

**USE OF SCIENTIFIC LANGUAGE IN
INSTRUCTION AND PERFORMANCE IN
CHEMISTRY: A STUDY OF SELECTED
SECONDARY SCHOOLS OF KABARNET
DIVISION, BARINGO DISTRICT, KENYA**

BY

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DECLARATION

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

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DEDICATION

This Thesis is dedicated to my son Emmanuel and daughters, Purity and Joy, with the prayer that they will diligently follow my foot steps in pursuit for knowledge that will transform livelihoods of many generations after them.

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ABBREVIATIONS AND ACRONYMS

B.Ed – Bachelor of Education

BS – Boys’ school

B.Sc – Bachelor of Science

C.A.Ts – Continuous Assessment Tests

D.E.O - District Education Officer

Dip. (Sc) Ed. – Diploma in science Education

GS – Girls’ school

IUPAC -International Union of Pure and Applied Chemists

K.C.S.E -Kenya Certificate of Secondary Education

K.I.E - Kenya Institute of Education

KNEC - Kenya National Examinations Council

K.S.T.C. - Kenya Science Teachers College

MoE - Ministry of Education

MS – Mixed school

N.C.S.T – National Council for Science & Technology

P.D.E. - Provincial Director of Education

P.G.D.E – Postgraduate Diploma in Education

S.I – stands for a French phrase *Système Internationale d’unités*, which means

International System of units.

SMASSE-Inset -Strengthening Mathematics and Sciences in Secondary Education In-service Training

ABSTRACT

The language barrier could account for the difficulty that learners and teachers find within science education leading to low performance in the science subjects at the secondary school level. The language used by chemistry teachers when presenting science concepts, principles and skills during the process of instruction may attract students to the study of chemistry (swing towards chemistry) or may discourage them (cause a swing away from chemistry). Thus, the use of language of instruction deserves careful attention. This study was therefore conducted to determine teachers’ ability to highlight and explain the meaning of scientific terminology related to chemistry. The primary focus of the study was to establish the relationship between teachers’ professional training and experience and their ability to highlight and explicitly explain scientific terms encountered during instruction. The study was also interested in finding out if students grasped a number of selected scientific terms the teachers used during instruction and if there was a difference between boys’ and girls’ performance in Chemistry in relation to scientific language. The study employed a cross-sectional survey design. The target population from which the sample for the study was drawn comprised all public secondary schools in Kabarnet division of Baringo district, Kenya. A total of twenty seven (27) chemistry teachers, six of whom took part in lesson observation sessions, and two hundred and

seventy (270) Form three chemistry students participated in the study. Chemistry Teachers' Questionnaire (CTQ) and Lesson Observation Schedule (LOS) were used to solicit information regarding teachers' professional training and experience and their ability to highlight and explain scientific terms related to chemistry. Students Interview Schedule (SIS) and the Chemistry Achievement Test (CHAT) were used to obtain information on students' understanding of scientific terms encountered during instruction and to determine if there was a significant difference with respect to boys' and girls' performance in chemistry regarding scientific language. Boys' and girls' performance in the CHAT was analyzed using the mean and the t-Test whereas the relationship between teachers' professional training and experience and their ability to highlight and explain scientific terms were analyzed using frequency distribution and chi-square (χ^2) test. The study revealed that chemistry teachers' professional training and experience has no direct relationship with their ability to highlight and explain scientific terms related to chemistry. Similarly, boys' and girls' performance in chemistry did not differ significantly. Based on the results of this study, the findings raise questions pertaining to the inconsistency between chemistry teachers' professional training and experience and their ability to emphasize scientific terms that label a range of concepts; students' inability to grasp meanings of scientific terms of chemical nature; and whether or not the skill to learn scientific terms is actually developed in the context of content delivery.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Problem

Science occupies an essential part in the school curriculum. How science should be taught and what specific contributions it makes are two key areas that are frequently explored. Unfortunately, for a number of reasons, some science teachers may fail to realize fully the great potential science plays in promoting the broad, overall goals of national development (Muwanga-zake, 1998). Although science remains prominent in today's secondary school curriculum, it is important to note that science subjects have continued to be performed poorly by students in secondary schools and national examinations. For example table 1.1 shows the overall K.C.S.E performance in chemistry for the years 2004 to 2007.

Table 1.1: National Overall Performance (mean scores) in Science Subjects for the Years 2004-2007.

Year	Mean score (%)		
	Biology	Physics	Chemistry
2004	30.67	25.18	20.85
2005	25.99	25.88	20.03
2006	27.44	40.31	24.91
2007	41.95	41.31	25.39

Source: The KNEC: The Year 2008 KCSE Examination candidates' Performance Report.

The following observations can be made from table 1.1:-

- (i) The overall performance in science subjects is low.

(ii) Slight improvement in performance of chemistry was registered in the year 2006 with a mean score of 24.91 up from 20.03. This happens to be the year when Chemistry was offered under the revised curriculum.

(iii) The overall performance in Chemistry is quite low compared with the other science subjects.

Baringo district and Kabarnet Division, Kenya, overall performance in science subjects was also considered in relation to the national overall performance. Tables 1.2 and 1.3 show the disparity in the performance.

Table 1.2: Baringo District Overall Performance (mean score/grade) in Science Subjects for the Years 2004-2007

Year	Mean score/grade(12 points)		
	Biology	Physics	Chemistry
2004	5.93(C)	4.56(C ⁻)	4.35(D ⁺)
2005	5.14 (C ⁻)	5.94 (C)	4.03 (D ⁺)
2002	5.51 (C)	7.10 (C ⁺)	4.38 (D ⁺)
2007	7.51 (B ⁻)	6.79 (C ⁺)	4.49 (D ⁺)

Source: District Education Office, Kabarnet

According to KNEC regulations and syllabus 2007-2008, subject results are indicated by grades from A to E as follows: -

Very Good	Good	Average	Weak	Poor
A	B ⁺	C ⁺	D ⁺	E
A ⁻	B	C	D	
	B ⁻	C ⁻	D ⁻	

Where A: 11- 12, B: 8 – 10, C: 5 – 7, D: 2 – 4, E –1 points

(KNEC, 2008).

It is worth noting, from table 1.2, that,

- (a) The overall performance in Chemistry is lower than in Physics and Biology at the district level, a trend similar to the case at the national level.

- (b) There is a slight general improvement in performance in Chemistry between the year 2004 and 2007.

Table 1.3 Kabarnet Division Overall Performance (mean score/grade) in Science Subjects for the Years 2004-2007

Year	Mean score/grade (12 points)		
	Biology	Physics	Chemistry
2004	6.54(C ⁺)	5.54(C ⁻)	4.43(D ⁺)
2005	6.21 (C)	6.04(C)	4.08 (D ⁺)
2006	5.96 (C ⁻)	7.16(C ⁺)	4.78 (C ⁻)
2007	6.64(C ⁺)	6.83 (C ⁺)	4.70 (C ⁻)

Source: District Education Office, Kabarnet

It is imperative to note, from table 1.3, that performance in Chemistry at the divisional level is slightly higher than in the district level. But the trend is the same as in both the district and national levels where performance in Chemistry is lowest.

In general, the information in the tables indicates that the overall performance in science subjects is generally low, with Chemistry being the least performed of the three at all levels. This low performance in science subjects in general and Chemistry in particular could be attributed to several factors. For instance, Muwanga-zake (1998) reported that;

- a) Teachers and learners generally perceive science as difficult.
- b) Teachers misrepresent their own content in the science classrooms.
- c) Students' attitudes towards science (Chemistry) influence their understanding of science concepts.

- d) Inadequate resources such as textbooks, laboratory equipment and chemical reagents.
- e) Students' language as a barrier and
- f) Language that teachers use in instruction.

Language used by teachers is getting increasingly important as Atwater (1996)

notes:

Traditional science teachers view science as being independent of mind or social context. This could be one of the reasons why language has not been considered important until lately (Atwater, 1996:828)

The language must be distinctly clear in expressing subject matter since what may be very clear to the teacher may be so much meaningless jargon to the learner. According to Henderson and Wellington (1998) for many learners the greatest barrier to learning science is language. The problem is that like many other African countries, Kenya has developed curricula and content that teaches science mainly in the second language, which is English. Thus, the majority of students may not comprehend quickly enough what is written or taught and thus may result into misconception. Further complications arise from the difference between the normal scientific English (for example compound, diffusion or molecule) that demands clarity and common English language (such as displace, essential or spontaneous) usage. Kenyans suffer additional problems in that there could be no direct translation of a scientific concept in vernacular. For example, the terms smoke, gas and steam may all be referred to, by one general term, as 'aros' in Kalenjin (the first language of

most students in the region the research was conducted). This concern has been noted by a number of scholars. For example Cleghorn (1988) notes,

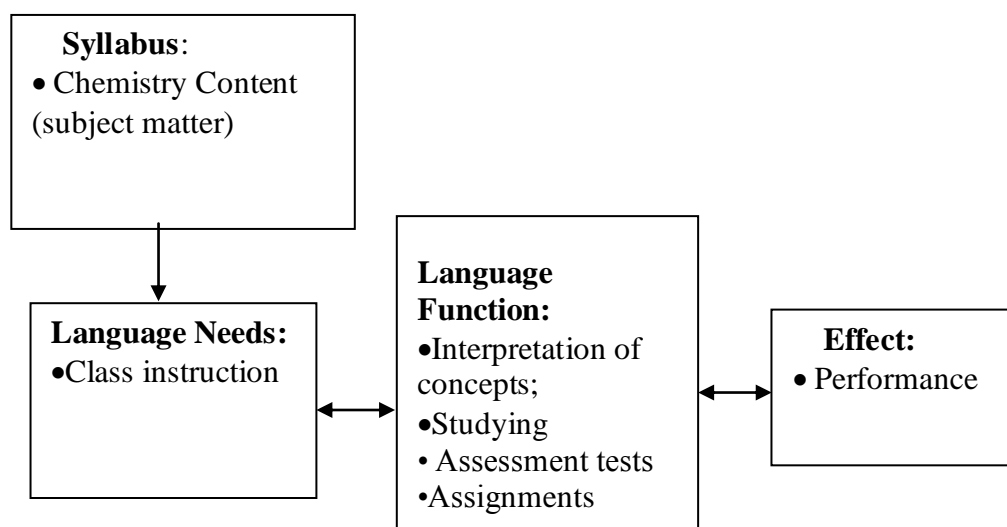
Teachers have difficulty in expressing science concepts via English and especially in relating the abstract world being created in the classroom to the concrete world outside. Language of instruction effects on teaching practices and schooling outcomes is an aspect of education in developing countries that has received scant attention. The language of instruction becomes an important target language to be mastered so that full access to the benefits of secondary schooling can be obtained (Cleghorn, 1988:2).

Thus, the language barrier could account for the difficulty that learners and teachers find within science education leading to low performance in the science subjects in the secondary school level. The language used by Chemistry teachers when presenting science concepts, principles and skills during the process of instruction may attract students to the study of chemistry (swing towards Chemistry) or may discourage them (cause a swing away from Chemistry). Thus, the use of language of instruction deserves careful attention.

1.2 Conceptual Framework

The Chemistry content is usually expressed in the syllabus and textbooks. The teachers have to plan for instruction and it is while planning and teaching that the language effect impacts. The following figure represents the conceptual framework that guided the present study.

Figure 1.1 conceptual framework of the research study.



The Chemistry Syllabus:

This is the blueprint that guides the teacher when planning for instruction, for example when making schemes of work. In the syllabus the objectives are defined and the content spelt out more specifically to give better guidance to the teacher. The syllabus is compiled in such a way that mastery of the knowledge, concepts, skills and attitudes should be achieved by the end of the secondary cycle. The technical terms (part of the knowledge aspect) that formed the observation schedule were obtained from the syllabus and/or schemes.

Language Needs:

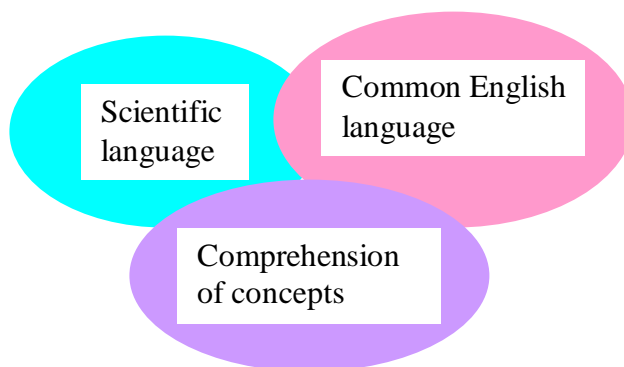
According to Jones (2000), the language of science is a purpose-designed tool used in specific contexts to meet specific needs. Students gain access to scientific ideas through language. Thus language is central to learning. It is important that Chemistry teachers clarify scientific facts and principles using a simple and appropriate language that can be comprehended by learners.

Learners should have a grasp of the language; both the ordinary English and the scientific language, to enable them understand subject matter when studying the subject.

Language Function:

Language is a way of making previous and present knowledge clear. Thus the language of instruction and the specialized scientific language play a significant role in the interpretation of concepts as illustrated in figure 1.2.

Figure 1.2: Interplay of language and comprehension of concepts



The process of thought is dependent on the growth in language. The ultimate sign of understanding a subject is the ability to convey one's knowledge in effective presentational or transactional language. Hence if learners are to get a good understanding of the language as an interpretive system, they must have experience of using it that way themselves (Sutton, 1974).

Effect of Language:

Proper use of the language in Chemistry lessons affects the performance of students. O'Toole and Dalton note;

Recent research indicates that the words used in science instruction provide difficulties for a wide range of secondary students. Some of these difficulties are 'science' based; some are 'language' based and some a mixture of the two. It seems clear that language difficulties hamper some students' performance in science (O'Toole and Dalton, 1981:95).

Mastery of both the language of instruction and the specialized scientific language by students, according to O'Toole and Dalton's argument, leads to high performance in chemistry.

1.3 Statement of the Problem

Just as knowing the language of a country helps one to understand the culture of the country, so knowing the language of science helps to understand the concepts of science. It helps because terminology, vocabulary and language itself are only tools used to help communicate the concepts of science (Carin and Sund, 1980). Chemistry is a subject in the secondary school curriculum with a specialized language with a set of terms and symbols that have unique meanings which require careful approach.

The low performance in science and specifically Chemistry noted in tables 1.1, 1.2 and 1.3 could be attributed to failure by Chemistry teachers to use correct technical terms special in chemistry and/or explicitly explain the specialized scientific language encountered during instruction. The study set out to investigate the use of language insofar as it affects comprehension of

selected scientific terminology by learners. Understanding of key concepts is likely to raise performance in school Chemistry.

1.4. Objectives of the Study

The purpose of the study was to establish whether language contributes to students' low performance in Chemistry in some selected secondary schools in Kabarnet Division of Baringo District, Kenya. The study was intended to achieve the following specific objectives:-

1. To determine if Chemistry teachers highlight and explain the meaning of technical terms special in Chemistry encountered during instruction.
2. To establish whether teachers' professional training and experience had any correlation with their ability to highlight and explain the meaning of technical terms special in Chemistry subject encountered during instruction.
3. To determine whether definitions and explanations of technical terms in Chemistry textbooks were sufficient, relevant and appropriate to the intellectual level of the intended learners.
4. To determine if there was a significant difference between girls' and boys' performance in Chemistry in relation to the scientific language.

1.5. Research Questions

This research sought to answer the following questions.

1. Did the chemistry teachers highlight and effectively explain meaning of technical terms special in Chemistry encountered during classroom discourse?
2. Was there a significant correlation between the teacher's professional training and experience and his/her ability to highlight and explain the meaning of technical terms special in Chemistry encountered during instruction?
3. Were the definitions and explanations of technical terms given in Chemistry textbooks adequate and appropriate to the level of the intended learners?
4. Was there a significant difference between girls and boys in responding to concepts related to scientific language?

1.6 Significance of the Study.

This study would hopefully help teachers to facilitate instruction and hence improve the overall learning outcome. The findings of the research would also be useful to curriculum developers of science at K.I.E. who develop chemistry syllabus. The findings would draw their attention to the language appropriate to the students' level of comprehension.

According to Soltis (1978) an important part of the process of training educators is getting them to learn and fully understand the complex language

and the ideas and relationships it concerns. Thus the research findings might help teacher training institutions to recommend more effective choice of language during instruction. This would enhance the use of appropriate science language among teacher trainees. The findings of the research might also add to the existing body of knowledge on difficulties associated with the language of science.

1.7 Basic Assumptions of the Study

The researcher based the study on the following assumptions:

1. The language appropriate to the students' level of comprehension is a function of their class texts and syllabus.
2. It was hoped that the 'Hawthorne effect' would be minimal.
3. Both boys and girls perform at the same level both in Chemistry and proficient in the language of instruction.
4. There is no difference in performance among students in day and boarding public schools.

