

**EXPLORATION OF TOPIC AREAS THAT TEACHERS AND
STUDENTS PERCEIVE DIFFICULT IN CHEMISTRY AT
SECONDARY LEVEL IN NAIROBI (KENYA)**

BY

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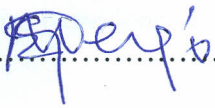
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DECLARATION

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

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DEDICATION

This work is dedicated to my high school chemistry teacher, Mr. Lusambiri formerly of Kakamega High School, who introduced me to basic chemistry and a feeling of difficulties experienced in learning of chemistry.

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ABBREVIATIONS AND ACRONYMS

- CSQ** Chemistry Students' Questionnaire.
- CTQ** Chemistry Teachers' Questionnaire.
- GOK** Government of Kenya.
- K.C.S.E** Kenya Certificate of Secondary Education.
- K.I.E** Kenya Institute of Education.
- K.S.T.C** Kenya Science Teachers College.
- KNEC** Kenya National Examinations Council.
- PDE** Provincial Director of Education
- PSSC** Physical Science Study Committee; responsible for physical science curriculum development in U.S.A.
- SMASSE** Strengthening of Mathematics and Science in Secondary Education;
- SSP** School Science Project.
- UNESCO** United Nations Education, Scientific and Cultural Organization.

ABSTRACT

Most researchers are keen to find out factors that lead to poor performance in National examinations in specific subjects. Among the subjects not well performed are the physical sciences, chemistry included. Despite the frequent changes in the chemistry curriculum at secondary school level, overall performance remains low in national examination with some topic areas still constantly posing difficulties to students and teachers. The factor of teachers' and students' perception of difficult topics in Chemistry had not been explored. The study therefore, explored teachers' and students' perception of difficult topic areas of selected topics in secondary school Chemistry basing on research questions and objectives of the study. One outstanding difficult topic electrochemistry was identified as per the responses of students after piloting and a test was set on it for in-depth study on elements making it difficult. The study was conducted in Nairobi province of Kenya and adapted a descriptive survey design. A total of nine (9) sample schools were drawn using a combination of stratified and random sampling procedure. Following categories of national and provincial, the schools were stratified into boys, girls and mixed. Random sampling followed the stratification. A questionnaire for both teachers and students and an interview schedule for teachers were used. Data collection was preceded by a pilot study in three schools; mainly to determine the validity and reliability of the instruments. The data collected was analyzed and presented using descriptive statistics, mainly frequencies and means. The findings revealed the following: 25% (4/16) of topics in the students' questionnaire were perceived to be difficult as per responses from boys' and girls' schools; while responses from mixed schools revealed 50% (8/16) topics as being difficult. Teachers' responses were: approximately 31% (5/16) of the topics were perceived difficult. In comparing teachers' and students' responses the following were the findings: 12.5% (2/16) of the topics were perceived difficult from both boys' and girls' schools while mixed schools shared 25 % (4/16). In terms of actual topics, Electrochemistry, Mole Concept, Organic Chemistry (II), Radioactivity and Energy Changes stood out as the main difficult topics. The difficulty was attributed to mathematical component, large concept map and abstract nature. Teachers indicated some strategies of dealing with difficult topics. These included: using practical approach, more practice assignments, pacing and motivation of learners. The difficult topics may be the most important in laying foundation in chemistry and if one has to do well, then these have to be firmly understood.

CHAPTER 1: INTRODUCTION

1.0 Introduction

The focus of this study is on teachers' and students' perceptions of difficult topic areas in the chemistry syllabus at the secondary school level. This chapter covers the background to the study, highlighting the rationale for the study and also giving the statement of the problem. The purpose, objective of the study and the specific research questions are provided. It concludes with the significance, assumptions, limitation, scope, conceptual framework and definition of terms.

1.1 Background to the Study

The secondary school chemistry curriculum in Kenya has evolved a lot since Kenya's independence in 1963. It has shifted in content, method of teaching and learning based on new objectives of the course. The main objectives of the course emphasize acquisition of manipulative skills and process skills, to be delivered via practical work. The other part of chemistry which is emphasized is the learning of concepts. There are many concepts in chemistry at this level. These include amongst others bonding, mole concept, rates of reaction, energy changes and electrolysis (KNEC, 2005).

The present chemistry syllabus has incorporated topics which are relevant to the life of learners. It requires teaching which refers to local examples such as industries where carbon dioxide is used as ingredient in soft drinks, under carbon and its compounds, health where magnesium is used in the synthesis of anta-acids, and environment where calcium hydroxide is used to reduce acidity in acidic soils all under acid, base and salt topic. This is supposed to show relevance and motivate learners (Twoli, 2006).

1.1.1 An Overview of the Evolvement of the Chemistry Curriculum

Changes to chemistry curriculum have been due to world-wide changes especially by U.S.A. and UK. There were many reasons which made Kenya and other developing countries to react to change and these include:

- A lot of science taught was theoretical.
- The course was rather abstract, lacked relevance to daily life of the students, therefore teachers and students found a lot of the content rather difficult (Bassey, 1963).

Woolnough and Allsop (1976) observed that practical work in science, worked to improve chemistry through laboratory, analysis of text materials, visual communication assessment methods in chemistry, whose essence was to avoid abstraction and cramming of concepts and knowledge which ought to be understood. Students with difficulty in memorizing felt handicapped, as observed in Nuffield science teaching project which generated imaginative ways of teaching the subject (Brian, 1967). The project was to develop material that would help teachers to present science in a lively, exciting and intelligible way and give learners a lasting sense of understanding chemistry as a structure of concepts.

A number of attempts have been made to improve teaching of chemistry at secondary school level. For example in 1960 there was the initiative by the African Curriculum Development Centre and Kenya Institute of Education (K.I.E) that attempted to write the whole syllabus to guide teachers by including learning procedures for practical and projects. However, the teaching work plans did not take into consideration the diversity of situation that the teachers found themselves in, like lack of teaching

resources and trained staff, therefore perceiving the curriculum difficult. As such, this initiative didn't succeed (Maundu, 1998).

In the 1960's UNESCO pilot project brought in some chemistry student materials that were to serve as laboratory manuals and a teachers' guide. They contained general information on subject matter and viewpoint of the course. However the standard of laboratory equipments required by the course was not available in most schools and the teaching was, therefore, theoretical with a lot of cognitive demand on the part of students. In 1969 the Nuffield approach to the teaching and learning of sciences was piloted in some Kenyan schools and the problem that faced the approach was lack of equipment.

Soon after the Nuffield project, came School Science Programme (SSP) in 1973, which was modelled on the Nuffield science methods. SSP also faced the same problem as the Nuffield. The SSP placed great demand on intuitive powers of the students and the need to continuously provide a hands-on approach (Amadalo, 1998). It was later abandoned due to poor staffing (inadequate qualified teachers), inadequate learning resources and the education system being examination oriented.

Despite the plausible aims of the initiatives to making teaching and learning of chemistry easy, teachers and students never got to benefit. The teaching of chemistry fell back to the traditional approach which is expository and emphasized theory. Eshiwani, (1982) observes that this is not scientific and therefore teachers and students found some topic areas difficult to handle. Since then there has been the Kenya's own version of the chemistry syllabus which follows the 8-4-4 system of Education. The 8-4-4 chemistry curriculum puts emphasis on science process (method

Table 1.1: The National Performance in Chemistry Papers over Five Years (KNEC 2003-2007)

Year	Paper	Candidature	Maximum Mark	Mean Scores (%)	Standard deviation
2003	233/1 :Theory		70	22.85	16.75
	233/2 :Theory		80		
	233/3 :Practical		40	14.55	7.02
	Overall	198,016	190	37.42	22.86
2004	233/1 :Theory		70	25.40	16.19
	233/2 :Theory		80		
	233/3 :Practical		40	14.22	5.46
	Overall	214,520	190	39.62	20.00
2005	233/1 :Theory		70	24.50	18.24
	233/2 :Theory		80		
	233/3 :Practical		40	13.56	5.90
	Overall	253,508	190	38.05	23.00
2006	233/1 :Theory		80	20.79	14.95
	233/2 :Theory		80	17.56	13.82
	233/3 :Practical		40	11.48	5.1
	Overall	236831	200	49.82	32.00
2007	233/1 :Theory		80	19.67	15.26
	233/2 :Theory		80	19.22	13.45
	233/3 :Practical		40	11.87	4.95
	Overall	267719	200	50.78	31.00

Source: KNEC Newsletter (2004, 2005, 2007)

From Table 1.1 the following observations can be made:

- i. The candidature in chemistry has continued to grow over the years, with an exception of the year 2006 where a slight drop was noted.

- ii. With regard to overall performance, it is observed that there is a swing up and down in the mean score of all the chemistry papers, the mean score has been consistently low as evidenced in Table 1.1.
- iii. The mean and standard deviation from 2003 to 2005 is computed on paper one (233/1) and paper two (233/2) which were marked out of 70 and 80 respectively. In the subsequent years the mean was calculated separately on the two papers, and both were low.
- iv. The practicals are marked out of 40 and the score has a heavy bearing on the final score of the chemistry paper in whole. But the practical performance is low in all years captured in the table therefore affecting chemistry performance

Table 1.2: The National Percentage Mean Score in Chemistry by Gender (2004 to 2007)

Year	Paper	Percentage Mean	
		Male	Female
2004	233	30.43	25.79
2005	233	29.44	24.54
2006	233	27.01	22.56
2007	233	27.69	22.65

KNEC Newsletter (2004-2007)

From Table 1.2 the following can be observed.

Mean score percentage for girls' from 2004 to 2007 is as follows 25.79%, 24.54%, 22.56%, and 22.655% respectively, while for boys' is 30.43%, 29.44%, 27.01% and 27.69% respectively. This is an indicator that a good number of students' have problems on set items, across boys' and girls' when it comes to responding to chemistry questions.

1.2 Statement of the Problem

It has been observed that science subjects are generally not well performed in the examinations, chemistry included (Twoli, 1986). Despite the frequent changes in the chemistry curriculum at secondary school level in both content and methodologies, the overall performance remains low in National Examination as shown in (Table 1.2). This may mean that some topics are not performed well. This research set out to investigate difficult topics in chemistry and reasons for the perceived difficulty among students and teachers. This was out of consideration that identification of difficult topics could be used to alleviate the problem. If that is done, learners are likely to perform better on the topics and improve in the chemistry performance in general. Improvement in chemistry will mean improvement in other courses related to chemistry.

1.3 Purpose of the Study

This study attempted to establish difficult topics in chemistry and possible reasons for the difficulty.

