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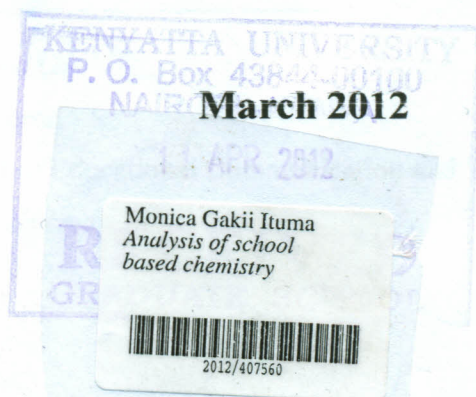
**ANALYSIS OF SCHOOL BASED CHEMISTRY
ASSESSMENT USED IN SECONDARY SCHOOLS
IN KAJIADO NORTH DISTRICT - KENYA**

BY:

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**A THESIS SUBMITTED IN PARTIAL FILFILMENT OF
MASTER OF EDUCATION (SCIENCE EDUCATION) IN
THE SCHOOL OF EDUCATION OF KENYATTA
UNIVERSITY**



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DECLARATION

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

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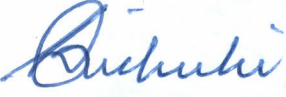
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DEDICATION

I dedicate this work to my husband Peter and my children Pamela and Lewis; you are a great source of inspiration.

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ABBREVIATIONS AND ACRONYMS

- CATs - Continuous Assessment Tests
- CBASSE - Commission on Behavioural and Social Sciences and Education
- G.E.N -Galileo Educational Network
- H.O.D - Head of Department
- K.C.S.E - Kenya Certificate of Secondary Education
- K.N.E.C - Kenya National Examinations Council
- K.I.E - Kenya Institute of Education
- NSES - National Science Education Standard
- QSA - Queensland Studies Authority
- UON - University of Nairobi

ABSTRACT

Assessment is a crucial part of teaching and learning. In school Chemistry assessment can be done in various ways, the most common one being through school based teacher made tests. This study investigated the nature of assessment tests that are made and used by teachers to assess learners in Chemistry in Kenyan secondary schools. The study described the present situation as regards the practice of testing in the schools. The study investigated various aspects of school based chemistry testing which included: teachers' reasons for testing; the process of testing; testing techniques; frequency of testing; science domains tested; policies that govern testing and teachers' general views on testing. The research used descriptive survey approach. Stratified random sampling was used to obtain the study sample. The study population of forty three (43) schools in Kajiado North district was divided into three strata; mixed schools, girls' schools and boys' schools. Random sampling was used to select the desired number of respondents from each stratum on proportionate basis. The study used questionnaires to collect data from chemistry teachers in the selected schools to provide information on the testing practices in the schools. Questionnaires were also administered to Form Three Chemistry students to determine the purpose of tests from students' point of view. Interviews with heads of science department (H.O.Ds) in the schools were conducted. Document analysis schedule was used to analyse samples of practical and theory test papers formerly used to test form three students. Data was analysed using descriptive statistics and presented in appropriate tables, charts and graphs. The findings showed that the purposes of school based chemistry testing were: to provide feedback to learners; determine learners' achievement; prepare learners for final examination; motivate learners and evaluate the effectiveness of teaching methods used. Testing was mainly done for formative and summative purposes but rarely for diagnostic purpose. It was found that tests constructed by the teachers assessed various domains for science learning but creativity and affective domains were rarely tested. Teachers frequently used written tests, practical tests, assignments and oral questions. The procedures regarding setting, administration, marking and grading of tests followed school policies but no national policies were in place. Teachers and learners viewed tests as a means of improving Chemistry learning. The recommendations of the study were that in-service and pre-service training should emphasize assessment methods especially those directed towards diagnostic evaluation and assessment of attitude and creativity domains. Kenya National Examination Council (KNEC) should emphasize project work in schools by examining project work at end -of- course chemistry examinations. KNEC should also develop a policy to govern school based Chemistry testing, and the curriculum developers should revise Chemistry syllabus content to enhance development and assessment of all science domains.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

This section considers the meaning and need for the study. The chapter is organized into ten sub- sections namely, background to the study, rationale for the study, statement of the problem, objectives of the study and research questions. Consideration is also given to the significance of the study, assumptions of the study, scope and limitations of the study, conceptual framework and definitions of key terms.

1.1 Background to the Study

Chemistry is one of the science subjects taught at secondary school level in Kenya. The main aim of teaching science at secondary school level is to enable learners develop scientific attitudes, acquire science knowledge, understand scientific concepts and master certain skills such as process skills and manipulative skills. Chemistry as a science subject is very important in everyday life activities of an individual and in economic development of a country. The knowledge and skills acquired in chemistry are useful in provision of services and in production of quality goods which can lead to the attainment of scientific and technological greatness. The learner also uses ideas, concepts and skills acquired in chemistry learning to solve problems in everyday life. To ensure that learners have acquired the knowledge and

skills, there should be some way of getting feedback during and after the learning process. This comes through assessment mainly in the form of tests.

Assessment is often referred to as a means of determining the extent to which students achieve the learning goals in education. There has been significant development in educational assessment over the years. Traditionally the role of assessment in science was to determine abilities of the learner at the end of the course (Kempa, 1986). Assessment emphasized the cumulative nature of scientific knowledge and was, therefore, used as a measure of these other than as a process of learning.

The scientific revolution following the work of Galileo, Copernicus, Kepler, Newton, Bacon and others spearheaded the empirical study which called for active participation of learners (Blair 1990, G.E.N, 2009). These developments led to a change in the assessment practices. It changed from assessment of product to process based assessment in which what the learner had learnt (knowledge and skills acquired) was assessed together with how it was learnt (the process of learning).

Assessment became part of the learning process as a feedback mechanism intended to motivate the learner to perform better (Sumner, 1991). This led to a great focus on the role of the teacher in assessment. Since the primary purpose of assessment is to improve learning, teacher made school based tests are gaining preference in chemistry education. This is mainly because of their spread over the learners' whole learning period and their frequency in administration. There are a variety of

advantages of school based tests over external examinations and the following stand out:

a) Balanced assessment

School based tests allow the science teacher to select assessment test formats that best match the intended learning goals and provides desired information to chart students' learning (Chiapetta 2010). It is therefore important for the teacher to prepare the tests rather than use externally prepared tests. Teacher made tests have the ability to measure both the process and the product of learning. They are also able to measure most of the domains of science learning unlike external examinations which mainly test cognitive and skills domain (Kempa, 1986). The teacher is best placed to assess creativity, practical application of knowledge and some science related dispositions of a learner.

b) High content validity

The overall content validity of school based tests can be much higher than that of the end of course external examinations. This is because they are conducted more often at times on the basis of topics covered. The Kenya National Examinations Council (KNEC) for example offers their chemistry examination in three papers which last only a few hours. This short duration can limit the variety and depth in which the Chemistry content can be tested. There are however no standards governing the quality of teacher made tests therefore the type of tests highly depends on the teacher.

c) Feedback

School based tests can be used for diagnostic, formative and summative purposes of science learning. Diagnostic assessment provides the teacher with information on the learners' prior knowledge and readiness to learn (Kempa, 1986). This information helps the teacher to design appropriate teaching methods and to clear any scientific misconceptions that learners may have. Formative assessment acts as a motivating factor to learning. It provides feedback to the learning process. After a teacher test, there is time to reflect on the weaknesses and improve learning. External summative examinations come too late in the course for the learner to improve on his/her performance. Teacher made school based tests can be used to serve a summative role because they provide information on how much knowledge and skill the learner has gained after a period of learning.

d) Practice

For an examination oriented curriculum like the one used in Kenya, school based tests provide learners with practice on how to answer questions during the end of course examination. They also practice on the use of scientific language and skills.