1.8. Scope and Limitations of the Study

The study was carried out in Chemistry classes in Kabarnet Division of Baringo District, a rural setting. Thus the results might not be generalized, as they are not representative of all Kenyan secondary schools. The results would only be adequate for descriptive purposes. The study was limited to Form three students who were taking chemistry as an examinable subject at K.C.S.E. level. Form four chemistry students were not selected since they

were candidates for the annual KNEC examinations and schools usually would not wish to have these candidates' classes interrupted. Schools with students with special needs and private schools were not involved in the study since none of these categories of institutions was available in the said division.

DEFINITION OF TERMS

Blind folding (lucky-dip) – is a technique used to randomly select schools to participate in the study by writing down all the schools according to their strata. Each school is given a number, the number representing the school are written on separate papers which are folded and placed in separate containers and a research assistant will be asked to pick a certain specified number from each category.

Decoding - the process of trying to understand the meaning of a word, phrase or a sentence or the interpretation of any set of symbols which carry a meaning.

Hawthorne effect – Refers to a situation where the presence of a research Observer may affect the natural behavior of respondents.

Intellectual abilities - refers to organized modes of operation and generalized techniques for dealing with material and problems. These abilities include knowledge of facts comprehension and application

Performance – means the student's ability to think, reason and solves problems and this is indicated by the score attained in Chemistry assessment

Scientific attitudes – Refers to qualities a scientist (or anyone) should possess in order to successfully solve problems.

Scientific language — refers to the skills of communication through speaking and listening. It is necessary to be able to discuss scientific facts, to articulate one's own interpretations of the facts and be able to share the result of investigation.

Stream – When students in the same grade are allocated to and taught in different rooms, then each group forms a stream. For example, if there are four Form three classes in a given school, then there are four Form three streams in that school.

8.4.4 System – This is a Kenyan system of education of eight years of primary education, four years of secondary education and four years of university education.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

For the purpose of this research study, the review of related literature was done under four sub-headings:- Role of language in the teaching and learning of science; learning associated with scientific and non-scientific language; language use in the chemistry classes and literature on related studies done in Kenya.

The role of language in the teaching and learning of science was examined with particular emphasis on special qualities inherent in the language of instruction. Learning associated with scientific and non-scientific language mainly highlighted on scientific vocabulary (technical terms special to chemistry e.g. crystallization, sublimation etc) and the language of instruction, common English usage, needed in order to cope with scientific subject matter associated with learning.

Language use in the chemistry classes is key to understanding how chemistry teachers communicate scientific principles, concepts and facts to students and the ability of students to comprehend and articulate scientific knowledge learned. The key to ensuring comprehension of a particular concept by students is both the teacher's and students' responsibility: Teachers should clearly and precisely present it in a language that can be easily coded by the

students. This chapter also briefly highlighted some related studies already done in Kenya.

2.2. Role of Language in the Teaching and learning of Science

Language is a medium of communication. Communication, according to Rowland and Birkett (1992), is the sharing of information, attitudes and feelings by words, tones and behavior. Reasons for communicating include gaining or passing ideas or knowledge, getting or giving help, learning or teaching, changing ideas, persuading and negotiating. Communication involves the receiver of a message and understanding it in the way the sender intended. If the message is not interpreted in this way then there has not been effective communication.

The language of instruction occupies a very important part in the teaching and learning process. The teacher's competence in presenting the scientific knowledge using language appropriate to the learner's level of comprehension determines the effectiveness with which teaching and learning takes place. Presentation of the scientific knowledge, concepts and skills using appropriate language is largely dependent on the teacher's experience and training, since a good teacher is a product of among other factors, experience and training. Learning science thus means learning to use the language of science through opportunities to practice the talking, reading and writing of science (Kuria, 1999; Jones, 2000).

All human activities have developed special terminologies to simplify the description of facts, methods and processes. Parts of these terminologies slowly enter common usage and jointly form our common language. Others remain confined in the special field. Science has not only created a terminology to describe its observations but has also developed a language corresponding to a way of thinking. The scientific language is usually more precise and rigorous than common English language; it is ‘a purpose-designed tool’, used in specific contexts to meet specific needs and uses abstractions with which most people are not familiar. Science concepts can be communicated by use of words, signs and symbols. These include graphs, charts, diagrams, mathematical symbols, chemical symbols (such as Na to stand for sodium) and formulae (for example, NaCl for sodium chloride) and chemical equations (for example, $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$). Hence it is essential for science teachers to be aware of how these signs and symbols can be instrumental in helping students to develop scientific concepts in classroom discourse. The scientific language is molded on a special attitude of the mind and therefore, it does not easily lend itself to precise translation. For full enjoyment of science, at least some of the scientific language must be learned, and the most appropriate place in which to learn it is school (Jones, 2000).

Carin and Sund (1980) note that the language of science, like all other languages, has its own rules, structure, easy and difficult parts and peculiarities. Parkinson (1994) notes that learners often become confused over words that sound or look similar, have difficulty with words that have

one meaning in everyday use and another, sometimes completely different, meaning in science. For instance ‘salt’ is a technical term in chemistry that refers to a chemical compound formed when a metallic ion combines with a non-metallic ion. For example;

$\text{Na}^+ + \text{Cl}^- \rightarrow \text{NaCl}$, (where Na^+ is the metallic ion, Cl^- is the non-metallic ion and NaCl is the salt). In everyday use, a salt refers to a substance used to season and preserve food. Allan (1974) points out that language of science also conveys its processes and thinking patterns, along with its concepts, ideas, facts, principles and theories. Like all other languages, the language of science must be taught, practiced and used constantly if the learner is to become proficient with its use (Carin and Sund, 1980).

The functional approach to teaching science is to introduce new scientific vocabulary where there is a need for it in conjunction with new principles. Scientific terms should be employed in discussions to illustrate their meanings and in making applications. For example, if the major concept is salts and the new scientific term to be introduced is solubility of salts, then the effect of temperature or the polar nature of water molecule could be included when discussing solubility of salts in water. Similarly, when a teacher says that crystals of copper (II) sulphate are blue, he or she is stating a ‘fact’ that only has meaning within the whole conceptual apparatus of elements, compounds and crystalline structure. When heated it turns white, is the statement that ‘the crystalline structure breaks down when the bound molecules of water are driven off as steam, leaving anhydrous copper (II) sulphate powder, which

does not absorb light of the same wavelength'. The language in which observations are recorded presupposes a view of the world that is not simply 'given' (Glaxton, 1991).

Language is the medium through which students gain access to scientific ideas, and when sufficient attention is paid to presenting language, this can facilitate learning. Words special to science subjects ought to be presented to the learners with deliberate care. The language teachers use in presenting scientific concepts, principles, skills and knowledge should be simple and easy to comprehend. This makes it easy for learners to grasp what is being presented and apply it in their daily experiences (Schofield, 1974). The process of thought itself is dependent on growth in language since the ultimate sign of understanding a subject is the ability to convey one's knowledge effectively. The importance of language in successful learning should be constantly promoted as a priority (Robson, 1986).

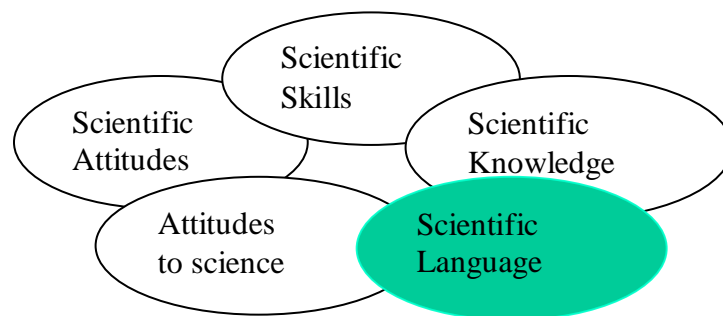
Farmery (2002) identifies four aspects of science; body of scientific knowledge, a collection of scientific skills, scientific attitudes and a unique scientific language and that science is a complex involving interplay of these four aspects. According to the author;

- (a) **Scientific knowledge** (also referred to as the content of science) implies that what constitute science are not the individual pieces of knowledge it provides but how we make sense of the knowledge.

- (b) **Scientific skills** – serve to reinforce scientific knowledge being taught, lead to the development of scientific attitudes and contribute widely to the study of a science as a whole.
- (c) **Scientific attitudes** – science is a way of thinking (through the demonstration of the ability to think through problems).
- (d) **Scientific language** - The skills of communication through speaking and listening. This thus indicates need for the development of a knowledge and understanding of scientific language for ideas and phenomenon in science. It is the language of science that allows scientists from all backgrounds, cultures, countries and language bases to communicate.

Farmery (2002), in defining science, as involving scientific skills, knowledge, language and attitudes, formulated a model of the interplay of these aspects:

Figure 2.1. Farmery model of the interplay of the scientific aspects.



Attitudes of science – Science involves a belief in science as being able to provide information for all.

Scientific attitudes – science involves having ideas about natural phenomena and having reasons why those ideas matter.

It is therefore essential that students are able to articulate their thoughts and the development of appropriate scientific vocabulary as one of the main aims of scientific learning. It is impossible to dissociate language from science or science from language.

The language scientists communicate in must be capable of precise descriptions of the complex problems and concepts. For example such terminologies as flammable or inflammable may be confusing to students. To some students inflammable might mean something that does not easily catch fire, yet both terms mean 'can easily catch fire'. Concepts can be communicated by verbal, mathematical or diagrammatic symbols. Some writers have been much more forceful in justifying the role of language in learning. For example, Mallet and Newsome (1977) assert,

New learning is integrated with existing knowledge at the point of personal response. Speculative, open talk can also be the means by which all lessons are infused with vitality and meaning. (Mallet and Newsome, 1977:219)

Bell and Freberg (1985) assert that when a teacher talks to his or her class, draws a diagram on the chalkboard, discusses a chart on the wall or asks learners to read a textbook his or her intended meaning or that of the textbook author is not automatically transferred to the mind of the learner. Each individual in the classroom constructs his or her own meaning from a variety of stimuli, including specific words read or heard which are in the learning environment. How similar the constructed meaning is to that intended by the teacher depends on the way the learner copes with the language the teachers

use freely as their own main means of instruction. The foregoing assertions are strong arguments advanced in support of the importance of language, in particular verbal language, in learning science.

Language does not merely label objects or events. If learners are to get a good understanding of language as an interpretive system, they must have experience of using it themselves. Students' learning is in making sense of what is said or written. According to Mallet and Newsome (1977), Piaget recognizes language as an important means of crystallizing and communicating thinking. Vygotsky maintains that once a child gains control of language as an instrument of organizing thinking his or her whole intelligence is transformed (Mallet and Newsome 1977:8). Students thus, require language for trying to put new ideas into words, for fitting together new ideas with old ones in order to bring out new understanding. Language enables us to codify the input of our senses, and thus to organize and make sense of our experiences. The coding ability of the human mind allows us to create and to comprehend meaningful language out of all the raw linguistic substance available to us. Language facilitates our thinking processes and some internalization of experience is a prerequisite for meaningful language use. Edwards and Mercer observe that;

The overriding impression from our studies is that classroom discourse functions to establish joint understanding between teacher and learner, shared frames of reference and conception, in which the basic process is one of introducing learners into the conceptual world of the teacher and of the educational community... It is essentially a process of cognitive socialization through language (Edwards and Mercer, 1999:115)

Language, thus unlocks the fountain of scientific knowledge hence due emphasis should be accorded to it.

2.3. Learning Associated with Scientific and Non-Scientific Language.

The language of instruction may be classified into:-

- (a) Specialist Language – Peculiar to each subject, and
- (b) Language of instruction – which mainly presents special problems especially in relation to students' language experiences outside school.

2.3.1. Scientific Language.

When one thinks of the vocabulary of science, one immediately thinks of its specialist, technical terms such as physical concepts (for example mass, force, and energy), names of chemical elements (for example aluminium, chlorine) or processes (for example extraction, evaporation, distillation, diffusion or crystallization). Scientific language is not merely a collection of verbal labels for technical concepts. Concepts and their interrelationships are communicated to students by means of propositions. These propositions

require the student to have learned the syntax of the language (its grammatical structure, the way in which ideas are linked together) and to understand a large body of non-technical vocabulary as well (Johnstone, 1983).

Scientists tend to communicate by using a highly specialized language that incorporates signs and symbols to communicate their ideas. These include graphs, charts, diagrams, mathematical symbols, and chemical symbols (for example H = hydrogen) and chemical equations (for example $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$) as well as the common English language of instruction (Schofield, 1974; Ziman, 1995; Jones, 2000). The language used in diagrammatic, tabular or graphic form needs to be carefully and systematically selected and practiced so that students learn to read the intended meaning. Hence, it is essential for science teachers to be aware of how these signs and symbols can be instrumental in helping students to develop scientific knowledge and understanding in the classroom (Jones, 2000). For example, when a teacher asks students to write an equation representing a given chemical reaction or process e.g. when a teacher poses the following question to students:

Q. An atom of hydrogen forms different two ions. Write two equations to show how a neutral atom of hydrogen can form the two different ions.

This requires the students to have had prior knowledge on how hydrogen atoms behave as members of group I and group VII of the periodic table. Chemistry teachers need to elaborate the scientific language used during instruction. For example, consider the following sentence:

“Hydrogen stands alone among the elements of the periodic table. Its single electron might make feasible its classification with the alkali metals but hydrogen does not lose this electron easily to warrant such classification. By implication alkali metals lose their electrons easily.” For full understanding of the foregoing assertions, the learner must comprehend the scientific terms such as ‘hydrogen’, ‘periodic table’, ‘electron’, and ‘alkali metals’

2.3.2. Non-technical Language (Language of Instruction)

English, as a second language, has been selected as the language of instruction in many developing countries, Kenya being one, for the following reasons:

- (a) It serves as a unifying influence in countries with many differing vernaculars,
- (b) It can also provide access to a wide range of reference material needed for higher education and national economic development.

There are many words used in the teaching of science that may cause difficulties for students even though teachers would not consider them to be specialist scientific words. For example, Gardner (1972) gives a list of such words that were found to present problems to students. Such include disintegrate, random, spontaneous, rate, symmetrical, average, partial, reverse. Cassels and Johnstone (1985) carried out an extensive research on learners’ understanding of non-technical words and found out that non-technical words associated with science are a source of misunderstanding for students. Words that are understandable in normal English usage change their meaning when transferred into, or out of, a science situation. For instance, the word

‘volatile’ was assumed by students to mean unstable, explosive or flammable. The reason for such confusion is that volatile, applied to a person, implies instability or excitability and this meaning is naturally carried over into science context with consequent confusion (Gardner, 1980). ‘Gas’ and ‘steam’ are two common words which easily present difficulty. To learners these two words mean the same thing, yet they are different since steam is water in gaseous state.

2.3.3. Scientific (Technical) and Non-Technical Language Difficulties

Why Consider Language difficulties in Science? Gardner observes,

There is a growing recognition and acceptance among teachers that mastery of language is crucial to an understanding of every field of thought. One cannot divorce science from English language (Gardner, 1974:63)

Four answers to the above question may be proposed.

The first two of these involve the nature of science and scientific language.

The third involves the nature of science students and the fourth involves the nature of science teachers.

- (i) Inherent in the very nature of science are various intellectual processes such as stimulus, discrimination, description, classification, correlation and explanation. These processes generate vast numbers of new terms that become part of the technical vocabulary of science.

- (ii) There is a growing recognition that the comprehension of science involves much more than simply a comprehension of its technical vocabulary. Many words and phrases of 'ordinary' English are needed in order to cope with scientific subject matter; many take on specific shades of meaning when used in scientific discourse; many are used with considerably higher frequency in science than in ordinary everyday usage. Comprehension of such terms is clearly essential for a proper understanding of science.
- (iii) Although scientific discourse uses the same linguistic structures as 'ordinary' English, there are slight differences that can introduce difficulties for the learner. Word length and sentence length, both factors related to the difficulty of reading materials, are probably higher in scientific texts than in the English that a student might normally encounter. Scientific discourse also tends to make heavier use of the passive voice (e.g. the beaker was heated, the temperature was noted, it was concluded that...) and this style of communication may prove difficult for some students.
- (iv) There is also a small amount of research evidence to suggest that many teachers fail to communicate effectively with their students, by using vocabulary and grammatical patterns that are not yet part of their students' cognitive structure. This

communication gap between teachers and students is not uniquely the preserve of science teachers but it may be that the highly abstract nature of scientific discourse helps make the gap wider than it might be in some other disciplines. If it is indeed the case that teachers aggravate their students' difficulties because of the patterns of language they employ while they are teaching, then it follows that our concern ought to shift away from the student alone to the teacher and students as members of an interacting system (Gardner, 1974).

