratories which enhance good performance in National examination.

Secondly, the researcher discovered that most teachers do not always take students to chemistry practical lessons. Schools whose teachers always took students to practical lessons and students taking the practical recorded higher performance in chemistry practical. While those schools whose teachers did not always take their students to practical lessons recorded low performance in chemistry. The findings of this study revealed that there was a significant positive relationship between use of laboratory and students’ academic performance in chemistry. Dewey’s (1896) constructivism theory, the theoretical framework adopted in this study, explains the finding. The theory postulates that discovery, hands-on, experiential, collaborative, project-based, and task-based learning are a number of applications that enhance students’ abilities to master scientific concepts. According to the theory, education must engage with and expand experiences (Smith, 1997). To attain this, the method used to educate must provide for exploration, thinking and reflection and that interaction with the environment is necessary for learning. Dewey advocates the learning process of experimental learning through real life experience to construct and condition knowledge. To emphasize this theory, Doğru (2007) compared science classrooms using traditional teacher-centered approaches to those using student-centered, constructivist methods. In their initial test of student performance immediately following the lessons, they found no significant difference between traditional and constructivist methods. However, in the follow-up assessment later, students who learned through constructivist methods showed better retention of knowledge than those who learned through traditional methods. These findings on the relationship between use of laboratory and students’ performance in chemistry are also supported by
previous studies. Hofstein at el. (2004) argued that laboratory activities have long had a distinctive and central role in the science curriculum, and science educators have suggested that many benefits accrue from engaging students in science laboratory activities. On the same note, Faroumbi (1998) contends that students tend to understand and recall what they see more than what they hear. Student can visualize concepts when they actually use laboratories in the teaching and learning of science. Even more, Prince (2011) argued that demonstrations and practical work have immense heuristic value, tremendous rhetorical power, an overwhelming persuasive force. He stated that, “if you don’t see it, you won’t believe it. And if you don’t believe it you won’t understand it. And if you don’t understands it, you won’t long remember it. The senses are important, not only for first discovering, but for receiving knowledge….” Tobin (1990) emphasized that laboratory activities appeals as a way to learn with understanding and at the same time engage in a process of constructing knowledge by doing science. According to, Dahar and Faize, (2011) learning and the understanding level in science is improved when students are engaged in science laboratory for practical experiments. Even more, Hofstein at el. (2004) suggested that if designed properly the science laboratory has the potential to play an important role in attaining cognitive skills such as scientific thinking, inquiry skills as well as understanding the process of scientific protocols. When properly developed, laboratory has the potential to enhance students’ achievement, conceptual understanding and understanding of the nature of science as well as their positive attitudes and cognitive growth (Kurbanoglu at el., 2010). This was strongly supported by Sabric & Emuas (2006) when their study revealed that there was a strong relationship between the total number of secondary science laboratory experiments in school and the academic performance achievement. Finally, Liu (2006) argued that, combined computer modeling or hands-on laboratories were more effective than either computer simulations or hands-on laboratory students’ conceptual understanding of the particulate model of gases.
Finally, the researcher discovered that most teachers were degree holders; however teachers with masters produced better result in chemistry. Hence the findings of the study revealed that there exist a very strong relationship between teacher’s academic qualification and student’s performance in chemistry.