There has been an increased emphasis on the use of Continuous Assessment Tests (CATs) in Kenyan schools especially those using the 8-4-4 system of education. Despite all the time and energy put on these tests, performance in chemistry subject in Kenya has remained low over the years. The mean score in chemistry has remained much lower than that of most other subjects. Table 1.1 shows relative

performance of Chemistry to other subjects in Kajiado North District over the last five years.

Table 1.1 Kenya National Examinations Council results for the years 2005 – 2009 for Kajiado North District.

Year /Subject	Overall Mean	English	Kiswahili	Mathematics	Biology	Physics	Chemistry	History	Geography	C.R.E	Home Science	Agriculture	Business Stu
2009	4.86	4.96	4.13	2.92	4.25	4.31	3.49	5.64	4.44	7.10	5.90	5.19	5.46
2008	4.88	4.99	4.86	2.99	4.26	4.23	3.46	5.16	4.40	6.79	5.81	5.20	5.30
2007	5.04	5.44	5.22	2.60	4.88	4.50	3.74	6.09	4.99	7.52	6.03	5.58	6.42
2006	5.08	5.13	4.76	2.89	4.42	4.57	3.82	5.80	4.46	7.37	6.10	5.60	6.50
2005	5.10	5.39	5.60	2.98	4.79	4.23	3.99	5.45	5.24	7.31	5.99	5.34	5.88

Source: Kajiado North District Education office

The table shows a worrying trend in that the mean score in Chemistry is much lower than the overall mean score attained each year. It is also lower than all other subjects except Mathematics. This is despite the constant use of tests in schools which take a lot of teachers' time and consume a lot of resources. This indicates that it is not satisfactory to use teacher assessments tests without looking at their practical value in the improvement of learning. There is therefore need to assess the nature and use of chemistry school based assessment tests to find out ways of improving performance in Chemistry.

1.2 Rationale for the Study

Chemistry at secondary school level in Kenya has been poorly performed over the years despite much effort by the government to improve performance in science subjects (KNEC, 2009). The poor performance in Chemistry and other science subjects has been linked to poor development of manpower and thus low technological and economic development in Kenya. This is because secondary science sets the foundation for the skillfulness of labour in a country (Gili, 2010).

Findings by researchers and educators show that the poor performance in chemistry can be attributed to inadequate teaching and learning resources, entry behavior of learners, low learner motivation, inappropriate teaching methods, family background of a learner, quality of teaching staff and the attitude of learners towards Chemistry. These areas have been investigated (Efumbi 2002, Kamau 2004, Inzahuli 2007, Mutuku 2009 and Orado 2009) and some of the results implemented but no significant improvement has been noted. There is therefore need to examine another dimension of chemistry learning that is likely to have an effect on performance. This being continuous school based assessment which can be useful in provision of feedback in learning.

This research examined the present situation as regards to the practice of school based chemistry assessment tests at secondary school level in Kajiado North district. The study endeavored to determine the use of school based assessment tests and provide recommendations for the improvement of the process.

1.3 Research problem statement

Teachers spend a proportionate amount of teaching time and energy in setting, administering, marking, grading and recording grades for CATs and end of term tests. Most schools are emphasizing the use of CATs at various intervals with some going as far as having weekly tests. Although these tests are meant to improve conceptualization and hence performance in Chemistry, no significant improvement has been noted at the end of course examination. This could be due to a number of factors related to the nature of the tests, the purpose of testing, mode of delivery of the tests and feedback generated from the tests.

Literature review shows that there has been no comprehensive study carried out in Kenya to investigate school based assessment tests in chemistry. It is, therefore, important to analyse teacher made chemistry tests used in the assessment of chemistry with the purpose of establishing their roles, content, frequency and other related aspects. This may eventually shed light upon the poor performance in Chemistry at K.C.S.E. level.

1.4 Objectives of the Study

The general objective of this study was to establish the status and the importance of using school-based tests in the assessment of chemistry learning. The specific objectives of the study were;

- a. To determine the main purpose of school-based tests in chemistry learning.

- b. To find out the frequency of use of chemistry school-based tests in schools.
- c. To establish the domains of chemistry learning emphasized in school-based tests.
- d. To investigate the process of chemistry testing in schools.
- e. To find out the policies which govern chemistry testing in schools.

1.5 Research Questions

The study will seek to answer the following questions:

- a. What are the aims of using school based tests in chemistry learning?
- b. How frequently do teachers test their students in Chemistry?
- c. What domains of chemistry learning do teachers test in schools?
- d. How is the process of setting, administering, marking, grading and providing feedback on tests carried out in schools?
- e. What policies govern assessment test programs in schools?

1.6 Significance of the Study

The findings of this study aim at guiding chemistry teachers in evaluating their assessment test practices to enhance the feedback system and thus improve performance in chemistry. The findings of this study may guide teacher trainers in

equipping pre-service teacher trainees with appropriate assessment practices that will guide them upon qualification.

The findings are also expected to help curriculum developers and policy makers to recognize the need for development of a national policy on chemistry school based testing and consider including results of teacher-made tests in the national end of course results. The findings may also be used to extend knowledge on the same area of study.

1.7 Assumptions of the Study

The study was based on the assumption that all Kenyan schools offer Chemistry or Physical Science (Chemistry option) as a teaching and examinable subject and that all Chemistry teachers in schools are trained and do engage in internal assessment of the learners.

1.8 Scope and limitations of the study

This study was limited to school based teacher made tests in Chemistry. It did not consider other examinations done in the school which are set externally such as joint-school mock examinations or national examinations set by Kenya National Examination Council (KNEC). The study covered secondary schools in Kajiado North District that use the 8-4-4 curriculum only.

1.9 Theoretical Framework

The purpose of the study was to investigate school based assessment of learners in Chemistry with an aim of determining how these assessments can be used to improve learning and thus performance in Chemistry subject. The study is based on reinforcement theory of motivation proposed by B.F. Skinner. It states that individual's behaviour is a function of its consequences. It is based on "law of effect". Individual's behaviour with positive consequences tends to be repeated, but individual's behaviour with negative consequences tends not to be repeated. In this view reinforcement can be used to encourage students to display an interest in Chemistry instruction. Skinner indicated that students' learning behavior could be affected by consequences such as the opportunity to move forward after completing one stage of an activity (Skinner, 1961).

This is a useful consideration in the designing of the objectives of school based Chemistry tests. The purpose of testing should be to provide feedback to the learners that would serve as a motivating factor in learning. Sumner (1991) noted that good performance leads to intrinsic motivation of the learner. Responses that are rewarded are likely to be repeated. (Good grades reinforce careful study). A student who performs well in a test tends to put in more effort in learning and thus improve in performance. Testing provides information necessary to chart students learning and guide the teacher in formulating appropriate instructional methods which are

motivating to the learner. Some testing methods in Chemistry such as practical tests and project work arouse learners' curiosity thus increasing interest in learning.

The external environment during testing must be designed effectively and positively so as to motivate the learner. This indicates the importance of appropriate test procedures. Skinner says that without knowing the science underpinning teaching, teachers fall back on procedures that work poorly or not at all, such as failing to provide positive reinforcement frequently enough.

Skinner suggests four steps in learning. These can be achieved through proper school based assessment. These are:

1. Specifying the desired behavior as objectively as possible. Aims of school based testing should be clearly outlined if the test is to achieve its role in improving performance.
2. Measuring the current incidence of desired behavior. Learning can be monitored from the results of school based continuous assessments.
3. Providing behavioral consequences that reinforce desired behavior. Reward for good test grades encourages learners to learn more.
4. Determining the effectiveness of the program by systematically assessing behavioral change. Test results provide feedback on the effectiveness of the teaching method used.

Continuous reinforcement is the fastest way to establish new behaviors or to eliminate undesired behaviors. Learning is enhanced by immediate feedback which improves performance on classroom examinations and promotes the retention of factual information (Roberta 2004). School based assessment can be used to provide immediate feedback and continuous reinforcement.