It may well be true that science is a difficult discipline because of its extensive specialist vocabulary, and its heavy demands on students' powers of abstraction and reasoning. It may also be true that many students lack the intellectual abilities needed to cope with science. However, it is too easy to dismiss the problem of language difficulties in science simply by arguing that they are inherent in the nature of science or in the nature of students. The teaching of science may be regarded as a task of translation of the thought patterns and findings of scientists into a form in which they become accessible to learners. The language patterns adopted by texts and teachers are often unintelligible to the student. Some thought-provoking examples of this are provided in an article describing research done by Barnes (1971) in England where he sought to investigate the patterns of language interaction between teachers and their students who were in their first term at secondary school. He tape-recorded twelve lessons in all, and made a study of the transcripts. Barnes (1971) used his transcripts to shed light on a

number of insights into the way language is used (and misused) in classrooms. His central and dominant theme is that there is frequently a gulf between the teacher and his or her students,

The teacher teaches within his frame of reference; the learners learn in theirs, taking in words, which 'mean' something different to them, and struggling to incorporate this meaning into their own frames of reference. The language that is an essential instrument to him is a barrier to them. (Barnes 1971:29).

Barnes (1971) argues that one direct cause of the communication gap between science teachers and their students is the over emphasis of technical terminology introduced for its own sake. Sometimes this terminology is simply unnecessary; sometimes it is introduced well in advance of the students' comprehension of the concept for which the technical term is merely a label. Hence there is need for teachers to simplify the language so that what is presented to learners can be understood.

It would be a mistake, however, to assume that difficulties with technical language are the sole source of language difficulty in learning science. Teachers and textbooks use large number of 'ordinary' English as they present technical subject matter. If the meanings of these non- technical terms are not understood, the meaning of technical subject matter may also be obscured. For instance, Gardner (1974) gives an example of personal experience in Papua - New Guinea. During an interview, a high school science student was asked, "What causes sound?" And he replied that sound is caused by vibrating objects. The interviewer then rapidly moved his hand back and forth several times and asked,

“Is my hand vibrating?” The reply was “no, because it is not making sound.” Clearly, for that student, a principle learned in school was learned as a meaningless verbatim; he did not know the meaning of the word vibrate and the ‘principle’ he had learned was nothing more than a tautology: sound-making objects vibrate. The anecdote illustrates the general propositions that certain words of ‘ordinary’ English are crucial to an understanding of scientific discourse, and that students may experience difficulty in science as a result of these difficulties with non-technical vocabulary. However, vocabulary difficulties of this kind are not perhaps the only source of difficulty with non- technical language. Two other sources of difficulty may contribute as well; these are associated with the use of unfamiliar linguistic patterns, even when the words themselves are familiar, and with the use of difficult logical connectives (e.g. moreover, consequently, if and only if). Comprehension of such terms is vital to an understanding of science. How then can learners be helped towards boldness, confidence and mastery? How can they be helped towards this language in such a way that it develops rather than retards their thinking? A bridge needs to be built between personal creative language and impersonal language. This is only possible when we express the new experience in our own language in our own way, taking over just so much of the new language of the subject as a right for us, trying it out and testing it. Rowland and Birkett (1992) advance three main areas where barriers to communication between the teacher and the learner may arise. These are,

- (a) The manner in which a message is sent.

- (b) The message itself.
- (c) The manner in which the message is received.

They suggest that teachers keep communication simple by using direct and clear language. If one has to use technical vocabulary, consider whether or not the receiver will know what you mean or whether some explanation may be necessary.

If the student can receive material and process it into his or her own language and thought patterns he or she is well on the way to understanding and to successful storage in the long-term memory. Johnstone (1983) recommends that all teachers at all levels watch their language. He cautions teachers that they should be careful when introducing abstract technical concepts. Teachers should not be apt to introducing such concepts too early or quickly; neither should they give their students insufficient opportunity to discuss new ideas or relate their previous out-of-school knowledge to the new material. Bentley and Watts (1992) are in agreement with Johnstone when they point out that it is not just a matter of clearly defining specialized scientific vocabulary when learners first come across them in their science lessons. But it is of giving them an opportunity to talk about their understanding of what they mean and to offer them an opportunity of using these technical terms in different situations. Words such as converse, liberate, correspond, simultaneous, factor, criteria etc, cause trouble for most high school students (Cassels and Johnstone, 1985). Words themselves have no intrinsic difficulty level but depend very much on the context. This is particularly evident in the area of

testing, especially objective testing, where precision of language is essential to elicit a unique response. For example in a study by Cassels and Jonhstone (1985) it was shown that the non-technical terms associated with science were a cause of misunderstanding for students (Gunstone, 1978). For instance,

Q. Two experiments are being carried out **simultaneously**. This means that they are carried out...?

Table 2.1. Students' responses on a multiple choice question

	Age and response (%)		
	12-13	14-15	16-17
A. One after the other	41	39	21
B. In different ways	3	4	1
C. In different rooms	1	1	0
D. At the same time	55	56	78

Words that denote real objects or entities (e.g. pipette, meniscus, diamond or thermometer) can be illustrated by the objects themselves, pictures, drawing or models. Sometimes there is an everyday synonym that is helpful, at least in the early stages of learning a new word. Processes (e.g. evaporation, diffusion, crystallization or distillation) are quite tricky to learners. For learners to understand these processes, it is important that the teacher demonstrates either experimentally or by use of models or flow diagrams. Students need help to abstract the idea from the experience. Words that denote scientific concepts (e.g. energy, mole, element, or compound) and mathematical concepts frequently used in science (e.g. rate, ratio, proportionality, etc) require clarification.

Finally, there is the question of who is to be responsible for improving the language abilities of science students, the science teacher or the English teacher? It may be argued that the answer to this question is the science teacher on two grounds: First, the science teacher is already helping to enrich students' vocabulary by teaching them the specialist language of science. Secondly, the science teacher is likely to have a much better grasp of scientific English than the English teacher. This means that the science teacher is far more likely to know the scientific context in which non- technical terms will arise. He or she is therefore, far more likely able to select more relevant examples for teaching purposes.

2.4. Language Use in the Chemistry Classrooms

Language of instruction plays a crucial role in the classroom activities. This is particularly true in chemistry where the introduction of new terminology to describe chemical processes, for example can be a cause of confusion (Levinson, 1974). Chemistry classes are linguistically rich environment in which students are exposed to a wealth of vocabulary. It is therefore necessary to use simple scientific language to develop clear scientific thinking than it is to employ 'anthropomorphisms'. Proper use of scientific language as well as the common English language in the Chemistry classroom discourse influences the performance of students in examinations (Reed, 1968). Das (1985) poses some questions:

- (a) Are the choice of words and phrases such that students are likely to understand?

(b) Does the teacher take into account the maturity level of the students?

Sometimes teachers present specialist words without care, either because they assume to be known by the learners or because the teacher seems unaware of using them. Bloom (1981) notes that the language used should be suitable to the student mental age to be able to enhance the development of intellectual abilities and skills. Teachers are required to assist students in developing a functional science vocabulary by teaching them to examine words and by consistently relating words to the processes, classifications and concepts to which they refer. Taking the small amount of time needed to examine the prefixes, stems and suffixes of a word makes many difficult words easy to understand and use. For example, the word exothermic is often difficult for beginning chemistry students until it is broken into

Exo = liberate / release/ give out / produce.

Thermal = heat

Thus, **exothermic** means to give out / produce / release / liberate heat.

Other similarly difficult words that become relatively easy when broken into prefixes, suffixes and stems include endothermic, electrolysis, crystallization, and chromatography. Unfortunately, many teachers don't realize the extent to which the structure of their sentences and their choice of words may be incomprehensible to the majority of their less able students. Words such as 'exhale', 'predominate' 'inflammable', 'flammable,' 'corrosive', or 'fundamental', may be understood by only a minority. For example, repeating

to students that ice, water and steam are the same compound, when to a student who has not grasped the elementary kinetic picture of matter, they are obviously **not** the same thing, since they neither feel the same nor look the same. Osborne and Fregberg (1985) suggest that abstractions should always be accompanied by concrete examples of what they represent to avoid misunderstanding.

2.5. Related Studies done in Kenya.

This section highlighted on some studies related to the present research study already done in Kenya. This enabled the researcher to establish a basis on which to carry out the present study. Kamau (1996) noted that very little has been done regarding classroom language use in Kenya, especially the scientific language. The author attributed this to the fact that in Kenya emphasis is laid on what is taught at the expense of how it is taught. Maritim (1984) mainly dwelt on structured interaction studies similar to that of Muthwii (1981). Maritim particularly dealt with the classroom interaction and use of language. In the study, the author found that students who initiate interaction with their teachers in the classroom achieved higher grades than those who did not. Muthwii (1987) observed that what is common to teachers' verbal discourse patterns from most cultures (Africa, Britain, or Canada) is teachers' dominance in classroom talk. Muthwii also noted from the findings that the practices were dominated by questions of the lowest cognitive level (recall of knowledge). Cleghorn (1988), in his studies on language use in teaching of science in Kenyan Primary schools, noted that teachers have

difficulty expressing science concepts via English and especially in relating the abstract world being created in the classroom to the concrete world outside.

Problems relating to English as a second language as well as matters of cultural inaptness play important role in the science classrooms. Kenyan teachers are faced with the challenge of ‘dual translation’, that is, in addition to teaching in a medium that is a second language for both teachers and students, teachers also have to help students find connections between the concrete cultural world outside of school and the semantic organizations of the abstract scientific world that is being constructed through classroom lessons. For students to comprehend science subject matter in English there is need for precision, reformulation of thought or clarification. Kamau (1996) observed that language offers and develops concepts. Subjects traditionally have their technical vocabulary and characteristic ways of expressing things. Kamau noted,

The success of the secondary school can be said to depend very considerably on the level of performance on language use. Unless learners can read, write and talk competently, they cannot benefit from the range of learning that the secondary school provides (Kamau 1996:27)

Many teachers tend to use language that might not be comprehended by some students. If the students’ access to technical terms is limited they will not acquire the prerequisite concepts that lead to understanding. Barnes affirms,

Much of the language encountered in school looks at the learners across a chasm. Some fluent children... adopt the jargon and whole stretches of lingo. Personal intellectual struggle is made irrelevant and the personal view is never called for. Language and experiences are torn asunder (Barnes, 1971:12).

Eshiwani (1974) in his studies on language and mathematical concept learning noted,

One difficulty with making the translation from vernacular to English and vice-versa for formal mathematical instruction in the schools is that there are no explicit vernacular words to express certain mathematical concepts (Eshiwani 1974:31).

This might also apply to chemistry, as noted earlier in this study. It is evident from the studies cited that little has been done concerning the conceptualization of language in effective teaching and learning of chemistry in the Kenyan Secondary schools. Kamau (1996) pointed out that many factors influence classroom language use – some general to various subjects while others are unique to a given subject. If the unique factors are identified and tackled appropriately, it may lead to the improvement of an individual subject. In view of this, the present study intended to find out the effect of language, particularly the scientific language, on the performance of students in Chemistry.

2.6 Summary

Chemistry teachers need to take particular care with the vocabulary they use in chemistry lessons because of the difficulties that scientific subject matter poses (Sands and Hull 1986). Paying close attention to scientific vocabulary

lets the teacher check a textbook with the students who use it. This enables him or her to predict the students' ability to use the text and also see if they understood both the language and scientific content. The students have to read carefully to get the sense of the passage. The procedure is thus concerned not just with vocabulary but it provides a useful starting point for increasing the teacher's awareness of students' difficulties. The new vocabulary must be thoroughly explained and understood for maximum learning to take place. Many teachers find it useful to include a vocabulary list of the new science terms that would be learned and used during the lesson. This list reminds the teacher to give due attention to the learning of such terms when they appear for the first time.

Waweru (1987) writes,

If one takes a random sample of people who have been out of school for the last five years and ask them what they remember of science in school...Chemistry was a lot of formulae...Physics were more formulae and a lot of calculation, Biology was slightly better, but there was a lot of difficult terminology (Daily Nation 19th Dec. 1987:p.10 Col. 1 – 3)

He pointed out that perhaps the solution could be tied in with the language used. For instance, take a technological and scientific property of a liquid in everyday use: 'acid' as used in car batteries. On the container is written 'acid burns': in teaching Chemistry in school students are taught 'acids are corrosive'. The difference in the two cases is the use of 'burns' and 'corrosive'. The real problem in Chemistry lessons is the use of specialized terms (for example corrosive), and some common words (such as reaction or

disproportionation) used in a restricted sense. Others are specially coined words e.g. hydrolysis, ionization etc. The difficulty is simply the sheer number of such terms. A simplified basic vocabulary enables the learner to capture the meaning of a concept. The question of how much specialized vocabulary to use is always with us. Technical vocabulary special to the subject should be introduced only when it is clearly needed to facilitate communication. A teacher who is aware of the role the specialist scientific language plays would always ensure he or she presents subject matter with well-calculated move to minimize misunderstanding. Barnes (1969) argued that language is fundamental to the teacher – student transactions which are the basis of classroom activity. He asserted,

It is from the method of communication as much as from what is communicated that a learner comprehends a school subject (Barnes 1969:28).

The problem of proper use of specialized language of science must be seriously considered if teaching and learning of chemistry is to be successful (K.I.E, 2006). Thus for meaningful learning to be realized, the choice of language employed by teachers should be carefully considered and selected. From the foregoing literature, it is noted that little research on use of scientific language and students' performance in Chemistry has been done in Kenya. Thus it appears that lack of comprehension of technical terms special in Chemistry is partly responsible for students' low performance in Chemistry.

CHAPTER THREE

RESEARCH METHODOLOGY

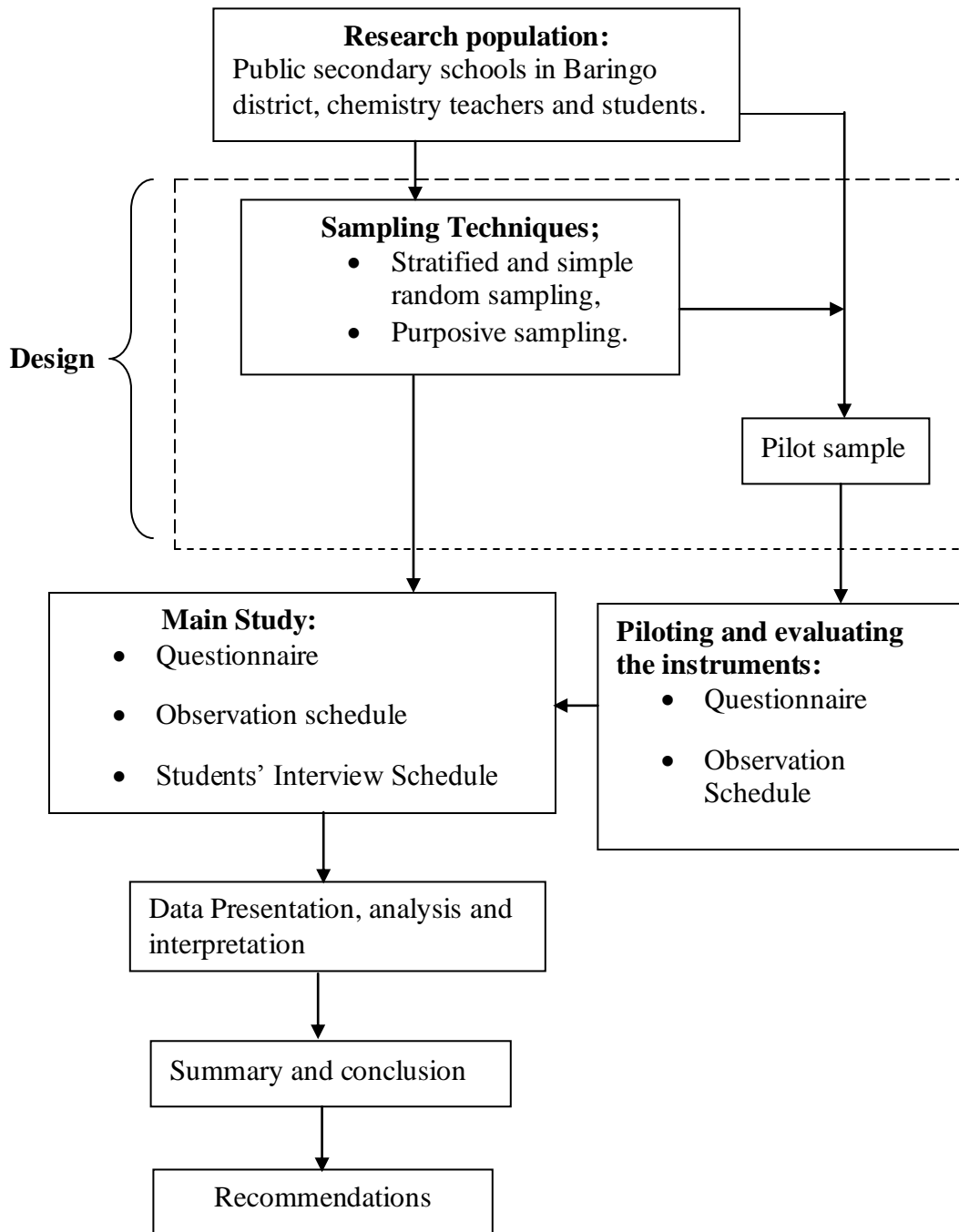
3.1. Introduction

Methodology is an operational framework within which facts are placed so that meaning may be seen clearly (Leedy, 1974). This chapter focused on the following areas:- Research Design; The population and sample; Research instruments; Data collection procedures; Ethical issues; Data Presentation and analysis; and Summary.