1.4 Specific Objectives of the Study

The study was guided by the following objectives:

- (1) To identify the topic areas of the chemistry syllabus that is considered difficult by teachers and students.
- (2) To establish the reasons teachers attributed to difficulty they experience in teaching and learning the topic areas.
- (3) To establish the instructional strategies used by teachers on difficult topics areas.

- (4) To compare perception of difficulty in common topic areas between teachers and students to establish similarities or differences in teaching and learning.

1.5 Research Questions

The following were the specific research questions for the study:

- (1) Which topic areas of the chemistry syllabus did students perceive as difficult?
- (2) Which topic areas of the chemistry syllabus did teachers perceive as difficult?
- (3) What are the reasons students and teachers attribute to the difficulty they experience when learning/teaching the topic areas considered difficult?
- (4) What are some of the strategies teachers use in the instruction of difficult topics (concepts)?

1.6 Significance of the Study

The findings of the study can be a basis for, identifying topic areas that can be emphasized more in the pre-service training of chemistry teachers. In addition, it should be used in preparing programs for in- service courses for the chemistry teachers and assisting chemistry teachers in reflecting about their methods of presentation in teaching some of the topics. It also provides a framework for future identification of difficulties in the teaching of some topics in chemistry. In addition it brings out the conceptual difficulty experienced by the students in the learning of chemistry. Lastly by improving chemistry subject curriculum, it makes it interesting to both teachers and learners.

1.7 Assumptions of the Study

Some assumptions are made in the study and the following are the main ones.

- (1) The sample used in the study is a representative of the wider population in Nairobi.
- (2) The reliability and validity of instrument used were relevant.
- (3) The teachers use similar approach in teaching chemistry

1.8 Scope of the Study:

This study focused on Form Four chemistry students in Nairobi province. The choice of the form four students is out of the realization that they had experienced most, if not, all the topics in the chemistry syllabus. Consequently they would give an honest perception of the topic.

1.9 Theoretical framework

John Dewey (1859 – 1952) believed that structured experience matters and disciplinary modes of inquiry could allow the development of the mind, thus creating dialectic between the child and the curriculum that the teacher must manage. The teacher's goal is to understand both the demands of the discipline and the needs of the child and then to provide learning experiences to enable the student to uncover the curriculum. Dewey believed that the ability of a person to learn was dependent on many things, one of which was the environment. (Wirth, 1966). "When education is based upon experience and educative experience is seen to be a social process, the situation changes radically. The teacher loses the position of external boss or dictator but takes on that of leader of group activities." (Dewey, 1938).

1.10 Conceptual Framework

The difficulty in topics/content areas by students can be due to a number of factors, among them, the Academic Learning Time. It has been shown that academic learning time is related to performance (Twoli, 1986). Abilities that student possess play a role,

spatial ability assists in mastery of abstract contents and vice versa. Mathematical skills help in mastery of content/topic that requires mathematics, for example the Mole, Neutralization and Physical Chemistry. Ability to conceptualize subject matters is an important factor. With less ability, the level of difficulty in content/topics experienced is high; if the student has difficulties in both skills, mathematical and spatial.

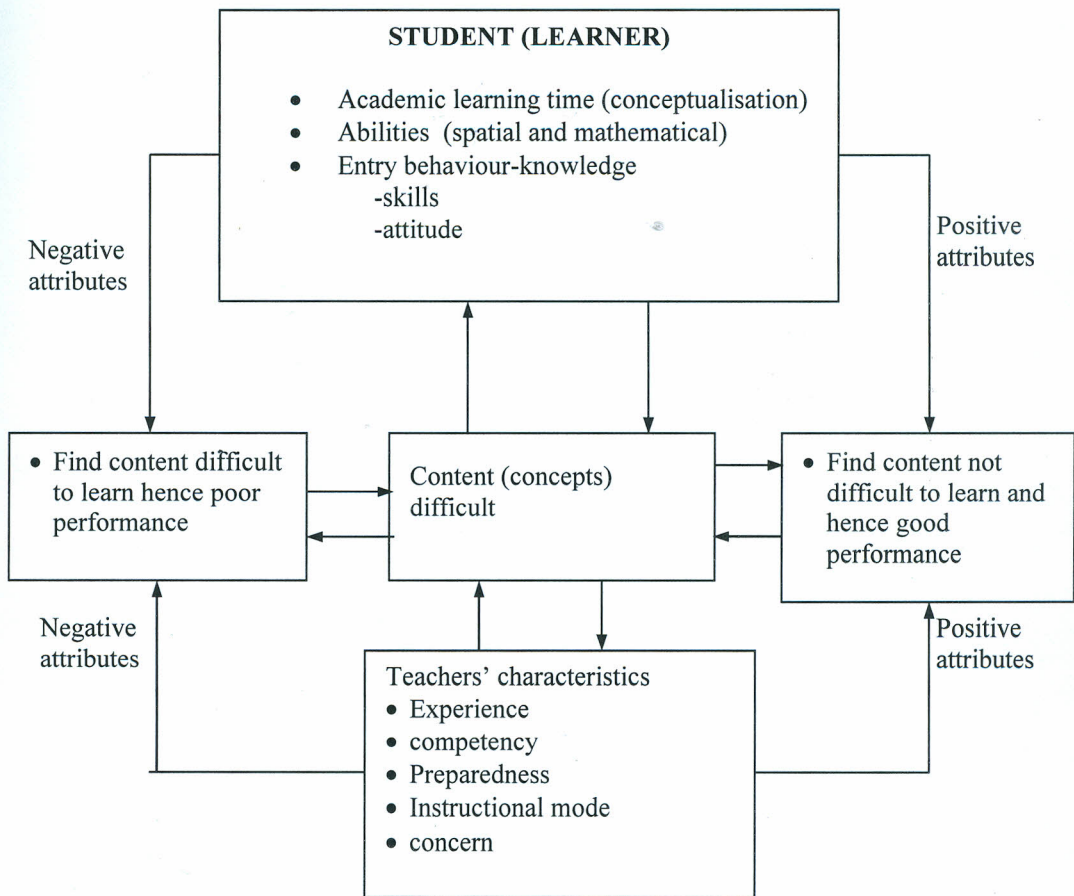


Figure 1.1: Conceptual framework

Entry behaviour which encompasses knowledge, skills and attitude plays a big role in understanding of content. For the teachers, difficulty in concepts/content in topic areas may be due to their mastery in content and professional skills, inaccurate assumptions of learners' abilities, limited teaching resources and content not related to

real life situation and therefore not appealing to students. When teachers and students perceive topic areas not being difficult, the outcome is high performance due to proficiency in content, enhanced science skills and ability to apply concepts of the topic areas. The other positive outcome is the favourable appeal that the subjects attain and consequently high accessibility to many students.

1.11 Definition of Terms

Difficult Concept: Content in chemistry syllabus, which are not well understood hence low internalization.

Mathematical skills: ability to compute mathematical entity using given operations.

Performance: The mean scores student score in K.C.S.E chemistry examination.

Public schools: Schools that are formally supported by the government in terms of grants subsidy and teacher recruitment.

Spatial abilities: abilities of students to think in space on abstract matters for understanding

Difficult topic: topics in chemistry syllabus that both learners' and teachers' find difficult.

Large concepts maps: Topic relating to many areas in it like mole concept relates to many areas like electrons, gases solutions, and solids.

Abstract concept: concept with no concrete experience.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

The difficulty experienced in teaching and learning topics in Kenya secondary chemistry course is one area that has had little emphasis in chemistry education in Kenya. This chapter gives a review of literature that provides insight into various areas related to learning difficulties in Chemistry. This includes: A chemistry curriculum, concept learning, and performance in chemistry, attitude, prior knowledge, learning styles and abilities, practical work, teachers' and students' factors affecting learning chemistry

2.1 Concept Acquisition in Chemistry

Concept acquisition and understanding can be used interchangeably. Once a concept has been internalized, remembering and applying it becomes easy. If a concept is not understood, there are two things that may happen. The learner would attempt to accommodate it in his/her memory by either rote learning or alternatively the learner disregards it altogether (Howard, 1989). Archenhold (1976) observed that particular knowledge is often forgotten, especially if it is taught in isolation and without active participation of the students. He further observed that the most difficult type of material to relate is that which consists of seemingly unrelated parts, bits that cannot be readily put together into some meaningful pattern. This may be what is happening in the chemistry in Kenya, resulting in conceptual difficulties and subsequent poor performances registered over the years.

Understanding is part of the chemistry education objectives in the Kenyan syllabus. However, the term understanding is somewhat vague and elusive (Howard, 1989). It may refer to being able to visualize a concept, to construct a useful representation

model, or to know and to find a plausible schema (mental framework) that allows one to assimilate the concept into what one already knows.

2.2 Aims of the Chemistry Curriculum

Bassey (1963) summarizes the generally agreed aims of secondary school science education under three headings, namely:

1. Understanding of simple aspects of nature of material world.
2. An appreciation of the major achievements of science and of its significance in the world
3. An ability to approach problems in a scientific manner.

These aims are mirrored in the general objectives for the Kenya chemistry curricula K.I.E (2002). These general objectives state that by the end of the course, learners should be able to:

- i. Select and handle appropriate apparatus for use in experimental work.
- ii. Make accurate measurements, observation and draw logical conclusions from experiments.
- iii. Observe and appreciate the need for safety precaution during experimental investigation.
- iv. Understand and appreciate the use of chemical symbols and formulae in writing equations.
- v. Use appropriate chemical terms in describing physical and chemical process.
- vi. Identify patterns in the physical and chemical behaviour of substance.
- vii. Apply the knowledge acquired to promote positive environmental and health practices.
- viii. Use the knowledge and skills acquired to solve problems in everyday life.

- ix. Apply principles and skills acquired in technological and industrial development.
- x. Acquire adequate knowledge in chemistry for further education and for training.

The objectives (i) and (ii) emphasize psychomotor competencies, while (iii) to (x) purely cognitive competences. The curriculum objectives are not being achieved because among other factors, the teaching emphasizes on performance in the examination, (K.I.E, 2002). Koballa (1988) in his assessment of the status of science education and science needs in Botswana, Malawi and Zimbabwe also observed this type of emphasis. The study revealed that science education in these cases stressed learning outcome on the lower levels of Blooms taxonomy of cognitive domain. In Kenya, K.N.E.C (2007c) observed that the topic coverage has been poor with the teachers either skipping over some or ignoring others altogether. Many of the teachers who are viewed as efficient (producing good grades) tend to put greater emphasis on completing work on time than on students learning. Koballa (1988) observed that such teachers tend to employ strategies that reduce cognitive demand on academic work. The rush to cover the syllabus may then lead to a number of topic areas becoming difficult to learn. This research explored whether the perception of topic areas difficulties by students could be explained in light of hurried manner in which the topic areas are covered.