1.10 Conceptual framework

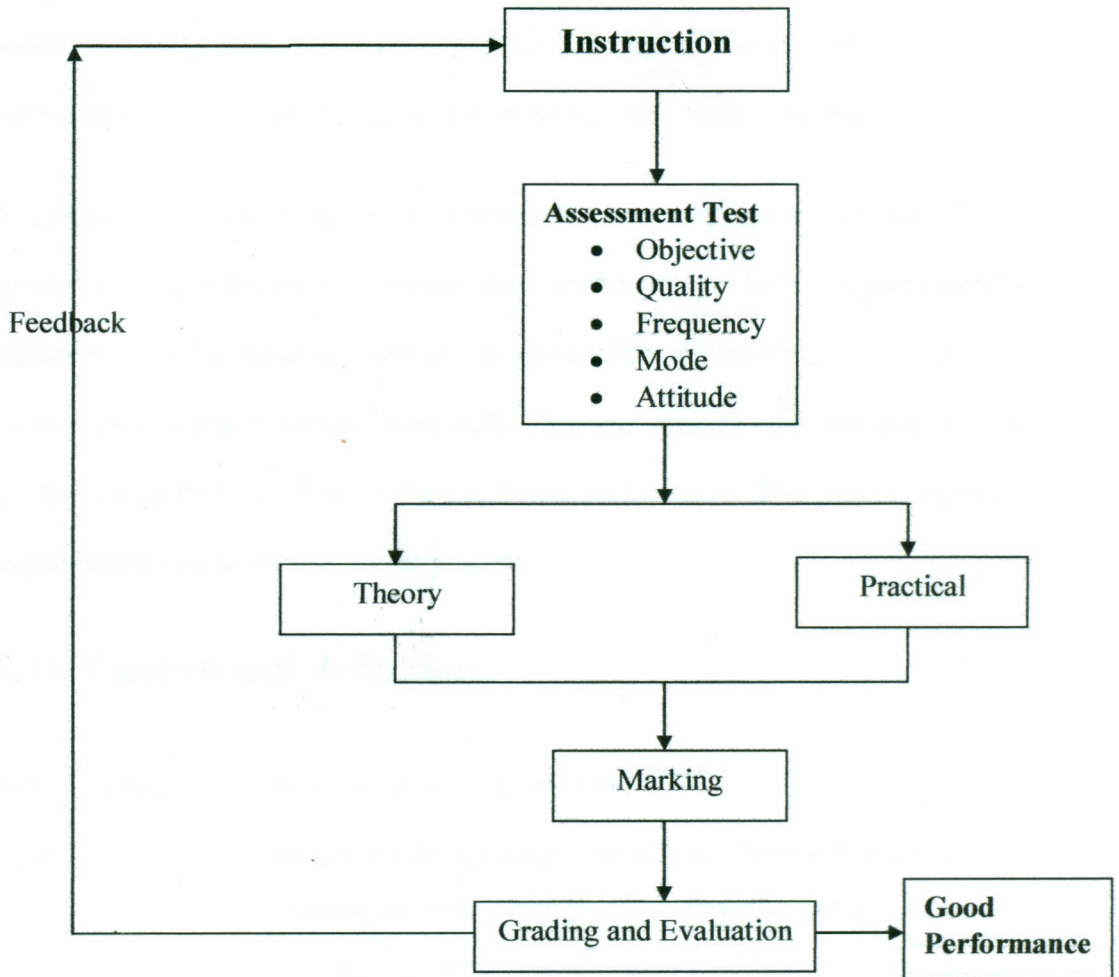
In Kenya, performance in Chemistry at the end of the secondary school course is determined by use of a national examination given by KNEC. Over the years performance in chemistry has been poor (table 1.1). A lot of research work has been done on the causes of poor performance in chemistry at secondary school level in Kenya (Efumbi 2002, Kamau 2004, Inzahuli 2007, Orado 2009, and Mutuku 2009). The following have been identified as the main factors influencing performance.

- Entry behaviour of learners and learner ability
- Teaching / learning resources
- Teaching methods
- Teacher characteristics
- Learners' attitude towards chemistry
- Assessment and feedback systems

This study focused on assessment procedures, specifically the tests used by Chemistry teachers in schools. The process of learning Chemistry, just like any other subject, starts with instruction through interaction between the teacher and the learner in the classroom or the laboratory. This is followed by assessment to

determine whether the set objectives have been achieved. The most common assessment method in schools is the use of tests. In Chemistry learning, assessment test can be theory or practical based. The tests are then marked, graded and feedback to the learners given. This process is as shown in figure 1.1.

Figure 1.1 Conceptual model of the study.



Source: Ituma, 2011

The effectiveness of the test in assessment highly depends on the quality of the test, test objectives, frequency of testing, modes of test and learners attitude towards the test. Chemistry tests are mainly in two forms; theory in which a learner answers a series of questions on paper and a practical in which learners carry out experiments and writes down the observations, inferences and answers to various related questions. Whatever the nature of the test, the achievement of its objective can be determined only after it has been marked and graded. Grades are indicators of performance and high grades show that objectives have been achieved.

It is important to provide feedback by revising the test with the learners with the aim of reinforcing good work and clearing misconceptions. This helps the learner realize his/her areas of weaknesses and put in more effort in learning. It also provides motivation to learners who perform well. They put in more academic learning time as they try to find out more leading to better performance. This can be viewed as useful conclusion to an assessment process.

1.11 Operational definitions

Achievement Attainment of the desired objective.

Assessment Process of determining what learners have achieved by use of specific measure which yields quantitative data.

Continuous assessment:

A system of assessing a student progress throughout a course of study as well as or instead of examinations

Domain	Field of knowledge in chemistry learning.
Feedback	Information about achievement of objectives given back to the educational system.
Instruction	The process through which a teacher facilitates the learners to acquire knowledge and skills.
K.C.S.E	Kenya Certificate of Secondary Education- an examination taken at the completion of the four year secondary education.
K.N.E.C	The Kenya National Examinations Council- The examining body in Kenya which conducts school national examinations.
Morning Prep	A duration in the morning before the teaching lessons when learners study on their own in preparation for the day's work.
Process skills	Skills that aid the investigation process during practical work.
Performance	Realization of specific academic accomplishment.
School based tests	Tasks aimed at measuring the performance of a learner, which are made by the teacher and used within the school.
Test	A device for measuring the performance of a learner. It connotes a standard set of questions to be answered.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews various aspects of school based assessment tests with a view of highlighting what has been researched and studied in this particular area. These include the role of assessment in schools, modes of assessment, domains of science assessed in tests, nature of tests, marking, grading and feedback as used in schools. The sources consulted were mainly theses, journals, textbooks and the internet.

2.1 The Role of Assessment Tests in Schools

Assessment of pupils' performance in science and Chemistry in particular plays an important role in learning. A lot of interest has therefore been taken in the assessment in form of tests. This is supported by Bennett, (2003 P.221) when he argues;

It is undeniable that assessment has been the subject of continuing debate and argument over matters such as the form it might take, what should be assessed, the extent to which teachers should be involved, how often assessment should take place and what should be done with data on pupils performance.

Assessment in chemistry learning can be done at the beginning of instruction, during instruction and at the end of instruction. These stages are classified by Chiappetta (2010) as diagnostic, formative and summative assessments respectively. Daugherty (1995) also gives a four-fold classification of types of purpose of assessment. These

are diagnostic, formative, summative and evaluative. Diagnostic assessment involves a process through which learning difficulties can be scrutinized and classified so that appropriate remedial help and guidance can be provided. It should be done in order to locate an appropriate starting point, to group learners appropriately and select instructional methods (Gadner, 1975). Formative assessment is done so that positive achievement of a pupil may be recognized, discussed and appropriate next action to improve learning planned. It aims at ensuring acquisition and development of knowledge and skills by identifying students' needs and guiding them towards desired goals. It forms an internal feedback loop (Bali et al, 1988).