3.2. Research Design and Process

Research design is the plan, structure and strategy of investigation used to obtain answers to research questions. It refers to the total architectural plan, the tectonic structure of the research framework (Leedy, 1974). This study employed a cross-sectional survey design. This design was chosen because of its ability to obtain both qualitative and quantitative data with regard to the teachers' use of scientific language in Chemistry classroom discourse. The design also gathers information not available from other sources and data from this design can be used to compliment existing data from secondary sources. The summary of the study is given in the flow chart format in figure 3.1.

Figure: 3.1. A survey research design and process for the study



Source: Adapted from Kwaka (2003)

Figure 3.1 shows the population from which the research sample was selected and the methods of sampling. It also gives the research instruments used and the process of the entire research study outlined.

3.3 The population and sample

3.3.1 The population

The target population from which the sample for the study was drawn comprised all the twelve (12) public secondary schools in Kabarnet division of Baringo district. The accessible population was all chemistry teachers and Form three students who were taking Chemistry as an examinable subject at K.C.S.E. level. Form three Chemistry teachers and their students were specifically selected for the purpose of the present study. The reason for the choice of the form three students was because it is at this stage in secondary schooling that students make a choice of the subjects to sit for the K.C.S.E examination. Hence, those students selected for the study were genuinely committed to learning of chemistry. Form four chemistry students were not selected since they were candidates and schools usually would not wish to have the candidate classes interrupted.

The researcher limited the study to Kabarnet division of Baringo district since the study focused on the effect the scientific language has in effective teaching and learning process and a rural setting was most suitable because the majority of Kenya's secondary schools are situated in the rural parts of the country. Kabarnet division also offers a typical Kenyan secondary school setup in boarding, day, single sex and mixed sex schools.

According to Best and Kahn (1993), research requires careful thought and consideration about a number of practical factors. In this regard, accessibility

and cost factors were legitimate concerns of the present study. The researcher therefore settled for the location mentioned earlier due to close proximity of the schools to each other and the transport system being well developed. This was an essential aspect to consider in terms of time required to visit the sample schools and traveling costs involved. The researcher was also familiar with the locality, which made it easier to develop an immediate rapport with the respective respondents of the study.

3.3.2 The Sample and Sampling Techniques

The sample schools were selected by use of stratified random sampling technique.

Schools were categorized into three strata: Boys (BS), Girls (GS) and Mixed (MS) secondary schools. From the three categories, two schools from boys, two from girls and two from mixed schools were selected through simple random sampling using the ‘lucky-dip’ (details provided under definition of terms) procedure to minimize bias. Table 3.1 shows how the sub-sample was selected.

Table 3.1 Sample Selections for Classroom Observation

Category of school	Total No. of Schools	No. of schools Selected	No. of Form 3 streams selected for observation per school
Boys	4	2	1x2=2
Girls	3	2	1x2=2
Mixed	5	2	1x2=2
TOTAL	12	6	6

In each of the sampled schools only form three classes was considered. Only one stream per class was randomly selected from those schools with more than one stream, otherwise purposive sampling was adopted. This resulted in a total of six streams observed. Each stream was observed for two of the possible five lessons taught in a week for four weeks to obtain reasonable data regarding use of scientific language. The researcher observed forty-eight (48) lessons for the whole session. All students in each stream selected were involved in the Chemistry Achievement Test (CHAT). Only 10% of the students who participated in the lesson observation sessions were involved in the Students Interview Schedule (SIS). The researcher administered Chemistry Teachers' Questionnaire (CTQ) to all Chemistry teachers, both involved and those not involved in the observation sessions, in Kabarnet division. A total of twenty seven (27) chemistry teachers, six of whom took part in lesson observation sessions, and two hundred and seventy (270) Form three chemistry students participated in the study.

3.4 Research Instruments

The main tools for the study were:- Lesson Observation Schedule (LOS); Chemistry Teachers' Questionnaire (CTQ); Students' Interview Schedule (SIS); Chemistry Achievement Test (CHAT); and Content Analysis Schedule (CAS).

(a) Lesson Observation Schedule (LOS)

The Chemistry lessons were observed using a LOS (Appendix A) that was specifically designed to suit this study. This tool was used to enable the

researcher to directly interact with the respondents in their setting. This is essential since responses given in the questionnaire alone without actual observation might not be reliable enough. The observation also gave the researcher an opportunity to check the extent to which teachers themselves use technical terms during instruction. The researcher made a list of the scientific vocabulary (technical terms) that were used in each lesson observed from the class texts, syllabus and teachers' schemes of work. The SIS and CHAT were developed based on these terms. Short notes were taken during the process of observation and coding of the items done in the observation schedule. Observer subjectivity was reduced by adopting standard definitions and explanations of scientific terms/vocabulary given in Chemistry textbooks and scientific dictionaries. Explanations of such terms were based in the context in which the terms were employed.

(b) Chemistry Teachers Questionnaire (CTQ)

This instrument (Appendix B) was used because of its objectivity and potential to solicit a lot of information from respondents. The use of a questionnaire provided a variety of opinions from all secondary school teachers of Chemistry in Kabarnet division of Baringo district concerning the contribution scientific language might have on the effective teaching and learning process.

A questionnaire of self-administered type was most reliable method for collecting such data. It consisted of teachers' general background and teachers' views on the scientific language. It had both structured and semi-

structured items. The structured items were used to obtain direct and exhaustive answers while the semi-structured items were used in cases where flexible responses were required and where respondents could reveal their opinions and attitudes. This tool was used to collect data from all secondary school Chemistry teachers in the said division so as to obtain sufficient information on the use of scientific language in Chemistry classes.

(c) Student Interview Schedule (SIS)

An interview for students was a necessary tool for the study in order to get the feel of a student's understanding of the scientific terminologies encountered during the classroom discourse. Its main use was to establish students' grasp on a number of selected scientific terms (vocabulary) the teacher used during the period of classroom observation. An audio tape recorder was used in some cases to record students' responses during the interview, which was later transcribed for the purpose of coding and analysis. The interview was conducted at the end of the four weeks period of classroom observation using the Student Interview Schedule guide (Appendix C). This was administered to only 10% of the sampled students since it was not possible to interview all the respondents who took part in the whole study due to time and cost constraints (Best and Kahn, 1993). The 10% of the sampled students was obtained by simple random sampling using the 'blind-folding' technique.

(d) Chemistry Achievement Test (CHAT)

This was particularly very important instrument since it assisted the researcher to find out the state of students' level of comprehension of the scientific

concepts in relation to the technical terms special in Chemistry used during the course of instruction. The CHAT (Appendix D) covered only the content taught during the four weeks' study period. According to Johnstone (1983), it is very hard, if not near impossible, to recapture the experience of learning something for the first time. It is thus essential to administer the test after a period of not less than a week after the four weeks period of classroom observation. In this regard, the researcher administered the test one and a half ($1\frac{1}{2}$) weeks after the actual lesson observation was complete. The test comprised twenty items, mainly of scientific (technical terms) orientation terminologies (Table 4.17). The test was administered to all Form three students involved in the classroom observation. To ensure that students prepared well and possibly equally in all the schools involved in the observation sessions, they were informed in advance of the test.

(e) Content Analysis Schedule (CAS)

The technical terms special in Chemistry forming the observation schedule were obtained from the class texts, Chemistry syllabus and/or schemes of work using content analysis schedule.

3.5 Data Collection

The data for this research was collected in two phases: the piloting stage and the main study stage.

3.5.1 Piloting

During this stage three research instruments were tested to determine their reliability and validity. These were the lesson observation schedule, students'

interview schedule and chemistry teachers' questionnaire. Standardization of the CHAT was also done at this stage. A split-half method of reliability (Lokesh, 1984) was used. Reliability index of .96 was obtained. For the purpose of the pilot study one school, not part of the main study sample, was purposively selected from the mixed schools stratum. A mixed school (one among the provincial schools' category and which does equally well as the other provincial schools in the division) represents both genders drawn from all parts of the division. The CTQ was administered to all the Chemistry teachers in the selected school. All the Form three Chemistry subject teachers were observed to obtain sufficient information necessary to determine the reliability and validity of LOS. Only 10% of the Form three students observed was selected for the interview schedule. The selected teachers for observation were then observed at least two times during his/her chemistry lessons. The information collected was then analyzed to determine the suitability of the instruments. This led to modification of the instruments.

3.5.2 The Main Study

During the main study, five instruments were used to collect data. These were LOS, CTQ, SIS, CHAT and CAS. Before administering these instruments the researcher visited the sample schools to notify the authorities. Permission from head teachers was sought. The researcher then proceeded to establish a working relationship with the respective Chemistry teachers. This was a crucial step since the confidence of the teachers should be sought by establishing rapport so that they could view the study positively.

Arrangements were then made with the teachers on the convenient time to begin the actual research study. LOS was the first to be administered. To limit observer effect, familiarization visits to the sample classrooms was arranged. Two lessons were observed without recording for the researcher to acquaint himself with the classroom settings and also to put the learners and teachers at ease. During familiarization visits he sat at the back of the classroom without recording to ensure interaction was free within the classroom and he was not considered as an intruder. This was important as Borg and Gall (1989) argue that unless he is concealed, the observer is likely to have an impact on the respondents. For example, an observer entering the classroom for the first time is likely to arouse curiosity of the students and possibly the teacher.

Class timetables for sample classes were requested for use in developing a schedule for visitation. The teachers were not given specific appointments. This prevented the teacher from making any special preparations, conscious or unconscious, on the part of the teacher. The teacher was assured that the data collected were to be used purely for research purposes. Frequencies of each coding category per lesson for all the observed teachers were calculated and descriptive statistics worked out and presented as percentages of the total responses.

The CTQ was administered after the four weeks of lesson observation. The SIS was administered immediately the four weeks of lesson observation was concluded. The CHAT then followed the SIS. To allow for transfer of

knowledge acquired from short-term memory to long-term memory, a period of one and a half (1½) weeks was allowed after the lesson observation and interview had been conducted before the CHAT was administered. Meaningful learning only takes place if what is stored in the short-term memory is successfully transferred to the long-term memory (Johnstone, 1983). Therefore, it is imperative to allow students time for this process to occur. It worth noting that the CHAT (Appendix D) covered only the content taught during the four weeks' research period and that students were informed in advance to revise for the test. If the information in the CHAT was tallying with what is in the long-term memory, retrieval of such information would take place through processing, thinking and remembering (Johnstone, 1983).

3.6. Ethical and Administrative Issues

The researcher obtained permission from the relevant authorities, including the Ministry of Higher Education, Science and Technology (NCST), office of the president and P.D.E, Rift Valley, to carry out this research in the respective schools. The D.E.O, Baringo district, was also notified before carrying out the study.

3.7. Data Presentation and Analysis

Data gathered using LOS, CTQ and SIS was coded appropriately and analyzed. Frequency counts of behaviour reported were tallied and expressed in percentages of the total responses. Tables were used to present the findings. For sections which utilized a five point Likert scale in CTQ the respondents

were required to respond to given statements as always (A), often (O), sometimes(S), rarely (R) or not at all (N). For purposes of analysis numbers were assigned to the responses as follows: A = 5, O = 4, S = 3, R = 2 and N = 1.

The mean score for each item for all the respondents and overall mean for the items were calculated. Data gathered from the students' interview that were not coded were used to supplement data from the Chemistry Achievement Test (CHAT), LOS and CTQ. Some of the responses from the SIS that were thought to be of significance were quoted as views of the respondents.

The data generated from the four main research instruments used were analyzed both qualitatively and quantitatively. Quantitative data was analyzed using descriptive and inferential statistics. The t-Test was used to establish the relationship between girls' and boys' performance in relation to the scientific language and Chi-square test used to determine if there was a significant correlation between the teachers' professional training and experience and their ability to highlight and explain the meaning of technical terms special in Chemistry encountered during instruction. The t- critical value necessary for significant difference in the mean performance scores was at the 0.05 level. From the two types of analyses, the findings were discussed and conclusions and relevant recommendations made.

3.8 Summary

The rationale of the research design, methods employed in the study and the way they would enhance the acquisition of information on the use of scientific language in the teaching-learning of chemistry were discussed in this chapter. The population comprised form three Chemistry students and their teachers. The key instruments used were Lesson Observation Schedule (LOS), Students' Interview Schedule (SIS), Chemistry Teachers' Questionnaire (CTQ) and Chemistry Achievement Test (CHAT).

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction

Data obtained from the four key research instruments namely; Lesson Observation Schedule (LOS), Chemistry Teacher Questionnaire (CTQ), Students Interview Schedule (SIS) and Chemistry Achievement Test (CHAT) were analyzed and the summary of the analysis and interpretation presented in this chapter. Brief discussion accompanied the data presentation.

The next section involves descriptive analysis of the data presented. The rest of the chapter deals with inferential analysis of the data, starting with a chi-square (χ^2) test for correlation, followed by a one-way analysis of variance (One-way-ANOVA) for means of the three strata; boys schools (BS), girls schools (GS) and mixed schools (MS) and lastly a t-Test for the difference in means of boys and girls. The analysis presented was done using the statistical package for social sciences (SPSS).

4.2 Data Presentation and Interpretation

The data analyzed was presented using tables in most cases. The presentation and interpretation of the analyzed data is presented thematically following the key objectives of the study. Specifically, the data was presented in order based on the following themes:-Data on participants; Commonly used Chemistry terms; Adequacy and appropriateness of definitions and explanations of scientific terms used in Chemistry textbooks; Use of scientific language by

teachers during classroom discourse; Teachers' professional training and experience in use of scientific language during classroom discourse; and Gender and performance in terms of scientific language.

4.2.1. Data on Participants

The Chemistry teacher plays a pivotal role in highlighting and effectively explaining meanings of scientific terms that label concepts since he/she influences to a great extent students' understanding of scientific concepts. Therefore, it was important to obtain the biodata of Chemistry teachers. The biodata was collected using the CTQ (Appendix B) and it included:- the teachers' gender, professional qualifications, teaching experience (in years), number of chemistry lessons per week and professional development. Some of these factors (biodata) may contribute to the way a teacher highlights and explains scientific terms describing concepts.

a) Chemistry Teachers by Gender

The CTQ was administered to Chemistry teachers in Kabarnet division of Baringo district. Table 4.1 shows the gender distribution of Chemistry teachers that participated in the study.

Table 4.1: Chemistry Teachers by Gender

Gender	Number(N)	Percentage (%)
Male	18	66.7
female	9	33.3
Total	27	100.0

From table 4.1, it is notable that the majority of the Chemistry teachers, at 66.7%, involved in the study were male while 33.3% were female. This shows imbalance in favour of males and this reflects the representation in the field.

b) Professional Qualifications

Table 4.2 shows the professional qualification of the teachers.

Table 4.2: Professional Qualification of Chemistry Teachers.

Professional Qualification	N	%
Diploma in Sc. Education	4	14.8
B.Sc	4	14.8
B.Sc / P.G.D.E	3	11.1
B.Ed (Sc).	16	59.3
Total	27	100.0

The findings of this study showed that a good number of Chemistry teachers who participated in the research were professionally qualified, with 85% having either diploma in science education, B.Sc/P.G.D.E or B.Ed (Sc) degree.

c) Teaching Experience

Table 4.3 shows the experience of chemistry teachers (in years).

Table 4.3: Chemistry Teachers Experience (in years).