K.N.E.C (2000c) explained that prior to 1994; chemistry paper (233) was assessed in two papers, one theory and one practical. From 1994, the theory paper was split into two parts, 233/1 and 233/2 in order to give a fairer coverage of the syllabus. Despite the restructuring of the assessment papers, the performance remained poor. One of the

suggestions that K.N.E.C (2000c) forwarded for effective tackling of the poor performance in some items in chemistry was re-examination of curriculum. The K.N.E.C (2000 c) goes further to ask the question, “is emphasis laid on the acquisition of basic skills and knowledge on which candidates can build on when they go for further learning, or are students bombarded with numerous, seemingly unrelated pieces of information lacking coherence and hence not interesting?”. The study endeavoured to establish whether the perception of difficulty areas may be viewed in the light of for instance, hurried coverage of the concept ; vagueness of objectives for topic areas on the part of the teacher.

2.3 Performance in Chemistry by students

Performance in Science and chemistry in particular has occupied the centre stage in research for a long time for example APU (1984); Comber and Keeves (1973); Murphy and Gott (1984); Bell (1997); Gorard(2001). Although the focus has been mainly on differential performance of girls and boys, research has been necessitated by the apparent low performance by students in science compared to other subjects. Earlier research indicated that boys were out performing girls in all areas of science but more recent research for example Bell (1997) revealed that girls are beginning to out-perform boys in all subjects apart from physics at most levels. According to OECD/PISA (2001), boys no longer have the edge over girls. A number of reasons have been given for the poor performance by students in science namely; attitude, prior knowledge, differences in learning abilities among others APU (1984).

2.3.1 Students attitude

Attitude has been defined differently. Generally attitude refers to a state of mind. Attitude is a way of thinking, feeling about something or somebody usually reflected

in a person's behaviour when she/he reacts towards or against some situations, persons, or object in a particular manner. Attitude towards science therefore refer to the views and images people develop about science as a result of influences in a variety of different situations (Bentley and Watts, 1989).

Research has shown that there is a decline in positive attitude towards school subjects and more so in science, Comber and Keeve (1973). The decline is most for physical science subjects i.e. physics and chemistry and more marked for girls than for boys. Some of the reasons given for poor attitude of girls towards science are socialization, where girls are socialized away from science and the masculine nature of science evidenced by the number of men in the field of science. Schibeci and Ricky (1986) in their study showed that students' attitude towards Science are strongly influenced by what the teacher does in class of which Henderson et. al (2000) agrees. According to Henderson et al (2000: pg 40), many aspects of teacher interpersonal behaviour and the laboratory learning environment are associated with student's attitudinal outcomes.

A teacher's strong leadership provision of a degree of student responsibility and freedom and integration of practical and theory components of the course are likely to promote performance, whereas a greater degree of strict behaviour by the teacher, emphasis on rule clarity and open-ended approach to the course are negatively associated with students' performance.

If for this reason that most science educators agree that the development of a positive attitude towards science should be an important goal of the school curriculum Aiken and Aiken (1969); Koballa (1988) found that a positive attitude towards science was related to the laboratory program.

2.3.2 Prior knowledge of students

According to Twoli (2006) the most important single factor influencing learning is what the learner already knows. According to Osborne and Freyberg (1985) learners enter science classroom already holding personally constructed ideas and beliefs which often conflict with the code of belief of science. Researcher, Boulanger (1981) has shown that prior knowledge is a contributing factor to performance.

2.3.3 Learning styles and Abilities

While studies have shown that it is possible to have students' who rarely followed direction when carrying out practical work without thinking, Baird (1986), studies also show that better learning styles can be encouraged Baird and Mitchell (1986); Paris et.al (1984). A better learning style enhances students' responsibility for their own learning and may bolster performance. This study determined how the various factors such as attitude, prior knowledge, learning styles and different abilities contributed to students' perception on difficult topic areas and their influence on performance in chemistry.

2.4 Science Practical Work

2.4.1 Aims of Science Practical Work

The aims of science practical work are to enable students to conceptualize, develop process and effective skills and generate enthusiasm and enjoyment in the subject matter. Woolnough (1991) observed that teachers' views on the relative importance of different aims of practical work in science for higher level classes changed from those held in study by, but considered the prime aim as that of encouraging accurate observations and descriptions (Woolnough and Allsop, 1985).

Practical work in Science, expressed importance of aims of Science Practical work in order of importance as follows.

- Encouraging accurate observation and description.
- Making phenomena more real through experiment.
- Promoting logical and systematic methods of thought.
- Arousing and maintaining interest in science.
- Elucidating theoretical work as an aid to comprehension.
- Developing specific manipulative skills.
- Helping remember facts and principles.
- Becoming able to comprehend and carry out instructions.
- Developing self-reliance, developing certain disciplined attitude.
- Developing an ability to communicate scientifically.
- Practicing seeing problems and seeking ways to solve them.
- Finding facts and arriving at new principles.
- Preparing the students' for practical examination.
- Verifying of facts and principles already taught.
- Developing an ability to co-operate.
- Indicate the industrial aspect of science.

Learning for understanding requires active participation of the students. Archenhold (1976) and particularly through practical work in the case of chemistry, KNEC (2007).

2.4.2 Effect of Practical Work on Performance

Chemistry cannot be adequately taught without exposing students' to practical work for better and cohesive understanding of concepts, KNEC (2007). A big part of the chemistry examination questions demands knowledge and understanding of practical work. Candidates are therefore at a considerable disadvantage if they have not been adequately exposed to the investigation approach KNEC (2007).

The importance of practical work in science is supported by inferences made in other studies. For instance, Koballa (1988) compared and inferred that students' who experience discovery, process-approach curriculum held more positive attitude towards science than did their counter parts. Process approach students' would be more inclined towards science and would be willing to explore further beyond teaching in class. They generally view science as, exciting and interesting; they desire to spend more time in science; and have a feeling that science is useful in both daily life and in their future.

Baseline survey by SMASSE (2000) project report, found that students' negative attitude towards science is attributed to infrequency of experiments carried out in lessons. The survey further found that teachers are reluctant to perform class experiments and that most practical sessions are teacher demonstration and in some cases the experiments conducted neither worked nor were they discussed. Under this kind of condition students' find many topics areas seemingly difficult and subsequently end up losing interest in the subject. This study explored the effect of non-application of practical work approach on teachers' and students' perceived difficulties in topic areas.

2.5 Teachers' Perception of Difficulty in Chemistry Topics

2.5.1 The Teachers' Proficiency in Content

Baseline studies by SMASSE (2000) established that a number of teachers' have poor mastery of content and consequently they have problems in determining the level of content to be given to their students. Teacher education and teaching do point to the significance of teacher's proficiency in subject matter with a belief that what teachers know influence what they do; what teachers do influences the success of their students, and when students experience success, teachers feel good, Koballa (1988). For instance Hewson,(in Koballa,1988), in designing of an instrument to identify teachers conceptions about science teaching assumed that teachers perception about science content and students' can influence their instructional practices. Waititu (2004) in studies of what factors complement the teaching of evolution, provide evidence that teachers' emphasis on concept and instructional accuracy were related to subject matter proficiency. Carlson, in (Waititu, 2004,) in his probe of the relationship between teachers' level of science knowledge and discourse in their classroom reported that:

- Teachers with limited knowledge of a topic are likely to discourage students discourse. They also discourage students questioning.
- The frequency of low order questioning by teacher rose on topics about which they had little knowledge.

In view of the finding in these studies, it was imperative to establish whether difficulty on topic areas as perceived by the teachers maybe based on their proficiency in content.

2.5.2 Perception of Difficulty in Topics by the Teachers

There is substantial evidence that teachers' make a difference in students' achievement, attitude formation and aspiration (Waititu, 2004). On the influence on attitude, Sogomo, (2001) notes that students' attitude towards a subject is a reflection of teachers' attitude. It is of great importance in promoting the pupils' attitude. A logical linkage with perception is that if teachers perceive a concept as being easy, they will teach it well and the students will understand and enjoy learning it. Oliver, (1967) observes that unless the teacher has attitude he desires to foster, it is unlikely that he will have success in communicating it to his pupils. This statement does apply to cognitive development too. It would thus be restated that: "unless a teacher perceives topic areas as being easy, he would not succeed in teaching them successfully". The converse would be that if a teacher finds a topic concept difficult to teach, his perception of that topic is that it is difficult and will not teach it effectively.

2.6 Student's Perception of Difficulty in Topic Areas

2.6.1 Class Level Factor in Perception of Difficulty in Topic Areas

End of Form II marks the "bar" of specialization in chemistry. The significance of this bar is that before it, teaching of chemistry is mainly acquisition of general knowledge in chemistry, Bassey (1963). If chemistry education is to be of any value then many students who do proceed with it after Form II, should gain much that is of lasting value. The choice of whether to pursue chemistry in senior class level depends largely on the appeal the subject has to the students. Waititu (2004) observed that there is a steady increase in students' understanding as they proceed in education.

The improved understanding of chemistry can be considered as owing to the more time spent in studying and also the motivation of the students. Improved understanding due to more time spent in studying may apply where the curriculum content is spiralled in a number of topic areas. In the chemistry curriculum some content are not spiralled and concept acquisition in these areas would have little to do with the time frame. This study intended to establish if there is any difference in perception of topic difficulty for course topics between Form III and Form IV with regard to order and spiralling in the syllabus.

2.6.2 The Mathematical Factors in Students' Perception of Difficulty in Topic Areas

Twoli (1986) it is common knowledge that, there are many mathematical concepts and processes that are used in chemistry program. A high number of those concepts and process do provide a background and have a high utilitarian value in understanding many of the chemistry concepts. This is particularly so if they are taught either before or at the same time when they are being used in learning the chemistry concepts. This study attempted to establish if the use of mathematics is a factor of the topic area difficulty.

2.6.3 Spatial Ability and Learning Science

A number of previous research studies have pointed to a strong relationship between visual-spatial ability and success in science. Similar results are reported in Twoli, (1986). There is a body of evidence that links visual spatial ability with performance in Science. In effect, findings show that spatial related ability is an important factor in the learning of science. Science differences in spatial ability favours boys; this factor gives males an advantage in the study of science, especially in the physical science

Gray (1981). This has been noted in a number of surveys including NAEP in the U.S.A. and APU in Britain. Weakness was shown by girls across sciences on questions featuring spatial related ability .Such questions included rotational motion, angles, two or three-dimensional reproduction or interpretation, and graphical skills. This study endeavoured to establish whether spatial ability is a vital component in perception of difficulties in topics in chemistry by students.