The results of this study were in agreement with some of the literatures cited earlier. Udofot (2010) posited that the nation places importance on quality of its teachers, and the education they receive is predicated on the high social demand society is making on education. The teacher prerequisite qualification requirements therefore, needs to be given priority attention. If quality Chemistry education is to be realized, appropriate qualification is needed by teachers to impart skills for productive and engaging practical activities in the learners. On the same vein, The Education and Training Commission of Europe (2010) posited that teacher qualification is an essential factor that provides learners with personal fulfilment, better social skills and more diverse employment opportunities. Afangideh (2011) observed that professional preparation is needed by science teachers and Chemistry teachers in particular, through adequate and informed exposure to course for teaching effectiveness as it influences student’s performance. Afangideh (2011) further observed that adequately exposed teachers who employed probing questions, problem based solving skills, discussions and feedback during interaction performed significantly higher than teachers who lacked exposure. Similarly, Akpa, (2012) argued that teacher cannot teach the students well if he/she is not well trained and grounded in the subject he/she is teaching due to poor qualifications. He further posited that, if a teacher is not well trained, the learning process will not be effective no matter how carefully a curriculum has been marked out, how detailed and scientifically accurate the textbooks, worksheets, equipment and operating instructions are and how adequate the physical facilities are. In a related study, Adedayo, (2012) examined the effects of teacher’s qualifications on the performance of senior secondary school students in physics. The results revealed that students taught by teachers with higher qualifications
performed better than those taught by teachers with lower qualifications. It was also shown that students performed better in physics when taught by professional teachers. According to Comber and Keeves (1993), teaching experience does not necessarily cause higher achievement in science, but knowledgeable teachers are less likely to pass misconceptions, are more confident in imparting information, use less time for preparation and are able to present a wider range of examples and analogies which, helps the students to comprehend concepts more easily. Towards this end, Ekuri at el. (2011) did a study on teacher qualification perceived Assessment Practices Needs of social studies Teachers in Cross River state, Nigeria. Results indicated that teacher qualification significantly influenced perceived assessment practices needs of social studies teachers.

4.4 Summary

From this study, it can be clearly concluded that students’ academic performance in Chemistry was attributed to; availability of laboratory materials, use of laboratory and teacher’s academic qualifications. Consequently, poor performance in Chemistry could be mostly attributed to inadequacy in laboratory use, availability of laboratory materials and teacher’s academic qualification. This affects the ability of student’s to manipulate apparatus, make observations, record the observations and draw graphs.

Pearson Product Moment Correlation test results on relationship between availability of laboratory materials and student’s academic performance revealed that there was a significant strong positive relationship at 0.05 significance. Likewise, Pearson Product Moment Correlation test results on use of laboratory and student’s performance in Chemistry shows that there was a significant moderate relationship at 0.05 significance. Finally, Spearman’s Rank Order Correlation test results on teacher’s academic qualification and student’s performance in chemistry revealed that, there was a significant strong positive relationship at 0.05 significance.
The results were in line with the general literatures, in that availability of laboratory materials, use of laboratory and teacher’s academic qualification have positive relationship with students’ academic performance in Chemistry.
CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarises the findings of the entire research concerning the relationship between chemistry laboratory work and students’ academic performance in chemistry. The information was obtained through; questionnaires, observation checklist and score sheets form. The chapter also includes a conclusion derived from the findings, and on which basis recommendations are made. Actions based on the findings are proposed, ending the chapter with suggestions for further research.

5.2 Summary

The purpose of this study was to find out the relationship between Chemistry Practical work and students’ academic performance in Chemistry in Kilifi North Constituency. Three null hypotheses were drawn in line with the objectives of the study, as listed below:

H_{01}: There is no relationship between availability of laboratory materials and student’ academic performance in Chemistry. Test: Pearson Product Moment Correlation of Coefficient.

H_{02}: There is no relationship between use of chemistry laboratories and students’ academic performance in chemistry. Test: Pearson Product Moment Correlation of Coefficient.

H_{03}: There is no relationship between teacher academic qualification and students’ academic performance in Chemistry. Test: Spearman’s Rank Order Correlation.

The result of this study found that, there exist a significant positive relationship between; availability of laboratory materials, use of Chemistry laboratory, teacher’s academic qualification and students’ academic performance in Chemistry. Thus all the null hypotheses were rejected.
5.3 Conclusions

The study set out to find the relationship between chemistry practical work and students’ academic performance in Chemistry. The research findings revealed that; availability of laboratory materials, number of Chemistry laboratory sessions attended by students and teacher’s academic qualification determines the student’s academic performance in Chemistry.