Summative assessment is done for the recording of overall achievement of the learner in a systematic way. This assessment can be used for reporting on pupil's performance from one teacher to another, from one school to another, from school to parent and from school to prospective employer. Evaluative assessment is a means by which some aspects of the work of the school such as program and teacher evaluation can be assessed and reported upon. This mainly applies to national assessment at KCSE level which commonly provides both prospective parents and those administering the system with evidence on which to base comparative judgments about the effectiveness of teachers, schools and even the local authorities. Daugherty (1995) however recorded that many teachers and their organizations questioned the validity of aggregate data of pupil performance as an indicator of the quality of teaching and schooling.

Tests are commonly used to assess chemistry learning at secondary school level. Tests are devices for obtaining a sample of an individual behavior. It connotes presentations of a standard set of questions to be answered. Teachers construct tests for various purposes. The purpose of a test greatly determines the type of test a teacher should construct. The main purposes of testing have been discussed by Bennett (2003), Kempa (1986), Sumner (1991), Bali (1988) and Daugherty (1995) under various items depending on the focus. These are:-

- i. Screening -Testing groups of pupils to identify those requiring special help. It also involves judging pupils mastery essential skills.
- ii. Diagnosis -Using tests to identify individual strengths and weakness and to guide in formulation of instructional method and grouping of learners.
- iii. Feedback -Using assessment to provide information about students' progress to the pupils themselves, the teachers, the parents, prospective employer or to curriculum developers.
- iv. Record Keeping-To keep records of scores on tests thus measuring growth over time.
- v. Certification-To provide qualifications which signify particular levels of knowledge competence.
- vi. Selection -To identify selected pupils who are capable of the particular levels of competence and performance required for a possible next step such as university entrance or promotion to the next class. It also involves ranking pupils in terms of achievement of a particular objective

- vii. Motivation - Encouraging good study habits including frequent reviews.
- viii. Evaluation -Evaluating the effectiveness of teacher's teaching method and ascertaining the effectiveness of the curriculum.

2.2 The Test Content

Learning is based on objectives. The achievement of these objectives can be assessed through testing. The attainment of qualities that learning seeks to foster in students can be measured through testing. According to Kempa (1986), Dass (2005), Bloom (1956) and Twoli et al (2007), objectives of science learning can be divided into five broad categories which are referred to as domains. Since sound evaluation should be based on objectives, the five content areas (domains) should be assessed in tests. These domains include: cognitive, skills/process, attitude, creativity and application.

2.2.1 Cognitive domain

This is found to be the most dominantly tested area in secondary school learning (Kempa 1986, Eubanks 1998, Ochanji 2000, Kwaka 2003). It involves learning of science concepts, principles, facts, laws and theories. The cognitive domain as proposed by Bloom (1956) proposes learning into six levels of cognitive abilities.

- a) **Knowledge** – involves recall or recognition of facts, concepts, laws and principles as they were taught. Tests at this level require bringing to mind

content matter as presented in the course with little or no alteration. It involves ability to state, define, list, name, arrange, match or outline facts.

- b) **Comprehension/understanding** – Involves use of specific rule, method or concept in a situation similar to those used in class. It tests student's understanding of scientific knowledge and relationships. This is manifested in student's ability to explain, summarize or show logical extensions of information. This involves ability to recognize, interpret, translate, contrast, classify, describe and discuss the taught concepts. It can also involve translating verbal descriptions or mathematical material into symbolic statements and vice versa.
- c) **Application of scientific knowledge to a novel situation** – The learner is able to select items of knowledge relevant to a new situation which involves ability to predict, prepare, choose, apply or demonstrate knowledge.
- d) **Analysis** – The ability of the learner to break down information into its constituent elements so that relationships among ideas may be made more explicit. The learner is able to identify, differentiate, compare, solve, appraise and categorize ideas.
- e) **Synthesis** – Involves the ability of the learner to organize information to obtain a new structure and put parts from diverse elements together to form a whole. It involves the ability to combine, summarize, restate, argue, organize, construct, formulate and discuss concepts.

- f) **Evaluation** – The student should be able to make judgments about the value of a set of materials and methods for a given purpose. It comprises of quantitative and qualitative judgments about the extent to which material and methods satisfy the criteria determined by the teacher or the student. It involves the ability of the learner to compare work with the highest known standards in its field especially with other work of recognized excellence. (Bali 1988). This includes the ability to argue, compare predict, appraise, rate, determine, value, judge, defend and criticize the learnt material.

Tests should be constructed to have a balance of all the above levels. However, teachers construct tests that tend to contain more items from knowledge and comprehension levels (Kempa 1986 and Ochanji 2000). A research on physics assessment tests used by teachers in Kakamega district found that question items centered on assessment of learner's knowledge, understanding and application of scientific knowledge added up to 70.3% of the total tests items (Ochanji 2000). This indicates that the emphasis on the higher levels of Bloom's taxonomy in school tests is very low. This could be because teachers find items in the lower levels of cognitive domain easier to create, mark and score.

2.2.2 Skills domain

Science education puts a lot of emphasis on acquisition of skills. Some of these skills are cognitive in nature (process skills) while others relate to practical abilities (manipulative skills) (Kempa, 1986). Manipulative skills are also referred to as

motor skills and include ability to handle, arrange, pour or fix. Process skills deal with the process of procedure or experimentation. These include observing, classifying, measuring, communicating, questioning, interpreting, inferring and predicting (Dass 2005, Twoli 2006). Observing is the most basic because it opens up clues for other skills. Apart from manipulative and process skills, subsidiary science skills are important in chemistry learning. These are mathematical skills and interpreting non-linear information. Non-linear information involves interpretation of graphs and tables to bring out patterns or relationships.

Testing in chemistry should include assessment of practical skills. Some objectives of teaching chemistry such as; to select and handle apparatus, to make accurate measurements and to draw logical conclusions (KIE 2002), clearly show an emphasis on the importance of testing practical work. Practical tests in chemistry assess whether candidates have acquired these skills and competencies. Orado (2009) indicates some of the competencies commonly assessed in practical tests as:

- Ability to follow a set of instructions to carry out an experiment.
- Manipulative skills – Correct handling of apparatus and correct volume measurements.
- Ability to make accurate observations
- Ability to record observations accurately
- Ability to make accurate deductions.

These skills can be assessed during routine laboratory practical lessons and records for each student kept (Cheung and Yip, 2003). Practical tests should also be as valid

and as reliable as possible. For a practical examination to have a good measure of validity, it should consider a cross section of basic process skills, manipulative skills, mathematical skills and interpretation of non-linear information. The Kenya National Examinations Council (KNEC) ensures validity of the practical examination by setting three questions. These three questions emphasize different skills as shown in the table 2.1.

Table 2.1 Skills emphasized in practical tests

Type of Practical question	Skills emphasized
1. Qualitative analysis	Process skills mainly <ul style="list-style-type: none"> • Observing • Recording • Interpreting • Inferring
2. Volumetric Analysis (Titration)	<ul style="list-style-type: none"> • Manipulative skills • Mathematical skills
3. Physical Chemistry	<ul style="list-style-type: none"> • Manipulative skills • Mathematical skills • Observing • Non-linear Interpretations

Source: Table adapted from Twoli, (2006)

During a practical test in Kenya, a student carries out certain tasks and procedures as instructed in the question paper and records the results on paper. The student's written record is collected at the end of the examination to be marked. This method of testing has a weakness because as Twoli (2006 p.175) noted;

The examiner does not observe the practical being done and can only assume that the skills were utilized to give the product on paper. It is therefore not possible to determine whether what is put on paper is the actual resultant performance of skills during practical. A candidate can guess or oversee the neighbour's test and just record the observations.