The literature review has captured information on a variety of parameters making some topic to be perceived to be easy and difficult in teaching and learning of chemistry, which translates to either good or poor performance. Methods of instructions required in chemistry to enhance positive attitude and facilitate conceptualization of difficult and abstract concepts, for example practical approach, student centered approach. Student factors, such as entry behaviour academic learning time and abilities.

Teachers factors such as proficiency in content, experience and professional skills and perception on difficulty topics and effects on teaching.

CHAPTER 3: RESEARCH METHODOLOGY

3.0 Introduction

This chapter discusses first the design of the study. The chapter then describes the location where the study was carried out, the target population, sample selection and sample size. Research instruments are described, administration of the instruments, piloting and actual data collection procedure discussed. Lastly, data analysis, logistical and ethical consideration are outlined.

3.1 Design of the Study

The study is a descriptive survey. This design is chosen because of its ability to obtain quantitative data with regard to exploration of teachers' and students' perception of difficulty in topic areas in the secondary school chemistry syllabus. The summary of the design and process of study is illustrated in Figure 3.1.

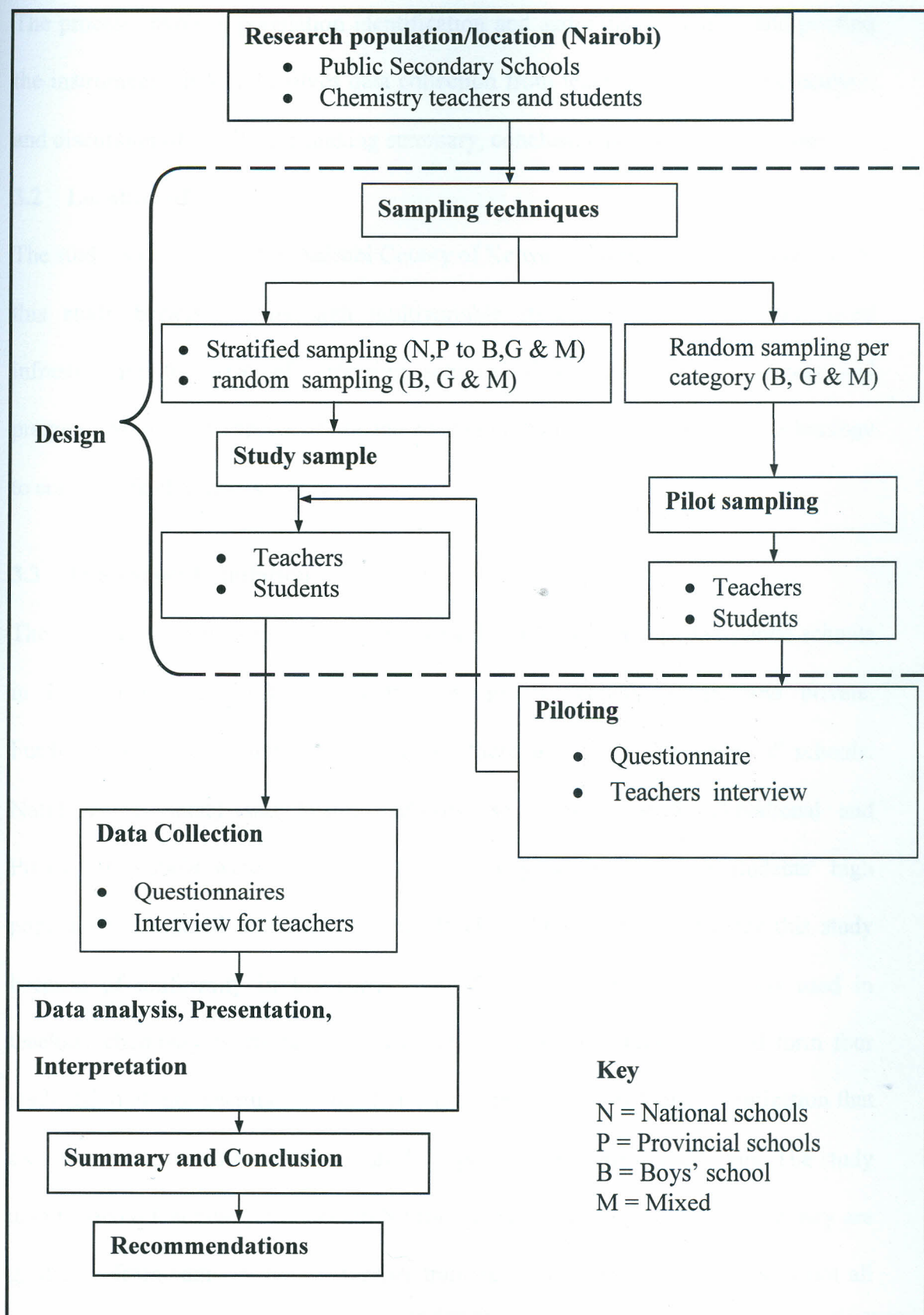


Figure 3.1: A Survey Research and Process for the Study

(Source: Adapted from Cohen and Manion, 1994)

The process involves population identification and sampling, designing and piloting the instruments. It also involves data collection from teachers and students; analysis and discussion of results and making summary, conclusion and recommendation.

3.2 Location of the Study

The study was conducted in Nairobi County of Kenya. Nairobi County is preferred for this study because of its high multivariable student population density, good infrastructure for ease of accessing schools, close proximity of schools and pragmatism in many aspects of life and education, such as advancement in technology to combat life challenges.

3.3 The Target Population

The population, from which the sample was drawn, comprises all the public schools in Nairobi County. Nairobi has two groups of schools; public and private. Furthermore, in the public schools types there are three categories of schools: National, Provincial and District schools (see appendices 5,6,7). National and Provincial schools were considered for the study because of their students' high population compared to district schools. Public schools were chosen for this study because of uniformity in the curriculum offered such that the syllabus used in teaching chemistry is the same for all such schools. The study involved form four students' studying chemistry. The choice of form four was out of the realization that they had experienced most, if not, all the topics in the chemistry syllabus. The study also involved Chemistry teachers in Nairobi public secondary schools, since they are graduates from same system of teacher training institutions and also most if not all schools are resource sensitive to be in line with new emerging trends in education.

3.4 Sampling Techniques and Sample Size

3.4.1 Sampling Techniques

Schools were selected using stratified and random sampling techniques to come up with a representative sample. This was necessary to capture the different categories of schools: National (N), Provincial (P) and different school types: Boys (B), Girls (G) and Mixed (M) schools. The selection of a National boys' school was done purposively. As for the provincial category, schools were stratified according to type that was boys, girls, mixed and then subjected to random sampling to obtain the required number per category. In each of the sampled schools, all chemistry teachers in selected schools responded to the teachers' questionnaire and interview schedule while one stream of form four classes randomly selected for the students questionnaire.

3.4.2 Sample Size

Aryl, Jacob and Razarieh, (1972), indicate that a sample size of 10%-20% of the population is acceptable in a descriptive survey. Since this study is a descriptive type, it covered 9 schools out of the total 47 registered public secondary schools. Thus 4 out of 18 of boys' including a national school, 3 out of 17 girls' schools, and 2 out of 12 co-educational schools in each category to form the total number which is 18% of the sample size. For each Form Four class, the survey sampled a single stream number of students having an average of 40 students per class, which was more than 30% for acceptable data as per research. With regard to teachers, the survey targeted all the chemistry practising teachers. (Table 3.1 and 3.2).

Table 3.1: Sampling Grid for Chemistry Students Questionnaire Administration

SCHOOLS				STUDENTS		
Category	Total № In each Category	Sample №	%	School Stream	Total No. To be sampled	
					Male	Female
Boys						
National	4	1	25	1	40	
Provincial	14	3	21.4	1	120	
Girls						
National	1	1	100	1		40
Provincial	16	2	12.5	1		80
Mixed						
Mixed	12	2	17	1	40	40
Total	47	9	19		200	160

Table 3.2: Sampling Grid for Chemistry Teachers Questionnaire

SCHOOLS				TEACHERS
Category	Total № In each Category	Sample №	%	Number of chemistry teachers
Boys				
National	4	1	25	3
Provincial	14	3	21.4	9
Girls				
National	1	1	100	3
Provincial	16	2	12.5	6
Mixed				
Mixed	12	2	17	6
Total	47	9	19	27

The selection of the schools per category of boys, girls and mixed was random. The selection of stream of students was random and approximately forty students per stream were subjected to the research instrument of questionnaire.

3.4.3 Description of Research Instruments

The research instruments comprised questionnaires for teachers and students; (Appendices 1, 2). Each of the questionnaires was made up of two parts. Part one asks for category information, while part two seeks information on the difficult topic areas

and the reason for the difficulties. Part two is a grid containing a column for indicating the perceived level of difficulties and the other column for indicating the reasons that contribute to the difficulties. The perceived level of difficulty is described using Likert ratings type with a numerical scale such as follows.

(i) Easy = 1

(ii) Average = 2

(iii) Difficult = 3

Teachers' questionnaire had part three and was asking strategies they employed in handling difficult topics. Secondly an interview schedule for chemistry teachers' by the researcher was done, to address the perceived difficulty in chemistry syllabus in both teaching and learning.

3.5 Piloting

Piloting was done to determine the suitability of the instruments. Three schools were randomly selected to capture uniformity across the three school types. They were: one school for boys, one for girls and one mixed. Chemistry teachers and one stream of form four students studying chemistry responded to the questionnaires. The schools that participated in the pilot study were not considered for the main study. Before administering the instruments, the researcher sought the necessary permission from the school administration. Arrangements were then made as to when it was to be appropriate to administer the questionnaires to both teachers and students, followed by an interview schedule for teachers. After piloting, the analysis was done to ascertain validity.

3.5.1 Validity of Instruments

Validity is a measure of the degree to which research instruments measures what they are supposed to measure. The pilot phase helped in validation of the instruments particularly in determining the clarity or ambiguity of items and level of language.

3.5.2 Reliability of Instruments

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. Reliability was ascertained using a split half method by grouping all odd numbered items and all the even number items together and correlating scores from the two groups of item after administering the instruments. The correlation was computed using the Pearson product moment formula as shown below

$$r = \frac{\Sigma X.Y}{\sqrt{\Sigma x^2 . E y^2}}$$

Deviation x = $X - \bar{X}$ = deviation of the score

Deviation y = $Y - \bar{Y}$ = deviation of the score

X Stands for raw score of half the group of split items (odd) and Y for other half group of split items (even). X and Y are mean rating scores for each of the half groups respectively. Using this formula the response between half members of the split items was found $r = 0.8927$ (appendices 4, 5), where r is the actual correlation between half split items of the students instruments. Consistency (α) of students instruments was estimated using Spearman Brown formula (Wiersman, 1995) as follows.