Experience (in years).	N	%
<4	5	18.52
4-7	9	33.33
8-11	9	33.33
12-15	2	7.41
>15	2	7.41
Total	27	100.00

The study revealed that the majority (at 81.48%) of the Chemistry teachers who took part in the research study have taught Chemistry for between 4 and 15 years. This period is sufficient enough for one to gain experience in

adequately handling subject matter since long period of teaching a particular subject enables one to have a good mastery of the content. Teachers who have taught for less than four year cycle may not have adequate experience in all the content of the science syllabus and only 18.52% of the teachers who took part in the study fell in this category.

d) Number of chemistry lessons per week

Table 4.4 shows the number of Chemistry lessons per week for Chemistry teachers.

Table 4.4: Chemistry Lessons per week

No. of Lessons /week	N	%
<15	10	37.04
16 - 20	12	44.44
21 - 25	4	14.82
>25	1	3.70
Total	27	100.00

The majority of the respondents, at 81.48%, had up to 20 lessons of Chemistry per week. This is a heavy load considering that they also teach a second subject.

e) Professional Development

Table 4.5 shows the distribution of Chemistry teachers who have attended a professional development course and those who have not.

Table 4.5: Have you ever attended an in-service course related to the teaching of Chemistry?

Gender	Number(N)	Percentage (%)
Yes	15	55.6
No	12	44.4
Total	27	100.0

It is worth noting that more than half, at 55.6%, of the Chemistry teachers involved in the study had undergone professional development through in-

service courses or workshops related to the teaching of Chemistry. Post qualification courses such as SMASSE inset exposes teachers to new approaches of handling Chemistry concepts hence may improve the teacher's competence. From these findings most of the Chemistry teachers who took part in the study were found to be in a good position to teach Chemistry.

4.2.2. Commonly used scientific terms in Chemistry

During lesson observation sessions, Lesson Observation Schedule (Appendix A) was used. Twenty (20) scientific terms/vocabulary which were common to all the six Form three classes observed were selected for the purpose of analysis and interpretation as listed in table 4.6.

Table 4.6: The Commonly used Chemistry Terms during Form three lesson observation sessions

1. Oxidation/Reduction	11. Brine
2. Dissociation/Ionization	12. Condensation
3. Combustion	13. Effervescence
4. Aqueous	14. Volatile
5. Neutralisation	15. Explosive
6. Molten	16. Valence electrons/Valency
7. Decomposition	17. Poisoning of catalyst
8. Reducing/Oxidizing agent	18. Sublimation
9. Precipitate	19. Complex ions
10. Dilute/Concentrated	20. Cracking

The technical terms special in Chemistry listed in table 4.6 formed the basis of finding out how Chemistry teachers involved in the study highlight and /or explain scientific terms during classroom discourse and consequently students' performance in Chemistry in relation to such terms (Appendices C and D).

4.2.3. Adequacy and appropriateness of definitions and explanations of scientific terms used in Chemistry Textbooks

Table 4.7 shows the views of Chemistry teachers involved in the study on the sufficiency and aptness of definitions and explanations of scientific terms in Chemistry textbooks.

Table 4.7: Do chemistry textbooks define and explain meanings of scientific terms labeling concepts?

	N	%
Yes	16	59.3
No	10	37.0
No answer	1	3.7
Total	27	100.0

More than half (at 59.3%) of the teachers involved in the study held the view that Chemistry textbooks outstandingly define and explain meanings of scientific terms that label concepts. According to the teachers of Chemistry involved in the study most of the current Chemistry textbooks approved by the Ministry of Education through K.I.E present the appropriate definitions and explanations.

4.2.4. Use of Scientific Language by Teachers during classroom discourse

Information concerning the way Chemistry teachers handle scientific language during classroom discourse was obtained using a Chemistry Teachers Questionnaire (CTQ) and Lesson Observation Schedule (LOS). This section dealt mainly with the following areas; teacher best suited to develop language

abilities of science students and development of scientific vocabulary by chemistry teachers.

a) Suitability of developing Language abilities of Science Students

Table 4.8 shows the teachers best placed to develop and improve language abilities of science students.

Table 4.8: The teacher suitable to develop language abilities of science students

No. of Lessons /week	N	%
Science teacher	7	25.9
English teacher	1	3.7
Both	18	66.7
No answer	1	3.7
Total	27	100.00

The highest proportion of Chemistry teachers involved in the study, at 68%, felt that both the science teacher and the teacher of English language are best suited to develop and improve the language abilities of science students. Only 26% of the respondents held the view that science teachers are in a better position to develop and improve the language abilities of science students for the simple reason that the science teacher is well versed with the content and language of science. The Chemistry teachers felt that teachers of English play some role in the development of language abilities of science students. But most important, the combined efforts of the science teacher and the teacher of English language are likely to develop language abilities of science students.

b) Development of scientific vocabulary

Table 4.9 shows the respondents' views on the development of scientific vocabulary.

Table 4.9: Do you consider scientific vocabulary in your objectives?

	Number(N)	Percentage (%)
Yes	23	85.2
No	4	14.8
Total	27	100.0

The highest proportion (85.2%) of Chemistry teachers who took part in the study consider the development of scientific vocabulary among their Chemistry objectives and therefore include them in their planning.

To find teachers' response to statements related to the use of scientific terms during instruction, a five-point Likert scale was used. The coding system used for the Likert scale was as follows: always (A) = 5, often (O) = 4, sometimes (S) = 3, rarely (R) = 2 or not at all (N) = 1.

For easy presentation each statement was coded according to the key in table 4.10.

Table 4.10: Statements and their codes for Chemistry Teachers Questionnaire (CTQ)

Statement	Code
When preparing schemes of work I highlight new scientific terms	T₁
When preparing for a lesson, I make a list of scientific words that need specific attention.	T₂
When constructing test items I consider the technical terms special to the chemistry subject	T₃
For any chemistry textbook recommended for use as class text I read it before use to;	
(a) Find out the language level	T₄
(b) Establish if scientific terms are well defined/explained	T₅
I define /explain scientific terms wherever I use them during the lesson	T₆

Table 4.11 shows the frequency counts of the responses from the CTQ (Appendix B) on the Likert scale.

Table 4.11: Frequency counts of responses from the CTQ

Code	A	O	S	R	N	Blank	Total
T ₁	6	11	10	0	0	0	27
T ₂	9	11	6	0	1	0	27
T ₃	10	11	4	0	0	2	27
T ₄	10	12	3	2	0	0	27
T ₅	17	7	2	1	0	0	27
T ₆	22	3	2	0	0	0	27
Total	74	55	27	3	1	2	162

Considering that all the items are positive, there is a high agreement with 74 out of 162 (45.7%). The mean scores for each statement were calculated together with the overall mean score. Table 4.12 shows mean scores for each statement and the overall mean score for all the statements on the five- point Likert scale.

Table 4.12: Mean score for the statements on a five point Likert scale in the CTQ

Statement code	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Mean	3.85	4.00	3.93	4.11	4.48	4.74
Overall mean	4.24					

NB: Maximum value of mean = 5, minimum value of mean = 1

From table 4.12 the overall mean score for all the statements of 4.24 shows that Chemistry teachers often handle scientific language during classroom discourse. This is an indication that Chemistry teachers are aware of the role scientific language plays in students' understanding of concepts which results in increased performance of students in Chemistry.

Chi-square (χ^2) test was performed to determine if the Chemistry teachers actually handle scientific language during classroom discourse. Table 4.13

shows the χ^2 values obtained for each statement and overall χ^2 for all the statements.

Table 4.13: Chi-square values for the frequencies on a five-point Likert scale in CTQ.

Code	A	S	R	χ^2
T ₁	17(21.8)	10(4.6)	0(0.7)	8.096
T ₂	20(21.8)	6(4.6)	1(0.7)	0.704
T ₃	21 (20.2)	4(4.2)	0(0.6)	0.642
T ₄	22(21.8)	3(4.6)	2(0.7)	2.973
T ₅	24(21.8)	2(4.6)	1(0.7)	1.821
T ₆	25(21.8)	2(4.6)	0(0.7)	2.640
Overall χ^2				16.876

df = 10, critical value = 18.307 at 0.05; Values in parenthesis are the expected frequencies; A=Always; S=Sometimes; R=Rarely

From table 4.13 the χ^2 values for all the statements, except for T₁, were less than the critical value of 5.991 at 0.05 level of significance. Similarly, the overall χ^2 for all the statements is less than the critical value of 18.307 at 0.05 level of significance. As such a significant majority of the Chemistry teachers held the view that it is useful but not necessary to give special attention to the scientific language during classroom discourse.

The study solicited further information from the teachers on how they handle scientific terminology encountered during instruction using a lesson observation schedule (Appendix A). Twenty (20) scientific terms/vocabulary, which were common to all the six classes observed, were identified and selected for the purpose of analysis and interpretation (**Table 4.6**). The six Form three Chemistry classes/teachers observed were coded as follows:-the two boys' schools were represented as **BS1** and **BS2**; the two girls' schools as **GS1** and **GS2** and the two mixed schools as **MS1** and **MS2**. The Lesson Observation Schedule gave information regarding whether Chemistry teachers

drew the attention of students to scientific terms special in Chemistry encountered during instruction. A three point Likert scale was utilized. The study rated the teachers' ability to highlight and explicitly explain scientific terms in each lesson observed as: well explained (**WE**), partly explained (**PE**) or not explained (**NE**). Table 4.14 gives the frequency counts obtained based on the twenty selected scientific terms.

Table 4.14: Frequency counts on LOS based on twenty (20) selected scientific terms.

Code	No. of responses						Total	(%)
	BS1	BS2	GS1	GS2	MS1	MS2		
WE	5	4	5	6	5	4	29	24.2
PE	8	8	5	6	5	4	36	30.0
NE	7	8	10	8	10	12	55	45.8
Total	20	20	20	20	20	20	120	100.0

Code: WE = well explained, PE = partly explained, NE = not explained

From table 4.14, it is notable that the scientific terms well explained by the teachers observed is less than a quarter (24.2%) of the total terms selected for observation. Despite the high responses from the Chemistry Teachers' Questionnaire (CTQ) by Chemistry teachers purporting to highlight and explain scientific terminology special in Chemistry encountered during lesson discourse, it is clear from the results in table 4.14 that the reality is that most of the scientific terms highlighted were either partly explained or not explained.

The mean scores for each school/teacher were calculated. The overall mean score was also calculated. Table 4.15 shows mean scores for each school/teacher.

Table 4.15: Mean scores for the individual teachers observed on a three point Likert scale.

School(Teacher)code	BS1	BS2	GS1	GS2	MS1	MS2
Mean score(x)	1.90	1.80	1.75	1.90	1.75	1.60
Overall mean score(x _o)	1.78					

NB: Max. Mean (x) = 3, Min. mean (x) = 1

From table 4.15 the mean score for the individual schools/teachers and the overall mean score were in the range $1 < x < 2$, where x is the mean score. This suggests that the Chemistry teachers involved in the study partly explained scientific terms technical to the subject during instruction.

Chi- square test was done to determine whether the frequencies obtained on the three- point Likert scale on the observation sessions (LOS) were significant. Table 4.16 shows the χ^2 values obtained.

Table 4.16: Chi- square (χ^2) values for the frequency counts on the clarity of Scientific terms special in Chemistry used during instruction

Respondent	Frequency counts			Total	χ^2
	WE	PE	NE		
BS1	5(4.8)	8(6)	7(9.2)	20	4.757
BS2	4(4.8)	8(6)	8(9.2)	20	
GS1	5(4.8)	5(6)	0(9.2)	20	
GS2	6(4.8)	6(6)	8(9.2)	20	
MS1	5(4.8)	5(6)	10(9.2)	20	
MS2	4(4.8)	4(6)	12(9.2)	20	
Total	29	36	55	120	

df = 10, critical value = 18.307 at 0.05; Values in parenthesis are the expected Frequencies; **WE** = well explained; **PE** = partly explained; **NE** = not explained

The calculated value 4.757 of χ^2 does not exceed the critical value of 18.307 at 0.05 level of significance, an indication that the Chemistry teachers involved

in the study seem not to highlight and explain meanings of scientific terms special in Chemistry encountered during instruction. This to some extent agrees with what was observed during the teachers' actual interaction with the students. For instance in some cases the Chemistry teacher under observation either partly explained or did not explain such terms. For example the following two instances were cited during lesson observation sessions:

“...when excess ammonia solution is added to the pale-blue precipitate of copper (II) hydroxide, a deep blue **precipitate** is formed” (Situation BS1).

Whereas the observation was correct, the explanation was partly correct since the pale blue precipitate on dissolving does not form a deep blue **precipitate** but a deep blue **solution**. In another case a teacher under observation gave the following explanation when he was discussing the chemical properties of dilute Nitric (V) acid:

“Dilute Nitric (V) acid reacts with metals such as zinc to form a salt and hydrogen gas” (Situation MS2).

In principle the products are correct but in practice one is wrong since dilute Nitric (V) acid is a oxidizing agent unlike the other dilute mineral acids. Hence it oxidizes hydrogen gas produced immediately to water, thus no gas is collected.

4.2.5. Teachers' Professional Training and Experience in use of Scientific Language during classroom discourse

The professional qualification of Chemistry teachers and their tendency to highlight and explain scientific terms was sought. Table 4.17 shows this information.

Table 4.17: Frequency counts on teachers' professional training and ability to highlight and explain scientific terms.

professional training	Frequency counts		Total
	Often	Rarely	
Dip. (sc) Education	27	3	30
B.Sc.	12	5	17
B.Sc/P.G,D.E	16	1	17
B.Ed	74	21	95
Total	129	30	159

Table 4.17 shows that most of the teachers often highlight and explain scientific terms encountered during instruction.

Chi-square test was done to find out whether a significant correlation exists between the teachers' professional training and his/her ability to highlight and explain the meaning of technical terms special in Chemistry that are encountered during instruction. Table 4.18 gives a summary of the Chi-square test results.

Table 4.18: Chi-square (χ^2) test for frequency counts on teachers' professional training and ability to highlight and explain scientific terms.

Professional training	Frequency counts		Total	χ^2
	Often	Rarely		
Dip. (Sc) Ed.	27(24.3)	3(5.7)	30	5.351
B.Sc	12(13.8)	5(3.2)	17	
B.Sc /P.G.D.E	16(13.8)	1(3.2)	17	
B.Ed	74(77.1)	21(17.9)	95	
Total	129	30	159	

df = 3, Critical value = 7.815 at 0.05; Values in parenthesis are the expected frequencies.

The calculated value of χ^2 of 5.351 is less than the critical value 7.815 of χ^2 at the 0.05 level of significance indicating that the teachers' professional training involved in this study may not significantly correlate with their ability to highlight and explain scientific terms that label concepts in Chemistry.

The actual assessment was done in classroom to determine the frequency of teacher's ability to explain the scientific terms encountered during instruction as observed by the researcher using the Lesson Observation Schedule (Appendix A). The results are shown in table 4.19.

Table 4.19: Frequency counts on teachers' experience and ability to highlight and explain scientific terms.

Experience (in years)	Frequency counts		Total
	Often	Rarely	
<4	22	7	29
4-7	39	14	53
8-11	45	8	53
12-15	12	0	12
>15	11	1	12
Total	129(81.1)	30(18.9)	159

Values in parenthesis represent %

Table 4.19 shows that irrespective of their experience, most of the teachers who participated in the study (81.1%) often highlight and explain scientific

terms encountered during instruction. This can be regarded as very positive for teachers.

Chi-square test was done to find out whether a significant correlation exists between the teacher's experience and his/her ability to highlight and explain the meaning of technical terms special in Chemistry that are encountered during instruction. Table 4.20 gives a summary of the Chi-square test results.

Table 4.20: Chi-square (χ^2) test for frequency counts on teachers' experience and ability to highlight and explain scientific terms.

Experience (in Years)	Frequency counts		Total	χ^2
	Often	Rarely		
< 4	22(23.5)	7 (5.5)	29	7.593
4 - 7	39 (43)	14(10)	53	
8 - 11	45 (43)	8(10)	53	
12 - 15	12 (9.7)	0(2.3)	12	
>15	11 (9.7)	1(2.3)	12	
Total	129	30	159	

df = 4, critical value = 9.488 at 0.05; Values in parenthesis are the expected frequencies

Since the calculated 7.593 of χ^2 does not exceed the critical value 9.488 at 0.05 level of significance, then the teachers' experience has no significant correlation with their ability to highlight and explain scientific terms that label concepts in chemistry.

Despite the teachers involved in the study being professionally qualified and experienced, Chi-square test revealed that their professional qualification and experience have no significant correlation with their ability to highlight and explain scientific terms labeling concepts in chemistry.

4.2.6. Gender and Performance in Chemistry in terms of Scientific Language

Students' performance in Chemistry in relation to scientific terms was sought using Students' Interview Schedule (Appendix C), Chemistry Achievement Test (Appendix D) and Chemistry Teachers' Questionnaire (Appendix B). Teachers' views on students performance in Chemistry in relation to scientific terminology were sought using the Chemistry Teachers' Questionnaire (Appendix B). Table 4.21 gives information on the views held by the Chemistry teachers who took part in the study concerning the relationship between emphasis of scientific terms during instruction and performance in them by students.