However this method is economical. This is because it can be used to test a large number of candidates by use of the same test paper at the same time and under almost uniform conditions (Bali 1988).

To ensure that candidates actually use the skills to perform the experiment, performance assessment model has been encouraged (Kempa 1986, Twoli 2006, Chiapetta 2010). In this model the candidates carry out the practical under direct observation of the examiner. It allows the examiner to assess the learner's proficiency in performing an activity. This method however is expensive and can allow the test to cover only a small portion of the chemistry syllabus content. It also lacks objectivity in marking and may suffer from intrusion of external factors. Observation of performance can however be made systematic by use of checklist or rating against which behavior is observed (Bali 1988). It is suitable where only a few candidates are involved. It could however be possibly tried in school based practical tests because teachers spend a lot of time with learners during the course of study.

2.2.3 Attitude / Affective domain

Behavior in affective domain is described as feelings, attitudes, interests, appreciation, beliefs and values. Dass (2005) and Kempa (1986) agree that basically this domain relates to students interest in Chemistry and the study of Chemistry. It

also relates to the learners personal beliefs and values towards science, social skills and professional attitudes. The objectives of secondary school chemistry learning place attitudes in a prominent position within instruction (KIE, 2002). Despite the emphasis placed on students' development of positive attitudes and other affective characteristics, research done in Kenya indicates that a good number of learners have poor attitude towards chemistry (Efumbi 2000, Kamau 2004, Mutuku 2009 and Orado, 2009).

The affective domain is also rarely assessed in schools (Kempa, 1986). A study carried out in Kenya by Ochanji (2000) shows that only 1.2% of items in physics examination tested the affective characteristics of learners. This could be due to some technical and methodological problems in testing the attitude domain. Attitudes can be assessed through interviews, written tests, attitudinal scales such as Likert scales and direct observations. Bali (1988) indicated that measurement of achievement in the affective domain encounters several problems. The main one being difficulty to translate terms used to describe behavior in affective domain into specific observable behavior and lack of complete consistency between affective qualities and their behavior manifestation. When questionnaires are used to determine affective achievements honesty is not guaranteed.

2.2.4 Creativity Domain

Creativity involves having an inventive and imaginative mind. It involves an element of newness where there is lack of previous existence of an idea or product.

Dass (2005 p.60) explains three aspects of scientific activity where need for creative aspect is paramount. These are;

- Manipulating conditions of study to be more accessible for investigation.
- Bringing natural objects to an artificial setting for investigation.
- Causing events to happen when occasion demands.

In secondary school chemistry, creativity can be observed when students engage in practical work, group activities, project work or on field trips. Some measures of creativity as brought out by Dass (2005) are:

- Becoming sensitive to problems
- Recognizing deficiencies, missing elements, disharmonies and generally gaps in knowledge.
- Planning for investigations
- Flexibility in reasoning
- Originality and fluency.
- Identification of difficulties.

He further points out that very little attention has been paid to creativity in the science classroom. The curriculum model used in Kenya may not put much emphasis on creativity since project work is not examined at KCSE level and class experiments are guided towards the achievement of a particular objective (Chiapetta, 2010). The pre-specification of explicit objectives of learning prevents the teacher from taking advantage of instructional opportunities unexpectedly occurring in the classroom (Stenhouse, 1981). In chemistry creativity can be assessed by use of

project work. It is doubtful if teachers use project work often enough to assess creativity adequately.

2.2.5 Application Domain

This involves the use of previously learnt material in a novel situation. Application is the best evidence that learning has taken place. Of the four goals of science education given by the National Science Education Standards as established by National Research council in the united States, (Dass, 2005 and Kempa, 1986) three are directly related to application. These are:

- i) To use appropriate scientific processes in making personal decisions.
- ii) To engage intelligently in public discourse and debate about matters of scientific and technological concern, and
- iii) To increase economic productivity.

This indicates the importance of developing and testing achievement in this domain. Unfortunately, the application domain in school science is either entirely absent or a minor add-on at the end of the chapter (Dass 2005). Application can be assessed by checking the learners' ability to;

- Apply knowledge in a new situation.
- Use new directions of inquiry.
- Ask new questions.
- Design new experiments.
- Use scientific knowledge to solve problems.

- Make interdisciplinary connections.

2.3 Assessment Techniques

There are various methods of assessment that can be used in chemistry learning. The objectives of teaching chemistry can be classified into two main categories; understanding of concepts and acquisition of skills. Chemistry assessment therefore includes theory and practical tests. The following types of test formats are recorded by Kempa (1986), Eubanks (1998), Twoli (2006) and Chiapetta (2010) as the commonly used formats in science assessment;

- a. Objective tests
- b. Structured tests
- c. Essay questions
- d. Oral tests
- e. Practical test
- f. Project work

a) Objective Tests

These contain closed or fixed response questions. They are selection items which include:

- Multiple choice items
- True-false items
- Matching pairs items
- Assertion-reason items.

These can be used to test a wide range of cognitive domain since relevant items can be responded to in a relatively short time. This increases the content validity of the test. Awarding of scores on these items is objective and the scores are easy to interpret. These items also encourage wide thinking. They however do not measure divergent thinking, imaginative thinking, linking of concepts and expression of scientific terminology. Current research suggests that, students may know more than they are able to demonstrate on multiple-choice tests (Eubanks, 1998). Many teachers believe that ability to choose an answer is different from, and less significant than ability to produce an answer. They are therefore not used in science tests at secondary school level in Kenya but are useful at lower levels of learning.

a) Short answer and Structured tests

These may be unrelated short answer or completion questions, or a set of questions that are related to each other (structured). Structured questions are based on a particular theme which could be a statement or a diagram. They test a cross section of concepts in the order of difficulty. Many of these questions covering nearly every part of the topic can be used in a single test. This improves the content validity of the test (Twoli 2006). Structured questions promote focused thinking on the topic under test (Twoli et al 2007). Short answer and completion tests are relatively easy to develop, mark and score. They however encourage fragmentation of scientific ideas (Kempa, 1986). Chemistry theory tests at KCSE level mainly contains short answer and structured questions.

b) Essay Tests

Essay tests contain questions that require an answer in several paragraphs and/or multiple calculations (Eubanks, 1998). They give learners freedom to organize and express ideas thus providing a good measure of a person's understanding of the area of knowledge under test. They are useful in testing higher level cognitive abilities and communication using scientific language. Marking of essay questions may suffer from a high degree of subjectivity (Ayot, 1987). However a well-made marking scheme can be used to make marking more objective. It is also not easy to interpret students' marks in terms of their ability in a particular ability area. Little content is also covered in the test lowering the validity of the test. For these reasons, essay questions are not used in assessing chemistry in Kenyan schools.

c) Oral Tests

Oral tests are interactive and enable the examiner to probe deeply into students understanding and knowledge of the subject (Kempa, 1986). They allow flexibility depending on the responses of the learners. These are very good in assessing higher order abilities and skills. They can also be used to adequately assess learners' affective and social characteristics. In secondary chemistry, oral questions are commonly used in diagnostic and formative evaluation done during instruction. For these teachers rarely award marks or grades (Ochanji, 2000). Oral tests may be very costly for summative evaluation. The awarding and interpretation of scores can also be very subjective. To reduce subjectivity, more than one examiner can be used or the proceedings can be recorded. This would however lead to an increase in cost and time spent.

d) Practical Tests

Chemistry learning is experimental in nature. Laboratory based experiments are therefore used to ease acquisition of knowledge and skills in Chemistry. Research done in Kenya by Iraki (1994) on expectations of practical work in physics, and another done by Orado (2009) on factors influencing performance in Chemistry practical work agree on the following areas of assessment in practical work.