$\alpha = 2r/1 + r = 0.94$, indicating good reliability (see appendices 3, 4)

3.6 Data Collection Technique

Two instruments were used to collect data. These are the chemistry teacher questionnaire and the chemistry student questionnaire. All through the researcher assured the school administration, teachers and students that the data collected was to be used for no other purpose other than the study and would with strict confidence. The researcher requested to be introduced to the students by a teacher from the school who was not a chemistry teacher during administration of chemistry students' questionnaire (CSQ). The chemistry teachers were left with the chemistry teacher questionnaire (CTQ) to complete them on their own time. The completed CTQ were collected on agreed dates and time.

3.7 Data Analysis

Data gathered was analyzed quantitatively using descriptive statistics. Responses from the CTQ and CSQ were coded and expressed as percentage of all total response of each coded category of questionnaire.

3.8 Logistical and Ethical Consideration

The researcher obtained permission from relevant authorities to carry out the research. First was the MOE to obtain the research permit (appendix 9) which was followed by the provincial director of education (appendix 8), Nairobi province. The head teachers of the sample schools were talked to, supported by a permit to personally allow the researcher to conduct the study in their schools. The consent of the chemistry teachers to participate in this study was sought before administering the instruments.

CHAPTER 4: DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.0 Introduction

The focus of this chapter is analysis, presentation and interpretation of data. The analysis was based on the research questions and objectives of the study, which were outlined in chapter one. These included:

- Which topic areas of chemistry syllabus do students and teachers perceive as difficult?
- What are the prevalent reasons both teachers' and students' attributed to the difficulty they experience.
- What are some of the strategies teachers use in the instruction of difficult topic areas?

4.1 Data Collection

Data was collected in nine secondary schools using CTQ and CSQ, and interview schedule for teachers. Four boys' secondary schools, comprising one national and three provincial schools, three provincial girls' schools and two co-educational schools, formed the sample.

Table 4.1: Response from Chemistry Students Questionnaire

SCHOOLS			%	STUDENTS	
Category	Total No. In each Category(sch)	Sample No.		Return rate./Total Sample	%
Boys					
National	4	1	25	32/40	80
Provincial	14	3	21.4	69/120	57.5
National	1	0	0	0	
Girls					
Provincial	16	3	18.75	88/120	73.3
Mixed					
	12	2	17	61/80	73.3
Total	47	9	19	250/360	71.76

From the Table 4.1 the following can be observed

- (i) Students total response or recovery number was 250; boys were 101, girls were 88, and mixed were 61, representing 71.76% recovery. This can be viewed as adequate for acceptable and plausible results.
- (ii) The non-response, therefore, represented 28% of sampled total population. This could be explained from the fact that research was conducted during school end-term when examinations were almost on. This is usually a busy period in schools.

Table 4.2: Response From chemistry Teachers Questionnaire

SCHOOLS			%	Teachers Return rate/total sample	%
Category	Total No. In each Category(Sch)	Sample No.			
Boys					
National	4	1	25	4/4	100
Provincial	14	3	21.4	9/12	75
Girls					
National	1	0	0	0	
Provincial	16	3	18.75	10/12	83.3
Mixed	12	2	17	7/8	87.5
Total	47	9	19	30/36	83.3

It is observed that thirty teachers responded, representing 83.3% of the returns. Only six (6) teachers which can be equated to 16.7% failed to respond. This can be viewed as fairly adequate response for the study.

4.2 Students' Chemistry Difficult Topics Response Ratings

The instrument was administered to form four students which included those from boys', girls' and mixed (co-educational) schools.

The instrument required the students to indicate whether they find the topic easy, average or difficult to understand its content. The responses by students were analyzed and the pattern is given in Table (4.3).

Table 4.3: Rating of Chemistry Topics by All Students

Topic	Easy		Average		Difficult	
	R. no/total no.	%	R. no/total no.	%	R. no/total no.	%
Electrochemistry	10	4	57	22.8	183	73.2
Organic Chemistry (2)	34	13.6	69	27.8	147	58.8
Energy Changes	30	12	82	32.8	138	55.2
Mole Concept	69	27.6	73	29.2	108	43.2
Radioactivity	75	30	69	27.6	106	42.4
Reaction Rates And Reversible Reactions	48	19.2	87	38.8	105	42
Metals	60	24	106	42.4	84	33.6
Hydrocarbons (Organic Chemistry1)	90	36	79	31.6	81	32.4
Sulphur And Compounds	86	34.4	115	46	49	19.6
Structure and Bonding	113	45.2	88	35.2	48	19.6
Nitrogen And Compounds	94	37.6	115	46	41	16.4
Chlorine And Compounds	91	36.4	120	48	39	15.6
Carbon And Compounds	127	50.8	99	39.6	24	9.6
Gas Laws	156	62.4	73	29.2	21	8.4
Acids, Bases And Salts	107	52.8	127	50.8	16	6.4

N = 250

R. no = recovery rate rate.

To give a total picture of the rating of difficult chemistry topics, the percentage (%) of all the responses were combined. The top six topics standing out as difficult and easy are given in Table 4.3, figure 4.1 and figure 4.2 respectively.

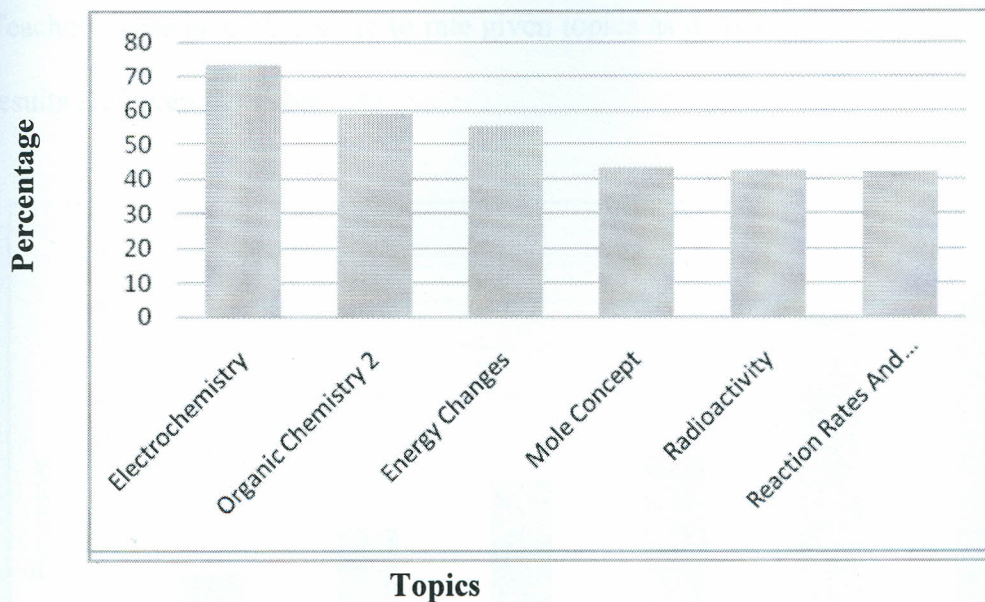


Figure 4.1: Difficult Topics as Rated by All Students

Figure 4.1 gives a representation of the difficult topics using bars which is similar to the information in Table 4.3. On the other hand, figure 4.2 gives a representation of the easy topics.

There seem to be close agreement among students on what they regard as difficult topics and easy topics. The most difficult is Electrochemistry 73.2%, followed by Organic Chemistry(2) 58.8%, Energy Changes 55.2%, Mole Concept 43.2%, Radioactivity 42.4% and Reaction Rates and Reversible Reactions 42% respectively.

The easy topics are rated in the following order (Table 4.3), Atomic Structure and Periodic table (4.4%), Acid, Bases and Salts(6.4%), Gas laws (8.4%), Carbon and its Compounds(9.6%), Chlorine and its Compounds(15.6) and, lastly Nitrogen and its Compounds(16.4%).

4.3 Chemistry Topics as Rated by Teachers

Teachers were given the scale to rate given topics as difficult, average and easy. The results are given in (Table 4.4)

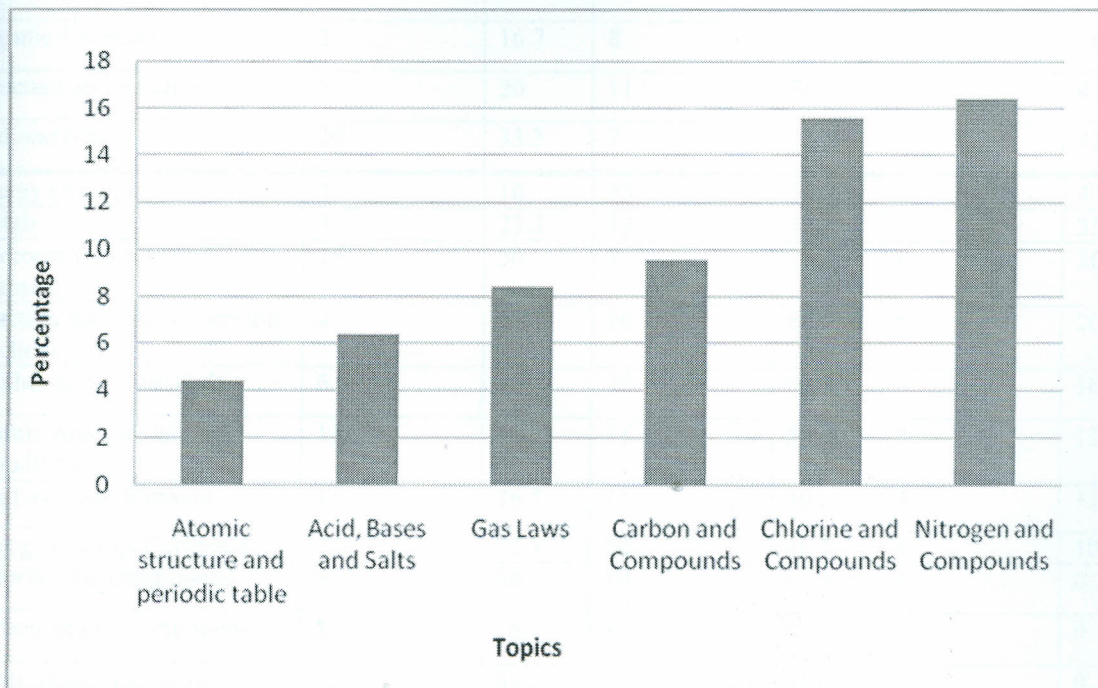


Figure 4.2: Easy topics as rated by students

Table 4.4: Teachers' Rating Difficult Topics

Topic	Easy		Average		Difficult	
	R. no/total no.	%	R. no/total no.	%	R. no/total no.	%
The mole concept	3	10	9	30	18	60
Electrochemistry	1	3.3	12	40	17	56.7
Organic Chemistry 2	5	16.7	8	26.3	17	56.7
Structure and bonding	6	20	11	36.7	13	43.3
Radioactivity	10	33.3	7	23.3	13	43.3
Energy changes	3	10	15	50	12	40
Metals	7	23.3	13	43.3	10	33.3
Hydrocarbons (Organic Chemistry1)	15	50	7	23.3	8	26.7
Reaction Rate and Reversible reactions	4	13.3	20	66.7	6	20
Sulphur and compounds	6	20	19	63.3	5	16.5
Atomic structure and the periodic table	11	36.7	15	50	4	13.3
Gas Laws and Pressure	11	36.7	15	40	4	13.3
Nitrogen and its Compounds	7	23.3	20	66.7	3	10
Chlorine and compounds	9	30	19	63.3	2	6.7
Carbon and its compounds	11	36.7	19	63.3	0	0
Acids, Bases and Salts	19	63.3	11	36.7	0	0

N=30

The teachers identified most difficult topics as follows; first, the Mole Concepts with 60%, second Electrochemistry with 56.7%, third Organic Chemistry (II) with, 56.7%, fourth difficult topic was Structure and Bonding, and Radioactivity at 43.2% respectively.