It can be concluded from the research that availability of laboratory materials, use of Chemistry laboratory and teacher’s academic performance are core to students’ academic performance in Chemistry practical.

5.4 Recommendations

5.4.1 Policy Recommendations

Based on the findings, the researcher made the following recommendations:

1) Given that secondary education is part of basic education MoEST (2007), the government should ensure that educational resources like laboratories are adequate in all categories of secondary schools.

2) The government should introduce refresher courses targeting science teachers who should remain relevant in the dynamic world full of new scientific knowledge, discoveries and concepts.

3) Teacher’s Service Commission should raise the minimum qualification for secondary teachers to a degree.

4) Students should be given more opportunity to experience science by being exposed more to practical work which may enhance better performance in science subjects.
5.4.2 Recommendations for Further Research

This study, while it has achieved its purpose, has raised a number of other questions that warrant further research. Additionally, the methodology and findings of this study open up several avenues for further research and discussions.

1) Another study should be carried out in another locale for the sake of comparison of the results

2) Another study should be conducted to explore other factors that could be contributing to poor performance in Chemistry in Kilifi North Constituency, Kilifi County other than laboratory work

3) Study on the relationship between students’ performance in primary science and student’s performance in chemistry to determine whether students’ performance in primary science affects his/her performance in Chemistry

4) Study on the relationship between Chemistry practical work and student’s academic performance in Chemistry applying experimental design.
REFERENCES


Fuller, R. (1985). Raising school quality in developing countries what investment boots learning?


Appendices

Appendix 1: Chemistry Teachers Questionnaire (CTQ)

School Code _____________

(To be completed by chemistry teachers in Kilifi North constituency)

The purpose of this questionnaire is to solicit information about you and concerning laboratory work in chemistry from practicing teachers of chemistry in Kenya’s secondary schools.

Your kind and honest cooperation will go a long way in assisting to achieve the goal of this study, which is to enhance the participation of both the teacher and the students in practical work in chemistry for effective teaching and learning.

Instructions

Please provide responses to questions in all sections. The information obtained will be treated with strict confidence. You need not write your name anywhere in this questionnaire. Tick [✓] the relevant or appropriate answer or fill in the blank spaces. There is no correct or wrong answer.

Section A: General information about the teacher and school.

1) Type of school: Boys only [ ] Girls only [ ] Mixed [ ]
2) Number of form four streams: 1 [ ] 2 [ ] 3 [ ] 4 [ ]
3) Gender: Male [ ] Female [ ]
4) For how long have you been teaching chemistry? (Give your answer to the nearest number of years) ________________

Section B: Teacher’s Academic Qualification and Use of Chemistry Laboratory

5) What is the highest level of education you have attained:
   S1 [ ] Diploma [ ] Degree [ ] Masters and above [ ] Others [ ].
   If your answer is OTHERS please specify __________________________
6) I take students for practical whenever we have chemistry practical lesson on the timetable: Not at all [ ] Sometimes [ ] Always [ ]
Section C: General information about laboratory work

Generally, which of the following is true?

7) Our laboratory has **enough working space** for all the students in the class/stream:
   
   Strongly Disagree [ ]  Disagree [ ]  Agree [ ]  Strongly Agree [ ]

8) Our laboratory has **adequate stools** for all the students in the class/stream:

   Strongly Disagree [ ]  Disagree [ ]  Agree [ ]  Strongly Agree [ ]

Thank you for accepting to participate in this study.
Appendix 2: Students’ Questionnaire (SQ)

School Code ________________   Student Code ____________

(To be completed by F/4 students in Kilifi North constituency)

The purpose of this questionnaire is to solicit information concerning practical work in chemistry from F/4 chemistry students in Kenya’s secondary school. Your kind and honest co-operation will go a long way in assisting to achieve the goal of this study, which is to enhance the participation of students in practical work in chemistry for their own benefit.