- Ability to plan practical work, identify the variables and measurements to be taken and choose experimental conditions and apparatus to use.
- Manipulative skills – working methods, safety measures taken, organization and accuracy in use of apparatus.
- Skills in observation and recording of observations.
- Ability to interpret results of practical work which involves reduction of data into tables and graphs and using the data to draw conclusions regarding the experiment.
- Ability to communicate results in a clear and logical manner either orally or in written form.

The conventional design of testing practical skills is where candidates perform experiments individually and record results on paper. These are assessed by the examiner and marks awarded (Twoli, 2006). The examiner assumes that for a candidate to get good results, he/she must have utilized the skills during the

practical. This however, may not always be the case. A number of studies show that correlation between results achieved by learners and the quality of their practical processes is low (Kempa, 1986). The new trend in the assessment of practical work is the use of performance assessment where a learner conducts a practical under direct observation of the examiner. This method is however very involving and expensive. It is only practical with small groups of learners. This assessment may be difficult in the final examination in Kenya but a good level of it can be applied in school based tests.

Practical examinations provide learners with an opportunity to develop important mental and manipulative skills and to put theory into practice. They however cover very little content and are relatively expensive. They also consume a lot of time. This may limit the number of times a teacher can test learners using practical tests.

e) Project Work

Projects are extended independent academic tasks that are usually practical in nature (Twoli et al, 2007). Project work is very useful because it is able to assess the process/ skills domain, creative domain and attitude domain. Projects encourage organizational ability because the responsibility of designing and executing the project rests upon the student. They have major limitations though because they are time consuming. The teachers may therefore not be able to use them very often in school based chemistry assessment.

2.4 Test Preparation

Any form of assessment test should be dependable so that those who need to use the results can have confidence in them. To ensure this, tests should have high validity and reliability. Reliability is the ability of test to yield similar results when repeated over a short period of time. A reliable test can be viewed as consistent, dependable and stable (Twoli, 2006). Reliability of a test highly depends on: the conditions under which the test was administered, the nature of attributes being measured by the test, the characteristics of the group being tested and the scoring of the tests. (Bali et al, 1988).

A valid test provides an appropriate measure of what it intends to assess (Bennett, 2003). It refers to the extent to which test results provide desired information. Educators agree that tests should be aligned to curriculum and instruction. They should measure what students have been taught or are expected to know (Hurwitz, 2000). Since all content areas cannot be included in a single test, questions making up the test should be a representative sample of all questions which might have been selected in the content area under test. To achieve this, a specification grid should be prepared. This is a tabular grid showing the number and kind of test items testing each objective of learning (Kempa, 1986). The specification grid therefore links content to objectives of the test.

Physical uniformity is important during the administration of tests. Physical facilities such as lighting, ventilation and timing should be adequate and uniform for those taking a particular test. The number of test items should depend on duration of

test, type of items chosen and complexity of thought processes involved in answering the questions in the test. Time should be sufficient for all examinees to attempt all the questions. However Bali (1988) indicates that due to differences in the working speed the examiner should allow adequate time for 75%-90% of the students to finish.

Testing should be continuous. This ensures continuous feedback as well as progressive measurement of students' achievement. However Noll (2005) notes that learning suffers when teachers spend time preparing too many tests. He argues that a teacher who could stay longer in a topic is forced to move on to prepare learners for the next test. Teachers should have question banks in order to prepare quality tests. The teacher should set a test that provides stimulation and challenge to the students' imagination. However Collette (1973 P.611) notes that;

Unfortunately, teachers do not always know how to make their tests an integral part of their teaching; they use the test for determination of grades.

He further notes that repeated failure in tests causes a student to hate the subject, get increasingly fearful of tests and this can distort how a student rates his ability.

Teachers should therefore use tests and test scores very carefully. Once the tests are prepared, they should be moderated. Moderation is bringing individual judgments in line with general standards (Daugherty, 1995). Moderation serves two functions: to communicate general standards to assessors and to control aberrations from general standards by appropriate adjustments. Daugherty (1995) noted that moderation by a

group of teachers is the most suitable because it allows them to clarify in discussion both the objectives of the syllabus and the bases of their judgments. In Queensland education system that uses school-based assessment, the assessment is externally moderated. This type of moderation relies on groups of trained teachers meeting formally to assure the quality of assessment instruments and to ensure judgements of standards are comparable from school to school through negotiation process (Queensland Studies Authority, 2010).

2.5 Marking of Tests

Marking written tests must be done carefully in order to provide reliable feedback on performance. To reduce subjectivity in marking, a detailed marking scheme should be prepared (Ayot, 1987). The structured and short answer items commonly used in chemistry tests provide a high degree of objectivity because there is only one correct answer for each question. The marking scheme should contain the answers and the marks distribution against specific answers. Twoli, (2006) brings out four important points to note when making a marking scheme;

- i) The marking scheme should be written alongside with the test paper during setting.
- ii) Marks should be allocated to parts of answers according to the difficulty of the concepts involved.
- iii) Marking scheme should allow for little flexibility which should be determined by the teacher as marking continues.

- iv) It is advisable to mark one question through all the candidates as it brings consistency in marking.

The teacher should mark test papers immediately they are done indicating mistakes with understandable symbols and making a list of common mistakes (Ayot, 1987). The marker should make measurement as objective as possible. A measurement is considered objective if marking is independent of the subjective bias of the marker. Marks should be recorded and the mean and deviation of scores from the mean calculated. These statistics provide the teacher with information on the level of knowledge and skill acquisition by a class and thus the effectiveness of the teaching method used.

2.6 Grading and Feedback

The overall purpose of testing is for the achievement of the attainment targets of the curriculum. Testing should therefore be related to this attainment. The results of a test should provide a basis for decisions about the learner's further learning needs. They should give direct information about the learner's achievement in relation to objectives (Daugherty 1995). For the tests to achieve this, the grading should be criterion- referenced. In criterion- referenced grading system, the grade of a learner is relative to performance against a given set of criteria (Kempa 1986). KNEC grades students' performance in chemistry using Norm-referenced grading system. In this system the grade of the learner is dependent on how well he/she has performed relative to the other members of the group. It does not reflect the learner's actual attainment. The grades awarded only show relative abilities of students. This

type of grading does not match the model of science learning preferred in the National Science Education Standards (NSES) (Chiapetta, 2010).

The current trend in educational assessment is from the use of norm-referenced grading system to criterion-referenced grading system. School based assessment tests in most schools are graded using the criterion-referenced grading system. Grades can be assigned as a numerical value, letter grade, percentage grade or point grade. Each school should have a grading policy which provides information on how grades should be interpreted. Students should be informed of the grading system in use (Chiapetta, 2010). The traditional marking systems involves a single set of letters such as A, B, C, D, E used to designate various levels of achievement. Terwilliger (1971) noted that the meaning of such symbols in marking should be sufficiently precise to assure comparability of usage among teachers. He further notes that this system does not give meaningful picture of the many different facets of achievement and inadequately communicates student's performance.

Assessment information should adequately communicate the ability of the learner as it may be required by a number of different people and organizations. These according to Daugherty (1995) and Liversidge et al (2009) include; parents, teachers, students, school administration, school inspectors, local authority advisors and further education admission tutors.

It is important to calculate group average scores and deviations so that interpretation relative to identified populations can be done. Results from test scores can be used to

tell subsequent teachers about learners' knowledge and progress (Sumner, 1991). This study was set out to find the grading systems used by chemistry teachers in secondary school in Kajiado North district.

2.7 Policies governing Testing

There are internal school policies made to encourage and regulate learning. Some schools have policies that every pupil should be given a compulsory homework in every timetabled subject once a week. They may require that each pupil passes a test in order to be allowed to the next class. Pupils who fail the test are given help with learning using methods they choose. Those who pass the test are given enrichment assignment mainly for intrinsic value in extending knowledge (Sumner, 1991). To ensure grades of tests are capable of comparison across classes and schools, school based assessments should be governed by a national policy. National policies would ensure uniformity and standardization with which teachers' ratings of student performance should be used as a fundamental element of the national assessment system. (Daugherty, 1995). An international comparative study for mathematics and science tests by CBASSE (1993) proposes an approach to improve science tests to meet international standards by formulation of a policy to international understanding of educational expectations.