The top four easy are first Acid, Bases and Salts and Carbon and its Compounds both with 0%, third is Chlorine and its Compounds 6.7%. Closing the top four easy topics is Nitrogen and its Compounds at 10%.

4.4 Comparison of Students' and Teachers' on Difficult Topics Rating.

The ratings of teachers and students on difficult topics were compared (Table 4.5)

Table 4.5: Teachers and Students Comparison of Difficult Topics

Teachers	%	Students	%
The mole concept	60	Electrochemistry	73.2
Electrochemistry	56.7	Organic chemistry (II)	58.9
Organic chemistry(II)	56.7	Energy changes	55.2
-Structure and bonding	43.3	Mole concept	43.2
Radioactivity	43.3	Radioactivity	42.4

This was done by collapsing Tables 4.3 and 4.4

The comparison shows that teachers' views on difficult topics are almost similar to the views of the students. All topics are shared by both the teachers and students, except on Structure and Bonding and Energy changes. This can be regarded as a close agreement, a reflection given by Sogomo (2001) that students' attitude towards a subject is influenced by the teachers' practices. Oliver (1967) added that: "unless a teacher perceives topic areas as being easy, difficult he/she would not succeed in teaching them effectively". This emphasizes the importance of the awareness of the density of each topic. It is possible that students' perception can be influenced by teachers.

4.5 Reasons for Regarding Some Topics as Difficult.

Apart from rating topics as either difficult or easy, the respondents were also asked to give reasons for their classification. Both students and teachers gave their reasons, which are reflected in Tables 4.6 and 4.7.

4.5.1 Teachers Reasons for the Difficult Topics

Teachers were asked to indicate reasons for considering some topics as difficult. The following were the results. (Table 4.6)

Teachers expressed the following with respect to difficult topics:

- Those with mathematical components were viewed as difficult. These included the Mole Concept, Electrochemistry, and Energy Changes.

- The other characteristic was to do with the size of the concept map. Those with large concept maps were viewed as difficult. The Mole concept came under this category.
- Large Formulae and long equations characterised difficult topics. The Organic topics and Electrochemistry were in this category.
- Abstract topics were also given the label of difficult topics, mainly because of lack of experimental backup.

Table 4.6: Teachers Reasons on Difficult Topics

Difficult topics	Reasons
1. Electrochemistry	<ul style="list-style-type: none"> - Large concept maps - Confusing terms, facts, laws and equations. - Abstract concepts - Mathematical component - Students entering behavior (prior experience, abilities, motivation)
2. Mole concept	<ul style="list-style-type: none"> - Mathematical - Abstract concepts - Large concept maps - Confusion of terms, facts, laws and equations. - Students' background (abilities, motivation)
3. Organic chemistry (II)	<ul style="list-style-type: none"> - Not taught at college or university. - Large formulae. - Large concept maps. - Confusion of terms, facts, laws, equations, diagrams and flow charts, - Lack of resources for concrete teaching. - Order of topic in syllabus. (comes late)
4. Structure and bonding	<ul style="list-style-type: none"> - Abstract - Lack of resources for teaching - No practical approach
5. Radioactivity	<ul style="list-style-type: none"> - Mathematical component. - Students' problems (prior experience, motivation abilities). - Order of topic in syllabus. (comes last in sequence). - Lack of experiments

4.5.2 Students' Reasons for the Difficult Topics

Students were asked to indicate reasons for the topics as difficult. The following were the main characteristics (Table 4.7).

Table 4.7: Student Reasons for the Difficult Topics

Difficult topic	Reasons
1. Electrochemistry	<ul style="list-style-type: none"> - Large concept maps - Student's problems (motivation, abilities). - Memorization of facts, laws, equations, diagrams. - Mathematical. - Topic abstract i.e. too theoretical therefore not able to visualize. - Teaching methods devoid of experiments leading to confusion on reduction and oxidation reactions.
2. Mole concept	<ul style="list-style-type: none"> - Large concept maps - Too mathematical - Topic abstract (i.e. too theoretical) - Inadequate experiments - Confusion in memorization of facts, laws, equations, etc. - Student problems <ul style="list-style-type: none"> o Abilities e.g. mathematical, spatial o Motivation - Prior knowledge of syllabus.
3. Organic chemistry (2)	<ul style="list-style-type: none"> - Abstract - Confusion in memorization of facts, laws, equations, diagrams and flow charts. - Large concept maps. - Introduction not based in prior knowledge of organic (1) - Student's problems (motivation, prior knowledge).
4. Radioactivity	<ul style="list-style-type: none"> - Lack of relevancy in life - Mathematical - Confusion on disintegration equations. - Sequence in syllabus - Student problem.
5. Energy changes	<ul style="list-style-type: none"> - Large concept maps - Mathematical - Memorization of facts, laws, equations, energy diagrams. - Content abstract e.g. Hess law - Student problem (motivation, abilities).
6. Reaction rates	<ul style="list-style-type: none"> - memorization of facts, laws, equations, interpretation of graphs (reactant, product, equilibrium) - Mathematical - Teacher problem - Instructional modes not experimental.

The main reasons for topic difficulty by students are close to those given by teachers.

These include:

- Mathematical component: many find the calculations in topics such as Mole concept, Electrochemistry and Energy Changes quite confusing.
- Teachers individual problems in students' view:
 - Preparedness/Experience: K.N.E.C (2007) observed that the syllabus coverage has been poor with teachers skipping over some topics, hurried coverage and ignoring some. This seems to offer a problem to teachers if they don't prepare well, e.g by making schemes of work and lesson plans. The two assist teachers on time management of the topic, resources needed (books, material), and use of better instructional approach Twoli (2006). This view was common on topics with large concept maps e.g. Organic, Electrochemistry and Mole Concept
 - Proficiency in content: A teacher has to be competent in content. Carlton in (Waititu, 2004) in reference to the relationship between teacher level of science knowledge and discourse in their classroom reported that "Teachers with limited knowledge of topic area are prone to discourage student's discourse, by discouraging students questioning and providing frequent low order questioning". This seems to offer problems on concepts that are mathematical and teachers limited skills in mathematics.
 - Instructional modes: A number of considerations are worth noting when thinking of selecting suitable a method for teaching a topic. These include objectives of the topic, learner entering behavior, resource available. However some teachers due to their own preferences and dislikes devote to instructional modes not favorable for some topics resulting to

difficulties. A good example is using a lecture when teaching electrochemistry.

- Student individual problems

- Motivation/Academic learning time: amount of time spent on a topic can improve understanding. Waititu (2004) states that improved understanding can be considered as owing to more time spent in studying and motivation of students. This seems to offer problems to students on topics with large concept maps that require constant revision for one to understand. With few and far between revision, difficulties are bound to be experienced. Motivation arises out of the fact that career aspiration of the students and performance in examinations. If the two correlate positively it results into higher motivation hence less difficulties in learning.
- Abilities (mathematical/spatial): Some scholars have expressed views on ability to learn science. Twoli (1986) gives reasons for students poor performance in science ,namely differences in learning abilities among others, as a problem. Such a student will find abstract concepts difficult expressed in topics, like Mole Concept, Radioactivity and Electrochemistry.
- Entering behaviours (prior knowledge, skills, and attitude): (Osborne and Freyberg, 1985) indicated that learners enter science room already holding personally constructed ideas which are in conflict with doctrine of science. This is notable on students in topic like Energy Changes that require prior knowledge in Mole Concept, Structure and Bonding and Kinetic Theory. This is also evidenced in

Electrochemistry where students require prior knowledge in valency, oxidation and reduction concepts.

- Large concept maps: some topics such as Mole Concept relates to many areas which include solution, gases, solids and electrons. Students seem to find switching and relating to various sections challenging.
- Abstract Topic:
These are topics which cannot be arranged for practicals for concrete experience which assist in conceptualization. This a problem encountered with both teachers and students in topics like Mole concept and Electrochemistry due to lack of resources.
- Formulae and Equations: These seem to offer problems to students especially in topic such as Energy changes, Organic chemistry and Electrochemistry.
- Lack of practical and relevance to life: (Woolnough and Allsop, 1985) expressed importance of practical work as making phenomenon more real, elucidating theoretical work as an aid to comprehension, helping to remember facts, principles. Therefore with no practicals the above will not be gained by students resulting in experiencing difficulties on some topics like Organic chemistry. Transfer of knowledge is vital in solving problems experienced in day today life. So a topic not offering transfer of knowledge for application and relevance in life doesn't motivate students, thus making it difficult. Radioactivity was such a topic.
- Order of topic in syllabus: This seems to offer to problems to both teachers and students. Teachers tend to either hurriedly cover it or ignore it. The net effect on teachers is inadequate preparation. Radioactivity topic and second

last Organic chemistry (II) are good examples. Students tend to focus on what had been covered earlier for fear of examination, overlooking last topics for this study Organic (II) and Radioactivity since they are viewed to carry insignificant marks to warrant passing in chemistry paper.

- Topic not covered at college/university. Applicable to teachers, as numerous teachers hinted during the interview that Organic (II) is hardly taught, meaning they have no content knowledge to go about teaching it. Therefore resorting to high school knowledge to assist teaching the topic Organic (ii) chemistry.