Table 4.21: Is low performance in Chemistry by students affected by teachers' failure to define/explain scientific terms?

	N	%
Yes	15	55.6
No	10	37.0
No answer	2	7.4
Total	27	100.00

More

than half of the Chemistry teachers (56%) involved in the study held the view that failure of Chemistry teachers to explicitly define and explain scientific terms that label concepts leads to students' low performance in chemistry.

Further information on students' understanding of the meaning of scientific terminology was sought. The statements related to this were coded as in table 4.22.

Table 4.22: Statements on the Likert scale and their codes for CTQ on students' understanding of the meaning of scientific terminology

Statement	Code
What is your opinion on students' understanding of the meaning of scientific terms?	T ₇
How often do students seek clarifications of the meanings of scientific terms?	T ₈

This section utilized a three- point Likert scale as follows: always (A) = 3, Sometimes(S) = 2 or rarely (R) = 1. Table 4.23 shows the frequency counts of the chemistry teachers' views on students' understanding of scientific terms.

Table 4.23: Frequency counts of responses from CTQ on students' understanding of the meaning of scientific terminology

Code	A	S	R	Blank	Total
T ₇	9	16	0	2	27
T ₈	9	14	3	1	27
Total	18	30	3	3	54

Code: A = always, S = sometimes, R= rarely

Most of the teachers who took part in the study held the view that students sometimes sought clarifications of the meanings of scientific terminology. The mean score for each statement was calculated. Table 4.24 shows mean scores for each statement and the overall mean score for the two statements on a three- point Likert scale

Table 4.24: Means score for frequency counts of Chemistry teachers' views on Students' understanding of scientific terms

Code	T ₇	T ₈
Mean score(x)	2.36	2.23
Overall mean(x _o)	2.29	

NB: Max. Mean(x) = 3, Min. mean(x) = 1

From table 4.24, it is notable that the mean score for each statement and the overall mean score for these statements range between 2.00 and 2.40. This implies that the teachers who responded held the view that students' understanding of the

meaning of scientific terms was fair and they sometimes sought clarifications of the meanings of scientific terms.

Chi-square test was performed to find out if the frequencies obtained on the three-point Likert scale agreed with the statements given in table 4.22 and 4.23. Table 4.25 shows the Chi-square values obtained.

Table 4.25: Chi-square (χ^2) values for the frequency counts of Chemistry teachers' views on students' understanding of scientific terms

Code	A	S	R	χ^2
T ₇	9(8.8)	16(14.7)	0(1.5)	1.620
T ₈	9(9.2)	14(15.3)	3(1.5)	1.615
Overall χ^2				3.235

df = 2, critical value = 5.991 at 0.05; values in parenthesis are the expected frequencies; A = Always, S = Sometimes, R = Rarely

A

The calculated χ^2 values do not exceed the critical value of 5.991 at 0.05 level of significance. This suggests that students involved in the study rarely sought clarifications on the meaning of scientific terminology encountered during instruction.

Students' Interview Schedule (SIS) (Appendix C) elicited information on students' understanding of the scientific terms encountered during lesson observation. Since it is not possible to interview all students involved in the class observation sessions, only 10 % of the sampled student participants took part in the SIS. Five interview questions were selected based on the twenty (20) commonly used scientific terms during Lesson Observation Sessions (LOS). The researcher rated the students' ability to respond to these questions as correctly explained (CE), partly explained (PE) or not explained (NE). The responses were coded and recorded as shown in table 4.26.

Table 4.26: Frequency counts on Students’ understanding of scientific terms based on the interview

Code	No. of responses						Total	(%)
	BS1	BS2	GS1	GS2	MS1	MS2		
N =	4	4	5	5	5	4	27	
CE	8	4	3	12	5	6	38	28.2
PE	5	5	8	5	7	5	35	25.9
NE	7	11	14	8	13	9	62	45.9
Total	20	20	25	25	25	20	135	100.0

N = Number of participants per school selected for observation; **Code:** CE = correctly explained, PE = partly explained, NE = not explained.

It is notable, from the table, that only 28% of the responses captured from the students interviewed were correctly explained. The highest percentage (46%) of the responses was not explained. This trend is similar to that noted in the Lesson Observation Schedule (LOS), (table 4.14). This shows how teachers’ explanations of scientific terms impacts on students’ understanding of concepts labeled by such terms and by extension on their performance in Chemistry.

Chi-square test was determined to find out the three-point Likert scale on the SIS estimated the likelihood that some factor other than chance accounts for the observed relationships as shown in table 4.27.

Table 4.27: Chi-square (χ^2) test for the frequency counts on Students' understanding of scientific terms based on the interview

Respondent	Frequency counts			Total	χ^2
	CE	PE	NE		
BS1	8(5.6)	5(5.2)	7(9.2)	20	11.381
BS2	4(5.6)	5(5.2)	11(9.2)	20	
GS1	3(7.0)	8(6.5)	4(11.5)	25	
GS2	12(7.0)	5(6.5)	8(11.5)	25	
MS1	5(7.0)	7(6.5)	13(11.5)	25	
MS2	6(5.6)	5(5.2)	9(9.2)	20	
Total	38	35	62	135	

df = 10, Critical value = 18.307 at 0.05; Values in parenthesis are the expected frequencies;
Code: CE = correctly explained, PE = partly explained, NE = not explained

The value 11.381 of χ^2 does not exceed the critical value 18.307 of χ^2 at 0.05 level of significance. This suggests that students were unable to grasp a good number of selected scientific terms the teacher used during the period of classroom observation. This in effect demonstrates how important it is for the teacher to highlight and ensure clarity in explaining the scientific vocabulary labeling concepts which are encountered during instruction. For example in some cases the students interviewed failed to correctly explain some scientific terms which were also omitted by the teachers during classroom observation sessions. For instance **50% concentrated nitric acid**, one of the technical terms comprising the interview questions, was assumed or totally omitted by most of the teachers under observation. This probably led to some students giving partly correct explanations such as:

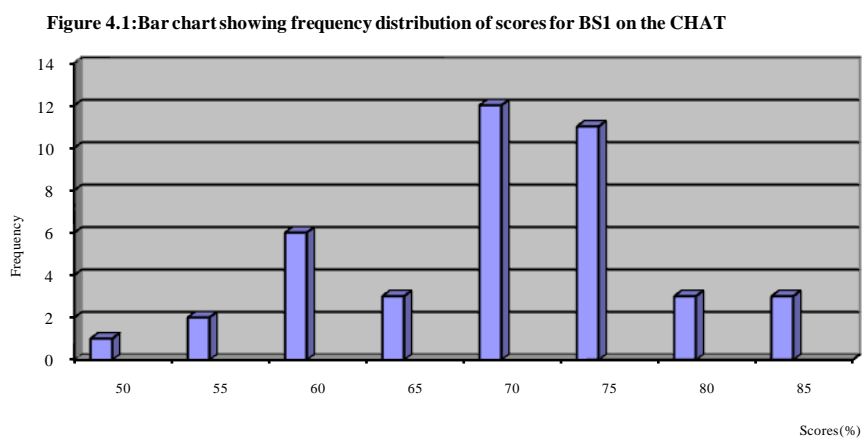
“50% concentrated nitric acid should be the average of the acid”; “50% concentrated nitric acid is to get accurate results”; “Amount of hydrogen (H^+) ions in the acid is ‘not fully concentrated’.” (Situation MS2)

To shed more light on students' understanding of scientific terms that label concepts, a Chemistry Achievement Test (CHAT) was administered. This test consisted of twenty (20) multiple-choice questions of verbal orientation (Appendix D). Each item had four options. These multiple-choice items were scored one point per item (Appendix E), giving a total of 20 points translated to percentage (%). This tool assessed students' knowledge and understanding of scientific terminology special in Chemistry. The questions on the CHAT showed a high reliability with spearman-Brown (Bb) value of 0.96.

Tables 4.28 – 4.32 show the frequency distribution of the scores (expressed as percentages) for the six schools observed coded as: two boys' schools (**BS1** and **BS2**), two girls' schools (**GS1** and **GS2**) and two mixed schools (**MS1** and **MS2**). The information in tables 4.28 – 4.33 were represented graphically using bar charts as in figures 4.1 – 4.6

Table 4.28: frequency distribution of scores on the CHAT for boys (BS1)

Scores (%)	50	55	60	65	70	75	80	85
Frequency: (N = 41)	1	2	6	3	12	11	3	3



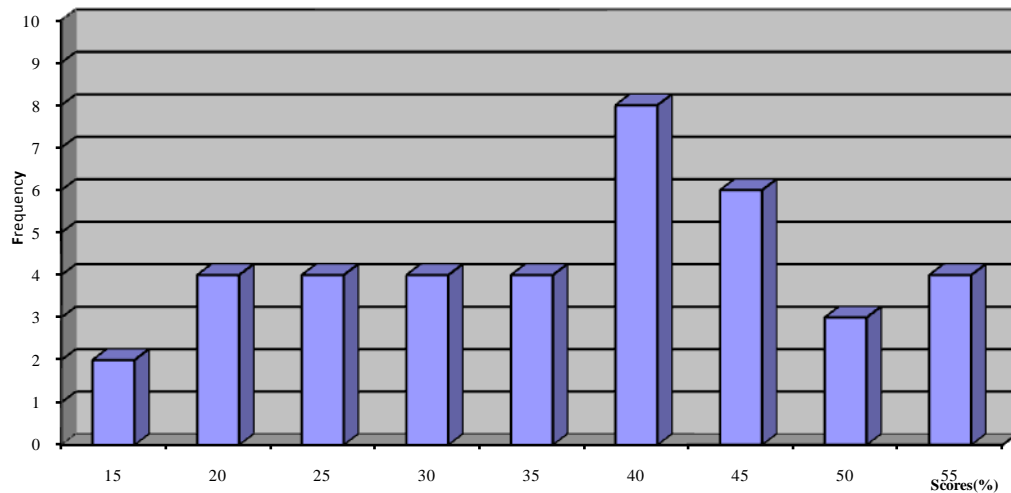
It is worth noting that more than half (23) of the students in school **BS1** scored between 70 and 75%, an indication that they understood the scientific terms they encountered during instruction.

Table 4.29 shows the frequency distribution of scores for boys (**BS2**) on the CHAT which is represented by a bar chart, figure 4.2.

Table 4.29: frequency distribution of scores for boys (BS2) on the CHAT

Scores (%)	15	20	25	30	35	40	45	50	55
Frequency(N = 39)	2	4	4	4	4	8	6	3	4

Figure 4.2: Bar chart showing frequency distribution of scores of BS2 on the CHAT



Unlike school **BS1**, students in school **BS2** did not perform well since most of them scored 40% and below.

Table 4.30 and figure 4.3 show the frequency distribution of scores for girls (**GS1**) on the CHAT.

Table 4.30: frequency distribution of scores for girls (GS1) on the CHAT

Scores (%)	20	30	35	40	45	50	55	60	65	70	80
Frequency(N = 51)	1	1	4	3	9	8	6	8	4	5	2

Figure 4.4: Bar chart showing frequency distribution of scores for GS2 on the CHAT

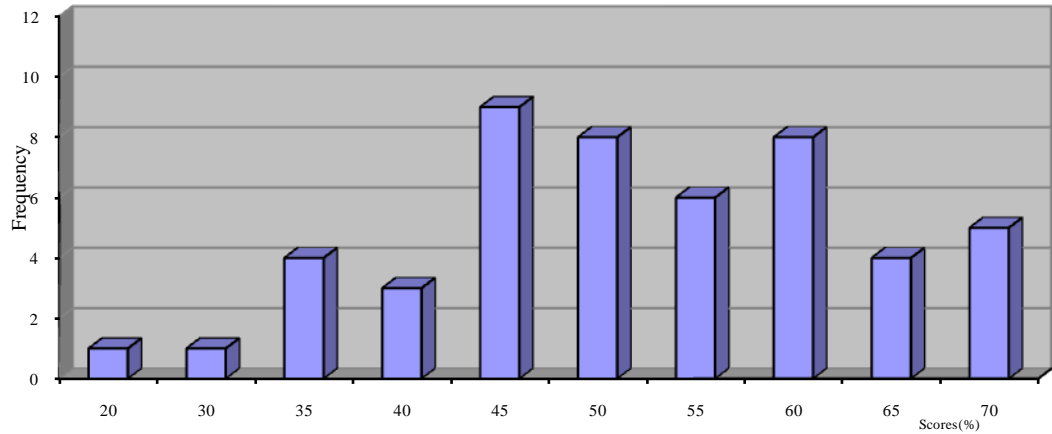


Table 4.30 and figure 4.3 indicate that most students of school **GS1** performed fairly well since the majority scored 45% and above.

Table 4.31 and figure 4.4 show the frequency distribution of scores for girls (**GS2**) on the CHAT.

Table 4.31: frequency distribution of scores for girls GS2 on the CHAT

Scores (%)	30	35	40	50	55	60	65	70	75	80
Frequency (N = 51)	1	4	1	6	6	8	9	10	5	1

Figure 4.4: Bar chart showing frequency distribution of scores for GS2 on the CHAT

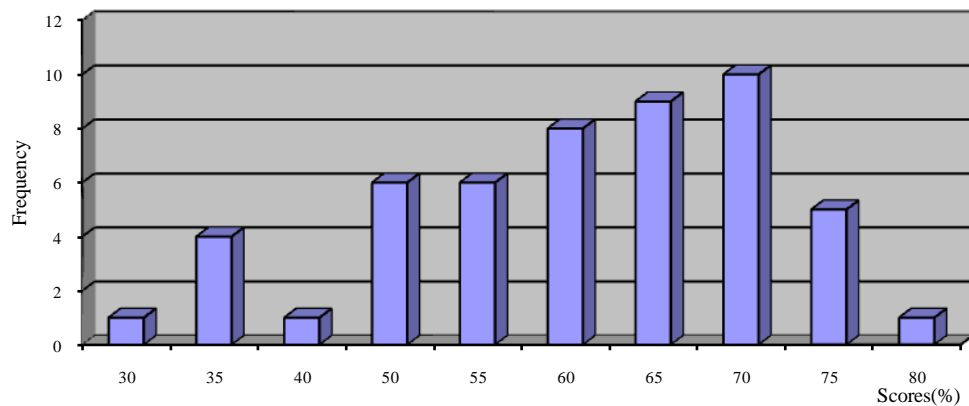


Table 4.31 and figure 4.4 indicate that most students of school **GS2** performed fairly well compared with school **GS1** since the majority scored 50% and above.

Table 4.32 and figure 4.5 show the frequency distribution of scores for mixed school (MS1) on the CHAT.

Table 4.32: Frequency distribution of scores for MS1 on the CHAT

Scores (%)	20	25	30	35	40	45	50	55
Frequency(N = 51)	6	4	5	9	8	8	7	4

Figure4.5: Bar chart showing frequency distribution of scores for MS1 on the CHAT

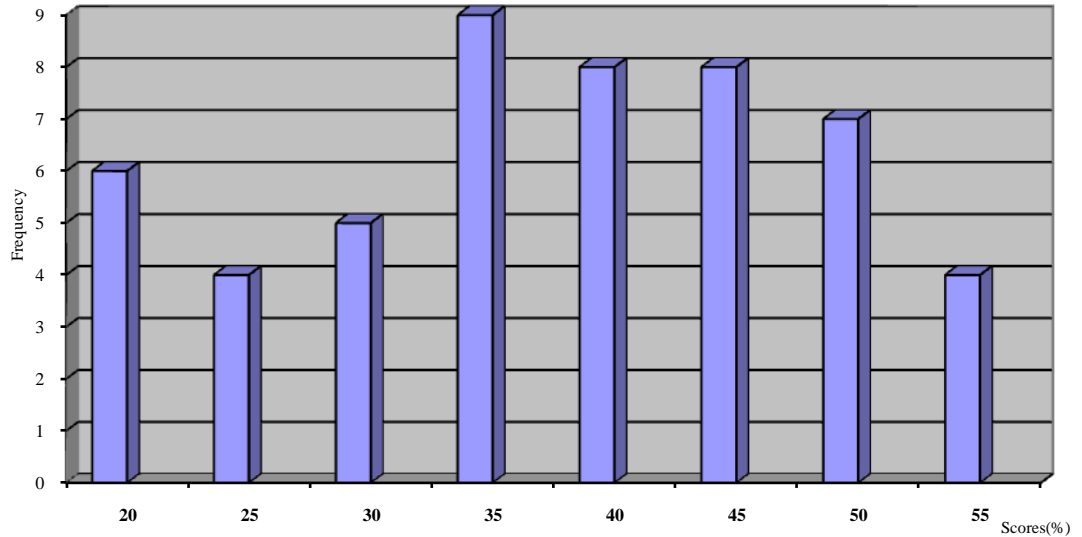


Table 4.32 and figure 4.5 indicate that most students of school MS1 did not perform well since most of them scored 45% and below

Table 4.33 and figure 4.6 show the frequency distribution of scores for mixed school (MS2) on the CHAT.