2.8 Conclusion

The literature review indicates that reasons for testing, domains of science learning which can be tested and testing methods are numerous. There are chances that teachers may be inclined towards certain aspects of testing at the expense of others. This could affect the quality of testing and the ability of school based tests to improve performance in chemistry. The procedures of chemistry testing in terms of setting of tests, administering the test, making of the marking scheme, marking and grading could affect the ability of school based tests in achieving their intended objective of improving performance. It therefore calls for analysis of these aspects of school based tests for judgment to be made. A study carried out by Ochanji in 2000 on assessment of tests used by teachers in the assessment of physics learning indicates need for a similar study in other subjects. No such study has however been carried out in Chemistry. Ochanji (2000) used only a questionnaire for teachers to obtain data. There is therefore need to use other instruments like interviews and students questionnaires to obtain more comprehensive data. The time lapse (2000-2010) has also seen an increase in test markets and their use in schools. It is therefore important to investigate the use of school based tests in Chemistry learning.

CHAPTER THREE

METHODOLOGY

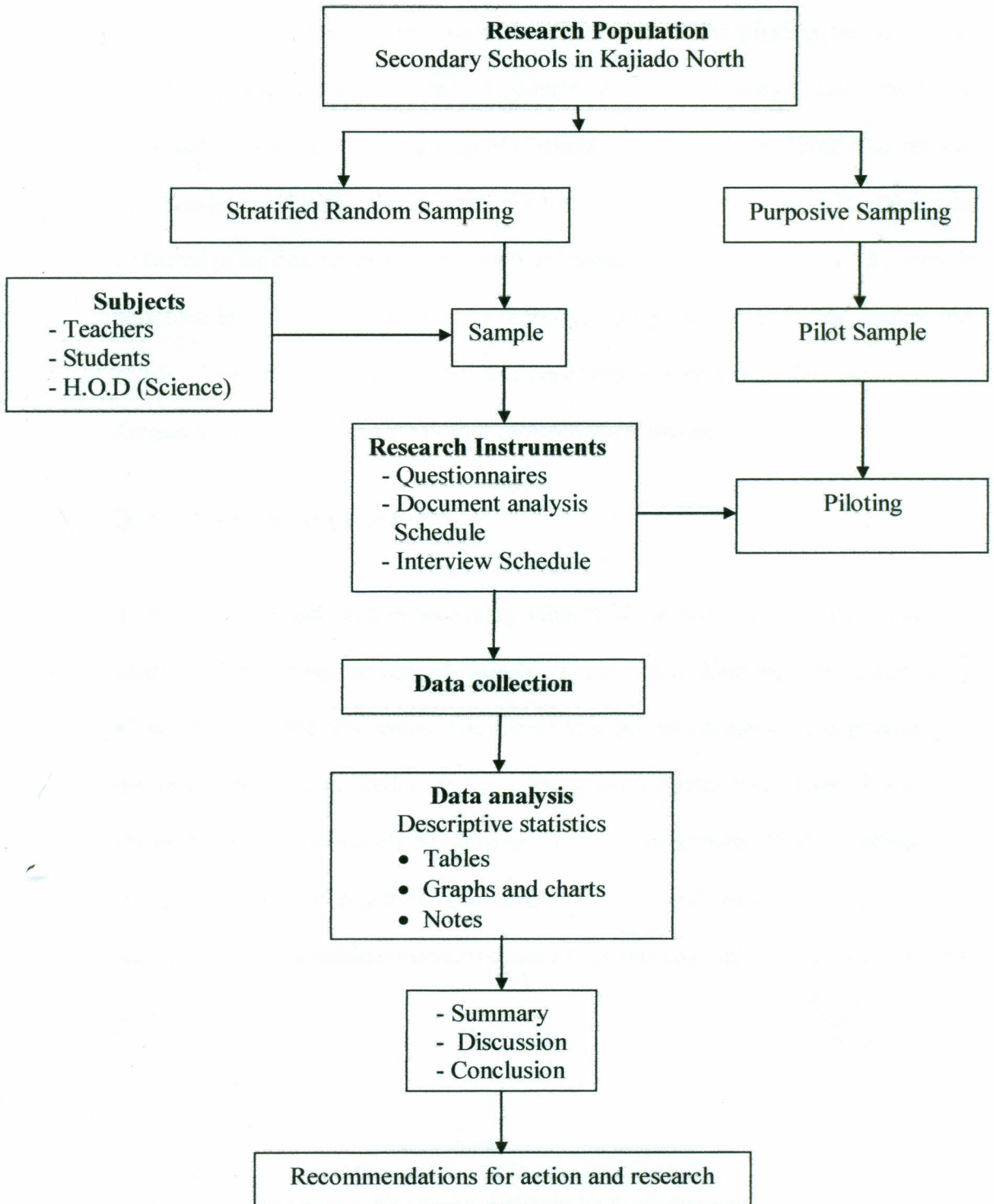
3.0 Introduction

This chapter outlines the strategy for data collection that facilitated answering of the research questions. It outlines the research design and process, population of the study, methods used in sampling and sample size. It details data collection procedure, research instruments used, piloting and logistical and ethical considerations.

3.1 Research Design and Process

This study employed a descriptive survey design. This was the most suitable approach because of its ability to collect a lot of data within a short time (Stenhouse, 1981 and Mugenda and Mugenda, 2003). The instruments used in survey are also objective and effective in providing comprehensive data for the study. The research process and design followed the stages shown in figure 3.1.

Figure 3.1 Research Design and Process of the Study



Source: Ituma, 2010

The process started with the consideration of the population of secondary schools in Kajiado North district. Purposive sampling was done for piloting the study and stratified random sampling used to provide sample from which data was to be collected. The sample was made up of Chemistry teachers, Form Three students and the Heads of Science Department (HODs) in the sampled schools. Data was collected using questionnaires, interview schedule and document analysis for tests. It was then analysed using descriptive statistics and presented in tables, graphs and charts. Discussion of the findings and conclusions were made. Recommendations for action and suggestions for further research were also made.

3.2 Location of study

The study was conducted in secondary schools in Kajiado North District. This is a district neighbouring the city of Nairobi on the South West side and about thirty kilometres from the city centre. The district was selected because of its proximity to the researcher's work station and a fairly good infrastructure. These helped the researcher to maximize on administration and management of the research and reduced the cost of research. The district is semi-arid with mainly pastoralism activities. These hardship conditions could affect learning and therefore performance in chemistry.

3.3 Study Population

The study focused on secondary school Chemistry teachers and students in Kajiado North District. There are forty three (43) secondary schools to select from in Kajiado North District (Kajiado North District Education office). Three (3) Boys' schools, four (4) Girls' schools and eight (8) mixed schools were involved in the study.

Thirty four (34) Chemistry teachers in the sampled schools responded to questionnaires. Questionnaires were also administered to a random sample of twelve (12) Form Three students from each of the sampled schools. Form three students were chosen to respond to the students' questionnaire in the study because they are expected to have learnt enough content covering most of the objectives stated in Secondary School Chemistry Syllabus. They also have elected to pursue Chemistry to K.C.S.E level, thus presuming that their attitude towards Chemistry positive. Form Four learners were busy preparing for their final examinations and it would have been inappropriate to interrupt their busy schedule. Heads of Science Department in the sampled schools were interviewed. These were able to give more detailed information on the testing procedures and policies that govern testing.

3.4 Sampling procedure and sample size

The study population consisting of forty three (43) schools in Kajiado North district was stratified according to the school types. This gave three main strata: boys' schools, girls' schools and mixed schools. A sample of the population in each

stratum proportional to the size of the strata was used. The number of schools, teachers and students in the sample was as shown in table 3.1.