4.6 Strategies Teachers use to Alleviate Difficulties in Teaching.

Teachers were asked to suggest some of the strategies, methods, techniques that lessen the difficulty when handling difficult topics. Various responses were offered ranging from personal innovations to institutional support such as resources. The main strategies highlighted by teachers were:

- Using a lot of relevant examples and exercises. This was for topics which involved mathematical operations. As one teacher put it during the interview:

“I would teach and after explaining the main concept, I would work out some examples on the board, for learners. When I feel they are getting it, I give them examples to work in their books as I go round to find out the misconceptions. At the end of the lesson I give them more examples to work out as an assignment”.
- Team work is used among teachers to aid one another on challenging topics because of content proficiency and mastery. This is common with mathematical topics like Energy Changes, Mole Concept and Electrochemistry.
- Slow pace when teaching difficult and abstract concept in topics like Mole Concept, Electrochemistry and Energy changes to learners of low abilities, since concept formation leads to meaningful learning thus understanding and retaining.

- Use of resources:

Resources facilitate concept formation. During the teachers interview some mentioned that they go as far as improvising some resources. The improvised resources include models and simulations. These fitted abstract topics such as organic chemistry.

- Remedial teaching:

Remedial teaching was mentioned many times .Koballa (1988) noted that differences in students characteristics is divided into categories, that is prior knowledge and abilities(mathematical, spatial) which accounts for major learning outcome in sciences. Since a class is composed of students with a variety of abilities, those with low abilities are required to undertake remedial sessions to boost more understanding. This will include re-emphasis of concepts and practice in working out mathematical problems (For the objective of learning to be achieved).

- Organizing field trips/work:

These serve an important role in learning science Twoli (2006) states that one aim of teaching science and chemistry is to apply its knowledge to our environment. To achieve these aim students need to be shown relationships between classroom and applied chemistry. This aids in seeing the link between chemical principles and technological applications. Fieldwork is one method of achieving this aim. As one teacher put it during an interview

“I would recommend to the school administration to arrange for fieldtrips to industries for students to observe the application part of chemistry on topics like reaction rates, on factors necessitating optimum production of goods”.

- Interactive teaching

Interactive learning is useful in science Archehold (1976) for example observed that particular knowledge is often forgotten when taught in isolation and without active participation of students. This is so when difficult concepts which consist of unrelated bits that cannot be readily put together into meaningful pattern. Some teachers suggested they employ interactive teaching methodologies which comprise of: teacher demonstration, student practical, and group discussion. They find these useful in bringing about better understanding in chemistry.

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This study considered teachers and students perception of difficulty in topic areas of chemistry syllabus and explored prevalent reasons for considering them difficult. The information was obtained through instruments which had a section that solicited for information regarding level of perceived difficulty using likert scale of easy, average and difficult. For teachers, extra information was required which asked them to suggest instructional strategies used when teaching difficult topics.

This chapter gives a summary of the findings from the study and conclusion. Recommendations for remedial actions are made in line with the findings. The chapter ends with a list of suggestions for further studies that would address areas that this study would not be able to address within the time and resources available.

5.1 Summary of the Findings:

The study considered responses from both teachers and students regarding aspects of difficult topics. This summary outlines the results of the views by both parties.

5.1.1 Difficult Topic as Viewed by Chemistry Students.

Students were given a list of topics to rank them from the ones they view as difficult, average and easy. The top six which were ranked as difficult by students were:

- Electrochemistry.
- Mole Concept.
- Organic Chemistry II).

- Radioactivity.
- Energy Changes.
- Reaction Rates.

Various reasons were given for considering these topics as the most difficult. These included: Mathematical component, large concept maps, abstract nature and many large formulae or equations. The topics Electrochemistry, Mole Concept and Energy Changes were associated with mathematical components. Difficulty of the other three had to do with theoretical treatments and large formulae and equations.

5.1.2 Difficult Topic as Viewed by Chemistry Teachers

Just as it was requested for students, teachers of chemistry were asked to rank chemistry topics as difficult, average and easy. Again the top five topics were ranked and the following was the order, starting with the most difficult.

- The Mole Concept.
- Electrochemistry.
- Organic Chemistry (II).
- Structure and Bonding.
- Radioactivity.

A number of reasons were given by the teachers for considering these topics as difficult. The reasons were almost similar to those outlined by the students, which were: mathematical ability demands which related to topics such as the Mole Concept, Electrochemistry. Other factors included large concept maps which related to the Mole Concept in particular. Structure and Bonding and Radioactivity were linked to their theoretical nature and hence not easy to arrange for practicals. In a way

they infer lack of resources to perform practicals for this topic. With respect to Organic Chemistry a number of issues arose. These included:

- The large formulae and equations.
- Lack of chemicals for practicals.
- Some claimed that they did not take it at the university as it was an optional unit.

5.1.3 Comparison of Teachers' and Students' Ranking Difficult Topics

The teachers' and students' ranking of difficult topics in chemistry gave an interesting pattern. There was a very close similarity in their views about difficult topics in chemistry. Considering the top five difficult topics, the only variation lies in one topic in each set. Teachers saw Structure and Bonding as difficult while students consider Energy Changes as among the top five difficult topics. The variation may be due to differences in focus of the sources of the difficulty. While teachers may focus on the instructional (teaching), learners could be focusing on the learning concepts. Teachers may be thinking of how difficult it is to get resources to explain bonding concepts which otherwise can be abstract and therefore difficult to learners.

5.1.4 Strategies Chemistry Teachers Use to Teach Difficult Topics:

Teachers were asked to give some strategies they use when handling difficult topics. A range of suggestions were provided.

- Pacing: It is important to slow down the pace of teaching. This allows learners to assimilate the points or sub concepts before adding another.
- Practice: Frequent working out mathematical problems and other questions can help learners to grasp the difficult areas. This is useful for mathematical

topics such as the Mole Concept, Energy Changes and Electrochemistry. Assignments at the end of every lesson would be useful. Along with giving, it is important for teachers to give immediate feedback.

- **Practical Approach:** Where possible, a number of concepts should be taught in a practical way. Few demonstrations and laboratory experiments may be useful.
- **Using Resources:** This is useful for abstract concepts such as Structure and Bonding. Use of models and simulations would be useful.
- **Motivation of learners:** Motivated learners can absorb more and are willing to work on their own. Motivation can be in a form of reward, just to say 'good' or other forms which include effective instruction. It is often observed that if a teacher prepares well and teaches effectively, then the learner will understand, perform well in tests and eventually be motivated in the subject.

5.2 Conclusion to the Study

This study gave opportunity to both learners and teacher to rank some chemistry topics in terms of difficulty. Both do agree that some topics are more difficult than others. The ranking order by students and teachers is very closely matched. Both have a common difficult ground which can be an advantage from the instructional point of view. It is, therefore likely that while a teacher is struggling to explain, the learner will be trying to put in maximum concentration to understand.

One other aspect this study had interest in was the strategies chemistry teachers use when teaching the identified difficult topics. It is desirable to note that most teachers appreciate that such topics require special strategies and have worked out common

and at times their own unique strategies. This is useful for a teacher of any subject and particularly so for science subjects which are often viewed as difficult.

5.3 Recommendations for Action

The following recommendations are based on the findings from this study.

1. Practicals are useful in sciences including chemistry. Teachers should make effort to reinforce concepts by practical backups.
2. Teachers should be well versed in chemistry content, if they have to teach authoritatively. There are cases where some teachers seemed to doubt their ability in some areas. A good example is Organic chemistry (II).
3. Subject combination for teachers can be a factor in tackling difficult topics. At present there seem to be no recommended subject combinations at the university. Some take chemistry and geography and even physical education (PE). The best recommendation should be with either mathematics or Physics. This may assist in transfer of concepts.

5.4 Recommendation for further studies

1. This study explored difficult topics in chemistry content at school level. It would be useful for a similar study to be carried out in other science subjects.
2. Mathematical ability is found to be a major factor in learning chemistry. It would be interesting to find out whether it is 'mathematics per se' or it is the 'conceptual mathematics'.
3. Some subject combinations at the University for the Bachelor of Education students could be a factor in quality instruction. A study can

be carried out to determine the optimum science subject unit combination for science teachers.

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APPENDICES

APPENDIX 1: CHEMISTRY TEACHER QUESTIONNAIRE

(To be completed by chemistry teachers in Nairobi Province)

The purpose of this questionnaire is to solicit for information concerning difficult topics in chemistry syllabus from 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. This questionnaire is made up of three sections, A, B and C. Answer all the questions in first two sections and also offer personal opinions. You need not write your name anywhere in this questionnaire. Tick () the relevant /appropriate answer or fill in the blank spaces. No answer is necessarily correct or wrong, feel free to give answers you consider appropriate.

SECTION A:

General information about the teachers and school

4. Type of school ; boys only (), Girls only (), Mixed ()
5. Indicate your gender ; male (), female ()
6. What is your professional qualification?
-B.ed(sc) (), B.sc with PGDE (), B.sc only (), Dip.ed(sc), () others ().

If your answer is others please specify.

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7. Up to what level did you learn chemistry?
-Form IV (), 'A' level (), university ()
8. How long have you been teaching chemistry in years? less than 2 (),
2-5 (), 6-10 (), 11-15 (), more than 15 ()
9. How many chemistry lessons do you teach per week? Less than 5 (),
5-10 () 11-15 (), 16-20 () more than 20 ().

7. What is your second teaching subject; math (), physics (), Biology (),
others ()

8. Lab Situation in school: (), Has chemistry lab, (), Has physical science
laboratory, () Has general laboratory.

If your answer is others please specify.

.....

SECTION B; Topics, contents, difficulty experienced

SCHOOLS CHEMISTRY TOPIC DIFFICULTY RATING SCALE

Introduction

I am interested in finding out your perception about how easy, moderate or difficult some chemistry topics are. Please rate the following topics by ticking only in one box for each topic, and follow up with a brief explanation (or statement) in support of the ticked option.

Rating scale for chemistry topics					
S/№	Topic	Easy	Average	Difficult	Reasons (for ticked option)
1	Atomic structure and the periodic table(chemical families, pattern & trend)				
2	Acids, Bases and Salts				
3	Electrochemistry				
4	Nitrogen and its Compounds				
5	Metals(Na, Al, Pb, Fe, Zn)				
6	Energy changes				
7	Gas Laws				
8	Organic Chemistry1 (alkane, alkenes, alkynes)				

9	The mole				
10	Reaction Rate and Reversible reactions				
11	Carbon & Cpds				
12	Sulphur & Cpds				
13	Chlorine & Cpds				
14	Structure & bonding				
15	Organic Chemistry 2 (alkanoic, alkanol, soap & detergents)				
16	Radioactivity				

SECTION C:

Teacher to give suggestions on the strategies he/she employs when dealing with topics perceived as difficult

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Thank you for accepting to participate in this study

APPENDIX 2: CHEMISTRY STUDENTS QUESTIONNAIRE

To be completed by Form Four Students in Nairobi Province. The purpose of this questionnaire is to solicit information concerning difficulties in topics perceived as difficult in Kenya's Secondary school chemistry syllabus. Your kind and honest

cooperation will go a long way in assisting to achieve the goal of this study, which is to enhance performance in chemistry across the board in students in all schools. This questionnaire consists of three sections, A, B and C.