Table 4.33: frequency distribution of scores for MS2 on the CHAT

Scores (%)	10	15	20	25	30	35	40	45	50	55
Frequency(N = 37)	1	1	1	2	6	7	1	10	4	4

Figure 4.6: Bar chart showing frequency distribution of scores for MS2 on the CHAT.

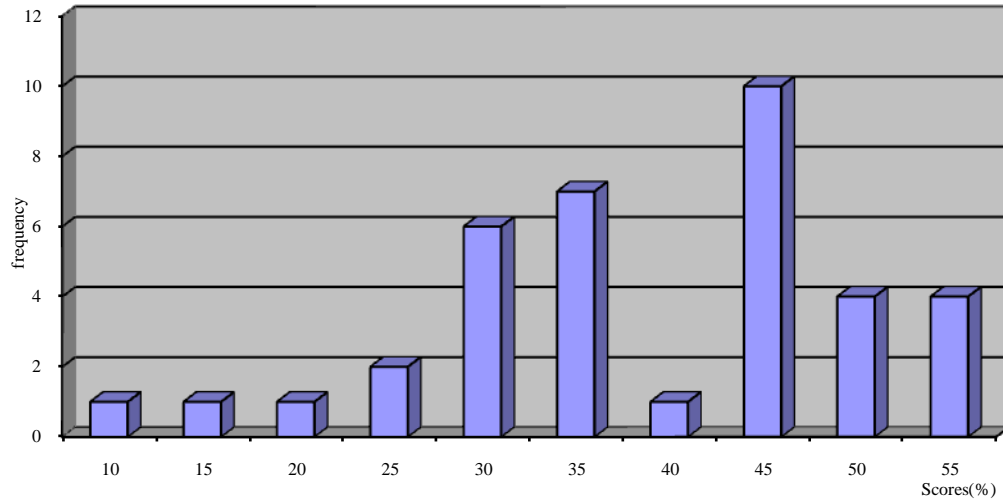


Table 4.33 and figure 4.6 indicate that most students of school **MS2** did not perform so well since most of them scored 45% and below

The performance of both mixed schools **MS1** and **MS2** were lower compared with those of single sex schools **BS1**, **BS2**, **GS1** and **GS2** since no single student scored more than 55%.

Table 4.34 gives the mean scores and standard deviation on the CHAT by school.

Table 4.34 Mean scores and standard deviation on the CHAT by school.

School	N	Mean score	Standard deviation
BS1	41	70.12	8.23
BS2	39	36.67	11.51
GS1	51	52.84	12.50
GS2	51	60.00	11.96
MS1	51	37.94	10.49
MS2	37	38.65	11.19

From table 4.34, it is notable that the mean score for the two girls' schools (**GS**) are closely related. The mean scores of the two mixed schools (**MS**) are also close to each other. It is also worth noting that the mean scores for three schools,

namely **BS2**, **MS1** and **MS2** are generally low which is an indication that scientific terms presented a problem to students in these schools.

A one-way analysis of variance (**ANOVA**) test was calculated to determine if there was any significant difference among the means of the three strata (Boys, Girls and mixed schools). Table 4.35 gives a summary of one-way ANOVA.

Table 4.35: Summary of one-way analysis of variance for the boys, girls and mixed Schools strata.

Source of variation	df	Sum of squares (ss)	Mean square (variance)	F
Between the means of samples	2	16831.78	8415.8	38.55
Within samples	267	58290.46	218.32	
Total	269	75122.24		

Critical value = 3.04 at 0.05

Since the calculated F value of 38.55 exceeds the critical value of 3.04 at 0.05 level of significance, the means of the three strata differ significantly.

The study endeavored to find out if there was a significant difference between girls and boys in responding to concepts related to scientific terms encountered during instruction. Table 4.36 and figure 4.7 give a summary of frequency distribution of scores for Girls and Boys on the CHAT

Table 4.36: Frequency distribution of scores for Girls and Boys on the CHAT

Scores (%)	Frequency (f)	
	Boys	Girls
10	0	1
15	2	1
20	7	5
25	10	1
30	10	7
35	11	16
40	14	7
45	15	18
50	10	19
55	10	16
60	6	16
65	3	13
70	12	15
75	11	5
80	3	3
85	3	0
N=	127	143

Figure 4.7: Bar chart showing frequency distribution of scores for boys and girls on the CHAT.

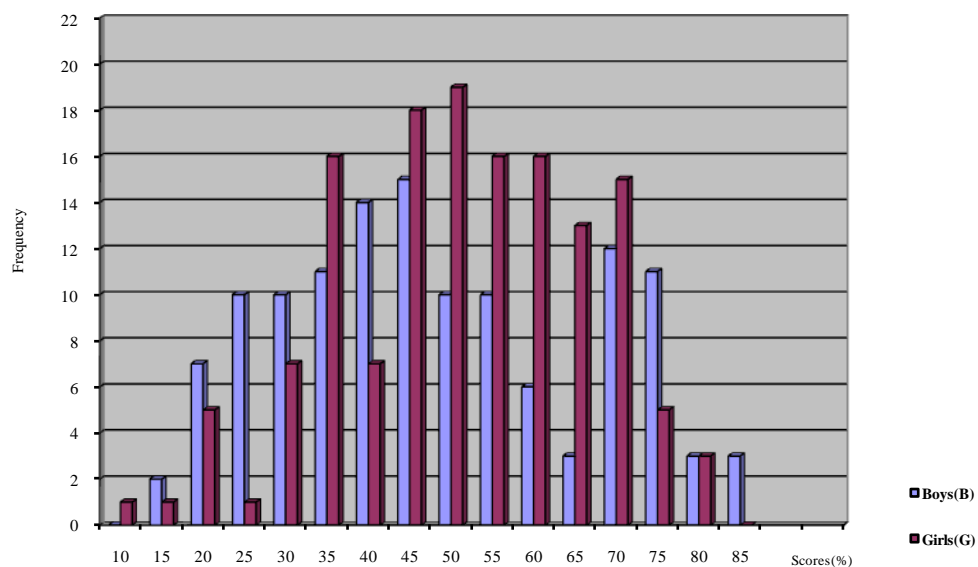


Figure 4.7 indicates that girls appear to out perform the boys in the Chemistry Achievement Test (CHAT) that emphasizes scientific terms.

The mean scores and standard deviation of Form three boys and girls on the CHAT were calculated to shed more light on what is observed in figure 4.7 as summarized in table 4.37.

Table 4.37: Mean score and standard deviation on CHAT by gender.

	N	Means score	Standard deviation
Boys	127	48.15	18.18
Girls	143	51.12	14.98

Table 4.37 shows that the mean score for girls on the CHAT is slightly higher than that of boys, a trend which was expected (Twoli, 1986). Girls might be using their natural language ability through socialization to transfer to science and specifically Chemistry learning.

A t-Test was determined to establish if this difference between means of boys and girls in responding to concepts related to scientific language is actually significant. Table 4.38 gives a summary of the t-Test.

Table 4.38: Summary of t-Test for the sex difference in scores on the CHAT.

	N	Means score	Standard deviation	t- value at 0.05 sig. level
Boys	127	48.15	18.18	1.454
Girls	143	51.12	14.98	

Critical value = 1.97 at 0.05

The calculated t-value of 1.454 does not exceed the critical t-value of 1.97 at 0.05 level of significance. Thus, there is no significant difference between Form three boys and girls in responding to concepts related to scientific terms special in Chemistry encountered during instruction.

4.3. Discussion of Findings

The specific objectives of this study formed the basis of the discussion of the findings. These objectives emphasized adequacy and appropriateness of definitions in Chemistry textbooks; use of scientific language by Chemistry teachers during classroom discourse; teachers' professional training and experience and their ability to highlight and explain scientific terminology special in Chemistry; and whether there was any significant difference in performance in Chemistry among girls and boys in relation to scientific language.

(a) Adequacy and appropriateness of definitions and explanations in Chemistry textbooks

The study revealed that most of the Chemistry textbooks used for purposes of instruction define and explain meanings of scientific terms labeling concepts. This implies that most of the current Chemistry textbooks approved by the Ministry of Education through K.I.E present the appropriate information. Hence, they may not be a source of low performance by students in Chemistry. The classroom context might be the problem.

(b) Use of scientific language by Chemistry teachers during classroom discourse

It imperative to note that the Chemistry teachers who participated in the study are aware of the role scientific language plays in students' understanding of concepts which results in increased performance of students in Chemistry. This agrees with Parkinson (1994) and Jones (2000) who reported that the teachers' competence in presenting scientific knowledge using language appropriate to

the learners' level of comprehension determines the effectiveness with which learning takes place since language is the medium through which students gain access to scientific ideas. Although the Chemistry teachers who took part in the study held the view that they often handle technical terms special in Chemistry during classroom discourse, a significant majority either partly explained or did not explain these terms during instruction. This came out clearly from the lesson observation sessions conducted using LOS (Appendix A). It is therefore essential that science teachers in general and particularly Chemistry teachers take careful attention when handling scientific terminology special in Chemistry during classroom instruction. In doing so, they enhance students' understanding of the technical terms special in Chemistry.

(c) Professional Training and Experience of Chemistry Teachers and their ability to highlight and explain scientific terms labeling Concepts.

Kuria (1999) and Jones (2000) asserted that presentation of scientific knowledge, concepts and skills using appropriate language largely depends on the teachers' experience and training. The results of this study contrasted the given assertion in that it revealed that despite most of the teachers involved in the research being professionally trained and experienced to teach Chemistry, they should by training be able to highlight and effectively explain scientific terms encountered during instruction but in practice they were not doing so. This may possibly, in part, be due to the teachers' insensitivity on the role the scientific language plays in determining students' performance in Chemistry.

(d) Students' Gender and Performance in Chemistry in relation to Scientific Language.

The study revealed that students were not fully able to grasp a number of scientific terms the teachers used during the period of lesson observation. This led to their low performance in the CHAT since the boys' mean score was 48.15 whereas the girls mean score was 51.12. But on average their mean score was 49.64, an indication that if teachers handle scientific terminology labeling concepts ineffectively it leads to low performance in chemistry by students. This finding is in agreement with Reed (1968) and Kamau (1996) who argued that proper use of scientific language in the Chemistry classroom discourse influences the performance of students in examinations. The finding of the study further lends support to that of Aigboman (1985), Jegede (2003, 2010) and Faleye (2004) who reported that lack of understanding of technical terms in science is partly responsible low performance in these subjects. For example, Jegede (2010) found out those Chemistry students in senior secondary schools perceived 39 (about 63%) out of 62 technical terms difficult to understand. For proper grasping of Chemistry concepts, these terms/words have to be understood.

This study also revealed that girls performed slightly higher than boys when it comes to handling concepts related to scientific terms (of verbal orientation) special in Chemistry encountered during instruction. This agrees with Kirkman (1997) and Twoli (1986) who noted that girls tend to outscore boys on tests of language.

4.4. Summary

This chapter gives the analysis of data collected both descriptively and inferentially.

- First was a presentation of the data in various forms that allow statistical interpretations;
- Followed by inferential statistical analyses through the use of chi-square to examine relationship between teachers' professional training and experience and their ability to highlight and explain scientific terms labeling concepts, one-way analysis of variance (ANOVA) for the three strata and t-Test to determine if there was any significant difference between means of Form three boys and girls.
- From the foregoing presented data, interpretation and discussion, Chemistry teachers, though professionally qualified and experienced, seem not to highlight and effectively explain scientific terms encountered during instruction.
- It is also imperative to note that students' understanding of scientific terms labeling concepts was rated fair. This was reflected in their performance in Chemistry in relation to scientific terms which they scored an average mean of 49.7%.
- It is also worth noting that girls performed slightly higher than boys when it comes to handling concepts related to scientific terms(of verbal

orientation) special in Chemistry encountered during instruction although this difference was not significant.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study sought to determine if teachers highlight and explain scientific terms special in Chemistry encountered during instruction and also find out whether there was a significant difference between Form three boys and girls performance in Chemistry in relation to scientific language.

The following were investigated concerning Chemistry teachers; professional qualifications, teaching experience (in years) and their chemistry teaching load and their ability to highlight and explain scientific terms. Students on the other hand were investigated in terms of their ability to comprehend the meaning of scientific terms that label concepts.

5.2 Summary and Implication of the Findings

5.2.1. Adequacy and appropriateness of definitions and explanations of scientific terms in Chemistry Textbooks.

The study revealed that Chemistry textbooks used for purposes of instruction adequately define and explain meanings of scientific terms labeling concepts. This implies that most of the current Chemistry textbooks approved by the Ministry of Education through K.I.E present the appropriate information. Hence, they may not be a source of low performance by students in Chemistry the classroom context might be the problem. This finding disagrees with the results obtained by Bob Chui Seng Yong (2010) who noted;

The readability of science textbook far exceeds the reading age of the students. In terms of the reading level, only about a third of the students were found to be reading at the instructional level while the majority were found to be at the frustration level. Moreover, results also showed that there was a positive significant association between student reading level and achievement in science (Bob Chui Seng Yong, 2010:59).

5.2.2. Use of Scientific Language by Teachers during classroom discourse

From the study results, the highest proportion of Chemistry teachers involved in the study held the view that both the science teacher and the teacher for English language are best suited to develop and improve the language abilities of science students. The implication of this finding is that there is need for proper coordination between the science teacher and the teacher for English language on how best they can assist the learner to develop strong competence in the use of both scientific language and the common English language as medium of interpretation of scientific knowledge. This is so since the teacher for English language teacher emphasizes personal language whereas the science teacher emphasizes impersonal language when describing scientific processes. Thus there is need to harmonize these differences through coordination among both the teachers for English language and Chemistry teachers.

The study further revealed that the Chemistry teachers who participated in the study were not able to highlight and effectively explain scientific terminology

which label concepts. As noted earlier the performance of students in Chemistry at K.C.S.E has been low, it appears that the Chemistry teachers might not be keen in clarifying scientific facts and principles using simple and clear irreducible language that can be comprehended by learners. This in essence led to low performance of students both in the interview (SIS) questions and achievement test (CHAT). It is therefore essential to organize in-service courses, such as SMASSE, that emphasize the importance of the use of scientific language during classroom discourse.

5.2.3. Teachers' Professional Training and Experience in use of Scientific Language during classroom discourse

It is worth noting that despite the Chemistry teachers involved in the study being professionally qualified and experienced to teach Chemistry, the study revealed that they were not able to highlight and effectively explain scientific terminology which label concepts. This finding disagrees with Kuria (1999) and Jones, (2000) who asserted that presentation of the scientific knowledge, concepts and skills using appropriate language is largely dependent on the teacher's experience and training, since a good teacher is a product of among other factors, experience and training. It appears that teachers do not take time to reflect on the impact of scientific terms on students' understanding of concepts. Hence there is need to sensitize them on the importance of scientific language on students' performance in Chemistry.

5.2.4. Gender and Performance in Chemistry in terms of Scientific Language

The findings of this study revealed that students were unable to grasp a number of selected scientific terms the teachers used during the period of lesson observation which in effect was reflected by the low performance in the achievement test. This finding lends support to that of Aigboman (1985) and Jegede (2010) who in their findings from similar studies concluded that students' poor performance in certificate examinations might be due to poor understanding of technical words in Physics and Chemistry respectively. This demonstrates the importance of teachers' role in highlighting and ensuring clarity in explaining scientific vocabulary, since careful attention to such terminology may raise the performance of students in chemistry. If teachers assume such terminology, students will continue to perform poorly in Chemistry.

5.3. Conclusion

The Chemistry teacher plays a significant role in determining the performance of students. Hence for the teacher to play his/her role effectively in highlighting and effectively explaining scientific terms special in Chemistry, there is need to in-service them on the importance of scientific language on the performance of students in Chemistry. It is also worth noting that Form three boys and girls equally performed in chemistry in relation to scientific terms since there was no significant difference between their mean scores in the CHAT. This is a good indication that gender disparity may not be a factor in determining students'

performance in chemistry in relation to scientific language. In view of these, there is need to exploit this gender parity.