Instructions

Please provide responses to questions in all sections. The information obtained will be treated with strict confidence. You need not write your name anywhere in this questionnaire. Tick [✓] the relevant or appropriate answer or fill in the blank spaces. There is no correct or wrong answer.

Section A: Students background information.

1) Type of school: Boys only [ ]  Girls only [ ]  Mixed [ ]
2) Gender:   Boy [ ]  Girl [ ]
3) Age (in years):  16-17 [ ]  18-19 [ ]  20-21 [ ]  22 and above [ ]
4) Number of form four streams: 1 [ ]  2 [ ]  3 [ ]  4 [ ]

Section B: Use of Chemistry Laboratory

5) How many sessions do you attend chemistry practical lessons per term?
   0-2 [ ]  3-6 [ ]  7-10 [ ]  11-13 [ ]

6) We go for practical whenever we have chemistry practical lesson on the timetable:
   Not at all [ ]  Sometimes [ ]  Always [ ]

Thank you for accepting to participate in this study.
Appendix 3: Observation Checklist

School Code ________________

1) Type of school: Boys only [ ] Girls only [ ] Mixed [ ]

2) Number of form four streams: 1 [ ] 2 [ ] 3 [ ] 4 [ ]

3) Does the school have a laboratory? YES [ ] NO [ ] OTHERS [ ]
   How many laboratories does the school have? 1 [ ] 2 [ ] 3 [ ] others [ ]

4) Indicate availability of the following provisions by ticking [√] in the appropriate column depending on the ratio of materials to students in the laboratory as described below:
   Not Available (NA) 0 Sparsely Available (SA) 1:3
   Moderately Available (MA) 1:2 Highly Available (HA) 1:1

<table>
<thead>
<tr>
<th>Facilities</th>
<th>NA</th>
<th>SA</th>
<th>MA</th>
<th>HA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stands and Clamps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 ml Burettes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250 ml Volumetric flask</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 ml Pipettes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>250 ml Conical Flasks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 ml Beakers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiling tubes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test tubes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop Watches</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermometers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Indicate availability of the following provisions by ticking [√] in the appropriate column in the laboratory as either available or not available.

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Available</th>
<th>Not Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fume cupboard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighing balance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical and apparatus store</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunsen burner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping system; tap water and sinks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Indicate availability of the following solid chemicals by ticking [√] in the appropriate column in the laboratory to indicate their quantities in Kilograms (kg) per year in the
ratio of 1:2:3:4 in 1 streamed 2 streamed 3 streamed and 4 streamed schools respectively as described below:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>NA</th>
<th>IS</th>
<th>S</th>
<th>HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium hydroxide</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium chloride</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barium nitrate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium carbonate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium hydrogen carbonate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead chloride</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc sulphate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron sulphite</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron III sulphate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium thiosulphate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper sulphate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium powder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium permanganate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Indicate **availability** of the following liquid chemicals by ticking [✓] in the appropriate column in the laboratory to indicate their quantities in **Litres per year** in the ratio of 1:2:3:4 in 1 streamed 2 streamed 3 streamed and 4 streamed schools respectively as described below:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>NA</th>
<th>IS</th>
<th>S</th>
<th>HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitric acid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 4: Students’ score sheet

Students’ Kilifi joint examination end of term II, 2014 Chemistry score sheet

<table>
<thead>
<tr>
<th>Chemistry paper 3 (practical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
</tr>
<tr>
<td>32</td>
</tr>
<tr>
<td>31</td>
</tr>
<tr>
<td>31</td>
</tr>
<tr>
<td>32</td>
</tr>
<tr>
<td>31</td>
</tr>
<tr>
<td>35</td>
</tr>
<tr>
<td>34</td>
</tr>
<tr>
<td>29</td>
</tr>
<tr>
<td>32</td>
</tr>
</tbody>
</table>
Appendix 5: Certificate of Ethical Approval

![Certificate of Ethical Approval]