Section A: Students background information

1. Type of school () Boys only , () Girls only, () Mixed
2. What is your age ()

Section B. Student Opinion on Level of Difficulty.

Responses should be according to the following: Easy. Average, Difficult. This is followed by another part where reasons should be given as to the level of difficulty.

The researcher is interested in knowing how you feel about each statement. Respond by ticking in the appropriate column and write your reason thereafter.

Give your views honestly and freely. There are no wrong answers.

SCHOOLS CHEMISTRY TOPIC DIFFICULTY RATING SCALE

Introduction

I am interested in finding out your perception about how easy or difficult some chemistry topics (Topic difficulty) are from the learners' perspective. Please rate the following topics by ticking only in one box for each topic, and follow up with a brief explanation (or statement) in support of the ticked option.

Electrochemistry
(cell & electrode work)

Atomic Structure
(s, p, d, f)

Energy changes in
chemical & physical
changes

Organic Chemistry
(ethane, ethene, etc)

Rating scale for chemistry topics

S/№	Topic	Easy	Average	Difficult	Reasons (for ticked option)
1	Atomic structure and the periodic table(chemical families & trends in periods)				
2	Acids, Bases and Salts				
3	Electrochemistry(electrolysis & electrochemical)				
4	Nitrogen and its Compounds				
5	Metals(Na, Al ,Pb , Zn, Fe)				
6	Energy changes in chemical & physical changes				
7	Gas Laws				
8	Organic Chemistry1 (alkane, alkenes ,alkynes)				

9	Mole concept				
10	Reaction Rate and Reversible reactions				
11	Carbon and its compounds				
12	Sulphur and Compounds				
13	Chlorine and Compounds				
14	Organic Chemistry 2 (alkanoics, alkanol ,Soap &detergents)				
15	Structure & bonding				
16	Radioactivity				

APPENDIX 3: Piloted students mean scale score.

S/№	Topic	Easy numerical scale=1	Average numerical scale=2	Difficult numerical scale=3	Mean scale score
3	Electrochemistry	6	31	100	2.69
14	Organic Chemistry 2 (alkanoics, alkanol ,Soap &detergents)	19	38	80	2.45
6	Energy changes in chemical & physical changes	17	45	75	2.43
9	Mole concept	38	40	59	2.15
16	Radioactivity	41	38	58	2.12
10	Reaction Rate and Reversible reactions	32	48	57	2.18
5	Metals(Na, Al ,Pb , Zn, Fe)	33	58	46	2.095
8	Organic Chemistry1 (alkane, alkenes ,alkynes)	50	42	45	1.96
12	Sulphur and Compounds	47	63	27	1.723
15	Structure & bonding	62	48	26	1.723
4	Nitrogen and its Compounds	52	62	23	1.788
13	Chlorine and Compounds	50	66	21	1.788
11	Carbon and its compounds	70	55	13	1.59
7	Gas Laws	86	40	11	1.45
2	Acids, Bases and Salts	59	70	9	1.65
1	Atomic structure and the periodic table	88	43	6	1.4

N=137

Mean scale score value= $\frac{f_x \text{easy}.1 + f_x \text{average}.2 + f_x \text{difficult}.3}{N}$

Total number of students=137

Appendix4: Calculation of Pearson product moment and reliability coefficient.

Odd: Mean \bar{x} = 1.86

\bar{y} even: = 2.075

Q/No	X	x $= x - \bar{x}$	x^2	Y	Q/N	y $= y - \bar{y}$	y^2	xy
3	2. 69	0.83	0.68	2.45	14	0.375	0.14	0.3425
9	2. 15	0.29	0.084	2.43	6	0.355	0.126	0.10295
5	2. 1	0.24	0.0576	2.12	16	0.0145	0.0020.0108	15
15	1. 72	-0.14	0.0196	2.2	10	0.125	0.0156	0.0175
13	1. 8	-0.06	0.0036	2.0	8	-0.075	0.0056	0.0045
11	1. 6	-0.26	0.0676	1.9	12	-0.175	0.0306	0.0455
7	1. 45	-0.41	0.1681	1.8	4	-0.275	0.076	0.11285
1	1. 4	-0.46	0.2116	1.7	2	-0.375	0.14	0.1725
$\frac{\sum x = 14.91}{No = 8}$			$\sum x^2$ $= 1.2921$	$\frac{\sum y = 16.6}{No = 8}$			$\sum y^2$ $= 0.5358$	$\sum xy$ $= 0.74275$

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \cdot \sum y^2}} = \frac{0.74275}{\sqrt{1.2921 \times 0.5358}} = \frac{0.74275}{\sqrt{0.692254}} = \frac{0.74275}{0.832} = 0.8927$$

$$\alpha = \frac{2r}{1+r} = \frac{2 \times 0.8927}{1.8927} = 0.94$$

Appendix5: Boys' Secondary Schools in Nairobi Province

Rank	Name of school	School category	No. of streams	Form 4 students	Chemistry teachers
1	Starehe Boys centre	N			
2	Moi Forces Academy	N			
3	Nairobi School	N			
4	Lenana school	N			
5	Upper Hill school	P			
6	Dagoreti High school	P			
7	Highway Secondary sch	P			
8	Aquinas High School	P			
9	Jamuhuri High School	P			
10	Eastliegh High School	P			
11	Ofafa Jericho High	P			
12	Muhuri Muchiri High	P			
13	Parklands High Sch.	P			
14	Pumwani Sec. Sch.				
15	St. Teresa's Sec. Sch.	P			
16	Nairobi Milimani Sec	P			
17	Mutuini High Sch.	P			
18*	Uhuru Sec. Sch.	P			
	TOTAL				

Source: Ministry of Education

Key: N = National

P = Provincial

Appendix6: Girls' Secondary Schools in Nairobi Province

Rank	Name of School	School category	No. of stream	Form 4 students	Chemistry teachers
1	Precious Blood Sch.	P			
2	Kenya High Sch.	N			
3	Pangani Girls High	P			
4	Moi Girls Sch.	P			
5	St.Georges Girl' Sch.	P			
6	Statehouse Girls	P			
7	Buruburu Girls	P			
8	Ngara Girls High	P			
9	Muslims Girls Sec	P			
10	Our Lady Of Mercy	P			
11	Parklands Arya Girls	P			
12	Huruma Girls High	P			
13	St.Teresa's Girl	P			
14	Nembu Girls' Sch.	P			
5	Nile Road Sec Sch.	P			
16	Embakasi Girls	P			
17	Ruthimitu Girls'	P			
	TOTAL				

Source: Ministry of Education

Key: N = National

P = Provincial

Appendix7: Mixed Secondary Schools in Nairobi Province

Rank	Name of School	School category	No. of streams	Form 4 students	Chemistry teachers
1	Hospital Hill High	P			
2	Our Lady Of Fatima	P			
3	Langata High Sch.	P			
4	Ruaraka High Sch.	P			
5	Kamiti Sec. Sch.	P			
6	Dandora Sec. Sch.	P			
7	Kayole Sec. Sch.	P			
8	Maina Wanjigi Sec.	P			
9	Kangemi High	P			
10	Ruthimitu Sec. School	P			
11	Kamukunji Sec.	P			
12	Kahawa Garrison Sec.	P			
	TOTAL				

Source: Ministry of Education

Key: P = Provincial

APPENDIX 8: LETTER OF AUTHORISATION

REPUBLIC OF KENYA



NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telegrams: "SCIENCETECH", Nairobi
Telephone: 254-020-241349, 2213102
254-020-310571, 2213123.
Fax: 254-020-2213215, 318245, 318249
When replying please quote

NCST/RR/12/1/SS-011/938

Our Ref:

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke
15th July, 2011
Date:

Edwin Ogengo
Kenyatta University
P.O Box 43844
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "Exploration of topic areas that teachers and students perceive difficult in chemistry at secondary level in Nairobi, Kenya" I am pleased to inform you that you have been authorized to undertake research in *Nairobi Province* for a period ending *30th September, 2011*.

You are advised to report to *the Provincial Commissioner and the Provincial Director of Education of Nairobi Province* before embarking on the research project.

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

A handwritten signature in black ink, appearing to read 'M. K. Rugutt'.


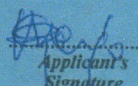
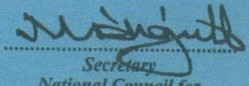
Dr. M. K. Rugutt, Ph.D, HSC
DEPUTY COUNCIL SECRETARY


Copy to:

The Provincial Commissioner
Nairobi Province

The Provincial Director of Education
Nairobi Province

APPENDIX 9: RESEARCH PERMIT

<p>PAGE 2</p> <p>THIS IS TO CERTIFY THAT:</p> <p>Prof./Dr./Mr./Mrs./Miss... <u>EDWIN</u> <u>OGENGO</u></p> <p>of (Address) <u>KENYATTA UNIVERSITY</u> <u>P.O BOX 43844 NAIROBI</u></p> <p>has been permitted to conduct research in</p> <p>.....Location, <u>NAIROBI</u>.....District, <u>NAIROBI</u>.....Province,</p> <p>on the topic. <u>Exploration of topic areas</u> <u>that teachers and students perceive</u> <u>difficult in chemistry at</u> <u>secondary level in Nairobi</u> <u>(KENYA)</u></p> <p>for a period ending <u>30TH SEPTEMBER, 20 11</u></p>	<p>PAGE 3</p> <p>NCST/RRI/12/1/ SS-011/938 Research Permit No.....</p> <p>Date of issue..... <u>15/07/2011</u></p> <p>Fee received..... <u>KSH. 1,000</u></p> <div style="text-align: center;">  </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;">  Applicant's Signature </div> <div style="text-align: center;">  Secretary National Council for Science and Technology </div> </div>
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<p style="text-align: center;">CONDITIONS</p> <ol style="list-style-type: none"> 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 	 <p>REPUBLIC OF KENYA</p> <hr style="width: 20%; margin: auto;"/> <p>RESEARCH CLEARANCE PERMIT</p>
<p>GPk6055t3mt10/2011</p>	<p>(CONDITIONS—see back page)</p>