5.4. Recommendations for action

- The study has shown that many students did not perform well in chemistry with respect to the chemistry terms. To assist them in the development of this area, chemistry teachers in the field be in-serviced on the role the scientific language plays in the performance of students in chemistry.
- To be effective in focusing on chemical terms, teachers should make a point to include specific terms in their lesson plans. This will ensure that they emphasize and help students understand these terms.
- Teachers of language and science should have constant consultation and cross referencing when handling special terms.

The following might also be useful to curriculum developers and workers. The study recommends that:-

- The curriculum developers emphasize the importance of scientific terms special to Chemistry on students' understanding of concepts in chemistry.
- Science teachers' training institutions introduce a topic emphasizing scientific language skills to impart on teacher trainees knowledge of effectively handling scientific terms special to science in general and Chemistry in particular.

5.5. Recommendations for further Research

There are areas exposed by this study that require further investigation. It is recommended that further studies be carried out to:-

- (i) Investigate teachers' gender and ability to highlight and handle scientific terms labeling concepts.

- (ii) Investigate the effects of students' attention and progression in chemistry performance and school in general.

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APPENDICES

APPENDIX A: LESSON OBSERVATION SCHEDULE (LOS)

SHEET NO. _____

(To be filled by the researcher while observing the lesson)

The purpose of this instrument was to find out how chemistry teachers handle scientific language (scientific terminology/vocabulary) during chemistry classroom discourse.

General information about the teacher and the school

Date _____ Name of the school _____

Type of the school _____ Class _____ No. of students _____

Teacher's gender _____

Scientific terms/vocabulary	Teacher's intervention/ skill in explaining			
	Well explained	Partly explained	Not explained	Comments
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10				

Criteria for Judging:

- (a) Repeating (number of times) to stress its use or the importance of the scientific term/vocabulary.

- (b) Use of examples, diagrams, pictures, models, chemical symbols and equations and objects to illustrate the meaning of the scientific terminology/concept.
- (c) Showing /demonstrating the process represented by the scientific word (e.g. titration evaporation, crystallization etc) taking place or use of models and/or flowcharts.
- (d) Use of everyday synonyms.
- (e) If the word for a concept is used in everyday language with a different or less specific meaning then particular care must be taken to explain that concept (e.g. salt)
- (f) Using root words e.g. **Exo** – give out ; **Thermal** – heat (**exothermic** – give out heat)

Footnote:

Explanations of the scientific terms are pegged on the standard definitions and explanations given in the Chemistry text books and scientific dictionaries. Explanations of such terms were based on the concept in which the terms are employed. These explanations are purely teacher centered.

APPENDIX B: CHEMISTRY TEACHERS QUESTIONNAIRE (CTQ)

The purpose of this questionnaire is to solicit information on the use of scientific language by practicing teachers of chemistry in Kenya's secondary schools.

Your kind and honest cooperation will go along way in assisting to achieve the goal of this study and improve the use of scientific language in fostering learning among Kenya's secondary schools students. You are requested to give personal views, opinions and answers. The information obtained will be treated with **confidence**. You need not write your name anywhere in this questionnaire. Tick (✓) the relevant/ appropriate answers or fill in blank spaces. No answer is necessarily correct or wrong. Feel free to give answers you consider appropriate.

Thank you for accepting to participate in this research study.

SECTION A: General Information about the Teacher and the School

1. Type of school: Boys [] Girls [] Mixed []
2. Indicate your gender: Male [] Female []
3. Highest academic qualifications
Dip. Ed (Science) [] B.sc. [] B.sc./P.G.D.E [] B.Ed [] M. Ed. []
Others (specify)
4. For how long have you been teaching chemistry? (Years)
Less than 4 [] 4-7 [] 8-11 [] 12- 15 [] More than 15 []
5. How many chemistry lessons do you teach per week?
Less than 15 [] 16-20 [] 21-25 [] More than 25 []
- 6 Have you ever attended an in-service course or workshop related to the teaching of chemistry? Yes [] No []
If yes, how long ago? (Please tick accordingly)
1 – 2 yrs ago []
3 – 5 yrs ago []
More than 5years ago []

SECTION B: Information on the use of the scientific language in chemistry classroom discourse.

I. The statements below show how teachers handle scientific language during classroom discourse. Show with a tick (✓) how often you perform the following tasks.

<i>Tasks</i>	Always (A)	Often (O)	Sometimes (S)	Rarely (R)	Not at all (N)
1. When preparing schemes of work I highlight new scientific terms (vocabulary) to be encountered during classroom discourse					
2. When preparing for a lesson I make a list of scientific words/terms that need specific attention during the lesson					
3. When constructing test items I consider the technical terms special to chemistry subject.					
4. For any chemistry textbook recommended for use as a class text by MoE, through K.I. E, I read through it before use to:	X	X	X	X	X
(a) find out the language level					
(b) Establish if scientific terms are well defined/explained.					
5. I define/explain scientific terms whenever I use them during the lesson					

NB: MoE = Ministry of Education

K.I.E = Kenya Institute of Education

II. Is the development of scientific vocabulary among your chemistry objectives?

Yes [] No []

If Yes, how?

.....

If No, why?

III. What is your opinion on students' understanding of the meanings of scientific terms?

Very poor [] Poor [] Fair [] Good [] Very good []

IV. How often do students seek clarifications of the meanings of scientific terms?

Never [] Rarely [] Sometimes [] Often [] Always []

V. In your view, do chemistry textbooks outstandingly define/explain meanings of scientific terms labeling concepts? Yes [] No []

VI. In your view is low performance in chemistry by secondary school students affected by teachers' failure to explicitly define/explain scientific terms?

No [] Yes []

VII. Teachers don't include definitions/explanations of scientific terms in their lessons because textbooks assumed them. What is your opinion? Please tick (✓) the phrase that applies best. (NB: **SD** – Strongly Disagree, **D** – Disagree, **U** – Undecided, **A** – Agree **SA** - Strongly Agree)

SD [] D [] U [] A [] SA []

VIII. Whom do you think is best suited to develop and improve the language abilities of science students?

The science teacher [] The English language teacher [] Both []

Suggest a reason for your choice

.....

IX Students sometimes have difficulty comprehending certain concepts when expressed in technical vocabulary. How do you help them out of such situations?



APPENDIX C: STUDENT INTERVIEW SCHEDULE GUIDE (SIS)

The researcher was guided by the class texts, chemistry syllabus, and the schemes of work in constructing appropriate questions involving the scientific terms used during the lessons observed for use in the interview.

These were:

1. When ammonia gas is dissolved in water the solution formed turns red litmus blue since it undergoes **ionization** whereas in methylbenzene it does not turn red litmus blue. What is **ionization**?

- *Breaking/splitting into ions*

2. **50% concentrated** nitric acid reacts with copper metal in the preparation of nitrogen (II) oxide. What do you understand by the term **50% concentrated nitric acid**?

- *Nitric acid added to equal amount of water.*

3. When carbon undergoes **combustion** it produces a lot of heat with the evolution of carbon (IV) oxide. What is **combustion**?

- *Burning in the presence of air.*

4. Acidified potassium manganate (VII) is a strong **oxidizing agent**. What is meant by an **oxidizing agent**?

- *A substance that adds oxygen to another substance // a substance that gains electrons from another substance // a substance that removes hydrogen from another substance.*

5. The reaction that produces ammonia in the Haber process is **exothermic**. What is meant by **exothermic**?

- *Giving out heat.*

APPENDIX D: CHEMISTRY ACHIEVEMENT TEST (CHAT)

(Administered to all form three students under observation)

Put a tick (✓) where appropriate.

Type of school: Boys [] Girls [] Mixed []

Indicate your gender: Male [] Female [].

NB: You need not write your name anywhere in this paper.

INSTRUCTIONS

Attempt all the questions in this paper.

Put a tick (✓) mark against the suitable choice.

For example:

What is meant by Isotopes?

[] A: Atoms of an element with the same atomic mass.

[] B: Molecules of an element with the same atomic number but different mass number.

[✓] C: Atoms of the same element with the same number of protons but different number of neutrons.

[] D. Atoms of the same element with the same number of neutrons but different number of protons.

1. Helium is used to fill light bulbs to prevent **oxidation** of the filament since helium is inert. What is meant by oxidation?

[] A: Gain of electrons

[] B: Addition of oxygen

[] C: Addition of hydrogen

[] D: Removal of air.

2. When chlorine gas is passed into **molten** sulphur, a red substance of sulphur (II) chloride is formed. Molten sulphur refers to:-

- A: Aqueous sulphur
- B: Hot sulphur
- C: Liquid sulphur
- D: Solution of sulphur

3. The type of bond formed between two elements is determined by the **valence electrons** of the elements. What is meant by valence electrons?

- A: These are the total number electrons in an atom.
- B: These are electrons in the outermost energy level of an atom.
- C: These are electrons gained by an atom to achieve the stable state.
- D: These are electrons occupying the innermost energy level of an atom.

4. Nitrogen (IV) oxide gas when cooled undergoes **condensation** to form a yellow substance called dinitrogen tetra oxide. What is meant by condensation?

- A: A process of trapping water from the air
- B: A process of changing a gas to liquid
- C: A process of losing heat to the air
- D: A process of squeezing water out of a substance.

5. Hydrogen gas used in the Haber process, in the manufacture of ammonia, is obtained from **cracking** of large molecules of hydrocarbons. What is meant by cracking?

- A: Breaking down long chain hydrocarbons to small molecules by heating.
- B: Destroying long chain hydrocarbons by burning
- C: Reducing long chain hydrocarbons using heat or catalyst
- D: Combining large molecules of hydrocarbons to form polymers

Read carefully the following information and use it to answer questions 6 -9.

A group of Form Three students of Matui Girls secondary school, in an attempt to prepare carbon (**IV**) oxide gas, used Calcium Carbonate and **dilute** sulphuric acid. Production of **effervescence** stopped immediately the reaction started due to the formation of a **precipitate** of calcium sulphate preventing further reaction.

What is meant by:-

6. Dilute acid

A: Solution in which the acid molecules are more than the water molecules

B: It is an acid solution that contains a high proportion of acid.

C: It is an acid with more hydrogen ions in a given volume of water.

D: It is an acid solution with less hydrogen ions per given volume of water.

7. Effervescence

A: Production of colourless solution

B: Evaluation of bubbles of gas

C: Eating away of solid substance.

D: Production of water.

8. Precipitate

A: A white solution of an insoluble salt

B: A soluble salt that coagulates from two soluble salts.

C: An insoluble salt formed and separated from solution.

D: A coloured solution that separates out from a colourless solution.

9. What does IV in brackets represent?

A: The oxidation number of carbon.

B: The oxidation number of oxygen

C: The valency of oxygen.

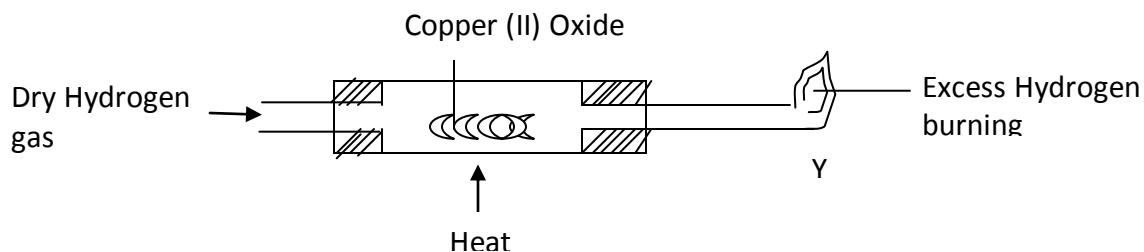
D: The electron affinity of carbon.

10. The principle behind the preparation of nitric (V) acid in the laboratory using a metal nitrate and concentrated sulphuric acid is: less **volatile** acid displaces a more **volatile** acid from its salt.

An acid is said to be volatile if:-

- A: It does not break up easily on heating
- B: It does not change into vapour easily
- C: It catches fire easily.
- D: It changes easily into vapour.

Study the diagram below and use it to answer questions 11 and 12.



Unreacted hydrogen gas is burned at point Y since it **explodes** when allowed to mix with air.

11. Which statement best describes the meaning of the term explodes?

- A: Increases in size.
- B: Bursts with great force into flames.
- C: Breaking up into pieces.
- D: Combining with nitrogen in air.

12. Hydrogen gas **reduced** copper. What is meant by the term reduced?

- A: Adding oxygen to a substance
- B: Removing oxygen from a substance
- C: Removing electrons from a substance
- D: Breaking a substance into smaller substances.

13. When water is added to a solution, the **concentration** of the solution decreases. What is meant by concentration of a solution?

A: It is the percentage of solute in a given amount of solvent.

B: It is the percentage of a solute in 1dm^3 of solvent.

C: It is the amount of substance in a 1 dm^3 of solution.

D: It is the amount of substance contained in 1dm^3 of water.

14. Calcium achieves stability by losing its two valency electrons to form a **divalent cation**. What does divalent cation mean?

A: A positively charged ion with a valency of one.

B: A negatively charged ion with a charge of $2-$.

C: A positively charged ion with a charge of $2+$.

D: An atom with two ions.

15. Which one of the following is the correct **ionic equation** representing a **neutralization** reaction?

A: $\text{H}^+_{(\text{aq})} + \text{OH}^-_{(\text{aq})} \rightarrow \text{H}_2\text{O}_{(\text{l})}$

B: $\text{H}_2\text{O}_{(\text{l})} + \text{H}^+_{(\text{aq})} \longrightarrow \text{H}_3\text{O}^+_{(\text{aq})}$

C: $\text{H}^+_{(\text{aq})} + \text{CO}_3^{2-}_{(\text{aq})} \longrightarrow \text{CO}_2 + \text{H}_2\text{O}_{(\text{l})}$

D: $\text{H}_3\text{O}^+_{(\text{aq})} \longrightarrow 2\text{H}^+_{(\text{aq})} + \text{OH}^-_{(\text{aq})}$

16. Most carbonates undergo **decomposition** on heating. In other words they

A: Increase in mass

B: Combine with other substances.

C: Separates into elements.

D: Break down into smaller substances.

17. When solid magnesium carbonate was added to a solution of hydrogen chloride gas in methylbenzene, there was no observable change. On addition of water to the resulting mixture there was vigorous production of bubbles of colourless gas because hydrogen chloride gas dissolved in water and **dissociates**.

Hydrogen chloride gas when dissolved in water dissociates. This means it_____

- A: Combines with water
- B: Breaks into ions
- C: Is surrounded by water molecules
- D: Becomes very reactive

18. Large scale production of Chlorine gas required in the bleaching industry is obtained from the electrolysis of **brine**. What is brine?

- A. A mixture of ammonia and sodium chloride solution
- B. A solution of sodium chloride.
- C. Concentrated solution of sodium chloride in water.
- D. Molten sodium chloride.

19. An **aqueous** solution of hydrogen chloride reacts with metals higher than hydrogen in the reactivity series liberating hydrogen gas. What is an aqueous solution?

- A: A solution of a substance in solvent.
- B: A solution of a substance in water.
- C: A solution that turns red litmus paper blue.
- D: A solution made by dissolving a substance in an organic solvent.

20. In the manufacture of sulphuric acid, using the Contact process, air is first purified before passing it to the catalytic chamber to minimize **poisoning** of the catalyst. What is meant by poisoning of the catalyst?

- A: Making the catalyst to melt into liquid
- B: To kill the catalyst
- C: Causing the catalyst to combine with air
- D: Making the catalyst less effective

Well done for attempting these questions.

APPENDIX E: MARKING SCHEME FOR THE CHAT
(One point per item)

Item No.	Key
1.	B
2.	C
3.	B
4.	B
5.	A
6.	D
7.	B
8.	C
9.	A
10.	D
11.	B
12.	B
13.	C
14.	C
15.	A
16.	D
17.	B
18.	C
19.	B
20.	D

APPENDIX F: RESEARCH PERMIT

PAGE 2

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss CHEPYEGON
CHEPSANG

of (Address) KENYATTA UNIVERSITY
PO BOX 43844 NAIROBI

has been permitted to conduct research in.....

.....**Location,**

.....BARINGO.....**District,**

.....RIFTAVALLEY.....**Province,**

on the topic USE OF SCIENTIFIC LANGUAGE

IN INSTRUCTION AND PERFORMANCE

IN CHEMISTRY: A CASE OF SELECTED

SCHOOLS OF KABARNET DIVISION,

BARINGO DISTRICT

for a period ending 30TH JUNE, 2010

PAGE 3

Research Permit No. NCST/RRI/12/1/SS/54/5

Date of issue 16.02.2010

Fee received SHS 1000



Amul
Applicant's
Signature

Phum
Secretary
National Council for
Science and Technology

CONDITIONS

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



REPUBLIC OF KENYA

RESEARCH CLEARANCE
PERMIT

GPK6055t3mt10/2009

(CONDITIONS— see back page)