THIS IS TO CERTIFY THAT THE PROPOSAL SUBMITTED BY:
Mr. Jairus B. Khamali

REFERENCE NO:
ERC/MED/002/2013

ENTITLED:
The Relationship between Chemistry Laboratory Work and Students Academic Performance in Chemistry

TO BE UNDERTAKEN AT:
Kilifi North, Kenya

FOR THE PROPOSED PERIOD OF RESEARCH
HAS BEEN APPROVED BY THE ETHICS REVIEW COMMITTEE
AT ITS SITTING HELD AT PWANI UNIVERSITY, KENYA
ON THE 8th DAY OF NOVEMBER 2013

CHAIRMAN
SECRETARY
LAY MEMBER

[Signature]
[Signature]
[Signature]
Appendix 6: Letter to the Principal

LETTER TO THE PRINCIPAL

Jairus Khamali
Pwani University
P.O.BOX 195
Kilifi

Dear Principal

Re: Permission to Conduct Research

I am requesting permission to conduct research in your school. I am currently doing Masters Degree in Mathematics and Science Education. As part of my studies, I am doing a research in investigating the relationship between Chemistry laboratory work and students’ academic performance in Chemistry in Kilifi North Constituency, Kenya.

With your permission, data will be collected using questionnaires, observation schedule and mark sheets. The tools will be administered by the researcher assisted by chemistry teachers and laboratory technicians.

I intend to protect your school and students’ anonymity and confidentially. Their real names will not be used in the final report. I will remove any reference to personal informal that might allow someone to guess the school’s name and student’s identity.

Remember that the school is not obliged to participate and may withdraw at any time during the study. If you require any further information about the research, do not hesitate to contact the researcher.

Jairus Khamali

……………….
Appendix 7: Consent Form

RESEARCH ETHICS CONSENT FORM
The relationship between chemistry laboratory work and students’ performance in chemistry, in Kilifi North Constituency, Kenya.

PART 1: GENERAL INFORMATION ABOUT THE STUDY

You are invited to participate in research about the relationship between chemistry laboratory work and students’ academic performance in chemistry, in Kilifi north constituency, Kenya. Jairus Bulimo Khamali a master’s student in the School of Education, Pwani University, will conduct the study.

Participation in this study is voluntary. If you agree to participate in this study, you will be requested to fill out questionnaires, soliciting for relevant information on the subject.

Participating in this study may not benefit you directly, but the information that you provide will help us learn more about persistent challenges related to chemistry laboratory and how they could possibly be addressed. You may skip any questions that you do not want to answer.

We assure you that all the information that you share with us through your participation in the study will be kept completely confidential. When the study is completed and data analysed, any information that could link you to study will be destroyed. Study findings will be presented in summary and your name will not be used in any report.

If you have any question about this study contact:

Jairus Bulimo Khamali, Tel Number 0726400761 Email kajairofirst@yahoo.com

Kindly note that this proposal has been reviewed and approved by Ethics Review Committee (ERC) of Pwani University, a committee whose task is to make sure that research participants are protected from harm. If you wish to find more about the ERC, please contact the ERC secretariat Pwani University.
PART II: CERTIFICATE OF CONSENT

I have read the foregoing information. I have had the opportunity to ask questions about it, and all my questions been answered to my satisfaction. I therefore give my consent to voluntarily participate as a respondent in this research.

Print Name of Participant

Signature of Participant

Date  Day/Month/Year

Statement by the Researcher/Person taking consent

I have accurately ready out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands that the following will be done:

1. A questionnaire will be administered

2. Confidentiality will be upheld.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this informed consent form has been provided to the participant.

Print Name of Researcher/ person taking consent

Signature of Researcher/ person taking the consent

Date
Day/Month/Year

If this sounds okay with you and you would like to be in the study, please sign.

<table>
<thead>
<tr>
<th>Name of participant</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Researcher: Jairus B Khamali</td>
<td>Signature</td>
<td>Date</td>
</tr>
</tbody>
</table>
Appendix 8: Kilifi County Map