Table 3.1 Sample size

School Type	Total Number of Schools	School Sample Size	Teachers Sample Size	Students Sample Size
Boys' School	8	3	7	36
Girls' School	12	4	10	48
Mixed School	23	8	17	96
Total	43	15	34	180

From the sampled schools, one Form Three class was randomly selected for the study. Twelve Form Three students were picked by use of random number sampling to complete the student questionnaires. These were a representative sample of the student population. Chemistry teachers in each of the sampled schools completed the questionnaire for teachers and the Head of Science Department was interviewed.

3.5 Research Instruments

Four instruments were used in the study. These included questionnaire for teachers, questionnaire for students, interview schedule for Head of Department (Science) and document analysis schedule on test papers.

I. Questionnaire for Teachers

These were completed by Chemistry teachers in the sampled schools (**Appendix A**).

They were used to collect data on the role of Chemistry assessment tests, methods

used by teachers in assessment, the frequency of testing, preparation, administration, marking and feedback on tests results and their views on how school based assessment tests could be used to improve performance in chemistry.

II. Questionnaire for students

They were completed by twelve randomly selected Form Three Chemistry students in each school in the sample (**Appendix B**). They gave the researcher more insight on the role of tests in Chemistry learning and further views on importance of feedback from the tests.

III. Interview Schedule for the Head of Science Department

Interviews with Heads of Science Department in the sampled schools were conducted (**Appendix C**). They helped the researcher find out more on the policies that govern testing in schools. They also helped the researcher with details in the testing process and record keeping. The interviews gave the researcher a chance in cross-referencing with the other instruments.

IV. Document Analysis

The H.O.Ds in the sampled schools were requested to give the researcher two test papers formally used to assess learners in chemistry. These were preferably a theory and practical test paper. Document analysis (**Appendix D**) was used to analyze test papers to provide information on the domains (content) of chemistry learning commonly tested. The test format of theory paper and skills tested in the practical

papers were also analysed. This reinforced information obtained through the teachers' questionnaire.

3.6 Pilot Study

Three schools, one from each stratum were used for piloting. These schools were not among the ones sampled for the study. The questionnaires were administered to a total of four teachers. Ten Form Three students from each school were selected using random number sampling to complete student's questionnaires. A total of thirty (30) students were involved in the pilot study. Interviews with the H.O.D (Science) in the three schools were conducted. Two test papers, one theory and the other a practical paper were collected from each school for analysis. The questionnaires and test papers were analysed.

Piloting enabled the researcher to determine the clarity of question items in the questionnaires. Questions that elicited ambiguous responses were accordingly adjusted. It therefore enabled the researcher to check the suitability of the instruments to collect required data. Piloting also helped the researcher to gain basic administrative experience in conducting the research in preparation for the larger group survey.

Piloting also enabled the researcher to check the ability of the instruments to collect reliable data. After piloting, the respondents were allocated random numbers. Using split-half method each type of instrument was split into two groups, those from even

and those from odd numbered respondents. The reliability of the two was correlated by the Spearman-Brown split-half coefficient:

$$\alpha = 2r_{xy} / (1+r_{xy})$$

Where r_{xy} is the reliability coefficient between two variables x (odd) and y (even).

The reliability coefficient r_{xy} is determined by Pearson product-moment correlation formula;

$$r_{xy} = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\sqrt{[\Sigma x - \frac{(\Sigma x)^2}{n}][\Sigma y - \frac{(\Sigma y)^2}{n}]}}$$

Σx represents sum of scores of respondents of one (odd numbered) group,

Σy represents sum of scores by the second (even numbered) group of respondents and n represents the number of respondents for each group.

For teachers' questionnaire the reliability was found to be 0.78, for students' questionnaire it was found to be 0.80 while that of document analysis was found to be 0.74. These values are above the value 0.70 cited by Siegle (2010) as minimum reliability required for research purposes. The instruments were therefore considered to give reliable data.

3.7 Data collection procedure

Each school in the sample was visited by the researcher to deliver questionnaires to be completed by chemistry teachers and students. Permission was sought from the school administration for the researcher to carry out research in the school. A brief

explanation of the purpose of the study was given at the beginning of the questionnaire to enable the respondents to feel confident to respond. During this visit chemistry teachers were administered with the questionnaires and an appropriate time to pick the completed questionnaires agreed upon. Since students' learning time could not be interrupted for questionnaire administration, the students' questionnaires were administered during lunch break (the period after lunch and before afternoon classes start) or after classes (after the last lesson of the day). The completed questionnaires were picked and analysed.

During the first visit to the school, the researcher agreed with the H.O.D. (Science) on when an interview could be conducted. The interviews were guided by the interview schedule appendix C. In most schools the questionnaires were picked on the day the interview was conducted. During the interview the researcher requested to record the discussion this was to ensure that details were not missed out during analysis. Out of the fifteen schools in the sample, two H.O.Ds were not available for the interviews therefore a total of thirteen interviews were conducted.

The H.O.Ds (Science) were requested to give the researcher samples of Chemistry assessment test papers formally used to test Form Three students in both theory and practical work. The papers required were to have been used within the last three years. A total of sixteen (18) practical papers and forty (35) theory test papers were collected. The number of practical and theory test papers was different because theory tests are used more often than the practical tests in schools. Also at Form Three level two theory test papers (paper I and paper II) and one practical paper

(paper III) are used to make a complete Chemistry test. The test papers were analysed using the analysis schedule appendix D. The test papers were returned to the teachers after analysis.

3.8 Logistical and ethical considerations

Permission to carry out the research was sought and given by the Ministry of Education, Science and Technology (Appendix H). The district Education Officer (Kajiado North) was also informed of the intent to carry out research in the district. The principals of the schools in the sample were consulted to allow research to be carried out in their schools. Consent from Chemistry teachers and H.O.Ds was also sought by the researcher. Teachers, learners and H.O.Ds involved in the study were assured of confidentiality by the researcher.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.0. Introduction

This chapter presents the findings of the analysis of Chemistry school based tests used in secondary schools in Kajiado North district - Kenya. The analysis is focused on the purpose of school based test in chemistry learning, the frequency of testing in schools, domains of chemistry knowledge emphasized in school based chemistry tests, the process of testing in schools and the policies that govern testing in schools. The analysis and interpretation of data is linked to the objectives of the study and the research questions. Data was gathered using questionnaires, interviews and document analysis schedule. It was analysed using descriptive statistics and presented in the form of tables, charts and graphs.

4.1. Bio-data and Qualification of Chemistry Teachers in the Study

A range of teachers and students were involved in the study. Chemistry tests used in school based assessment are mainly constructed and used by the Chemistry teachers. Questionnaires were therefore administered to thirty four (34) Chemistry teachers. They were required to give some personal and general information. From the

questionnaires, information on the teacher's bio-data and qualification was determined.

4.1.1 Gender of teachers involved in the study

The Chemistry teachers' questionnaire required the teachers to indicate their gender.

Table 4. 1 Gender of teachers involved in the study

Gender	No	%
Male	15	44.1
Female	19	55.9
Total	34	100.0

N=34

The results show that 44.1% of the teachers involved in the study were male while 55.9% were female. It indicates a reasonable gender balance which implies that the data collected had no gender bias.

4.1.2 Professional qualification of teachers who participated in the study

The teachers were asked to indicate their professional qualification in the chemistry teachers' questionnaire.

Table 4.2 Professional qualification of teachers involved in the study

Professional qualification	N _e	%
M.Ed.	4	11.8
B.Ed.	21	61.8
B.Sc.	2	5.8
PGDE	4	11.8
Dip(S1)	3	8.8
Total	34	100

The distribution of teachers showed that teachers with Bachelor of Education (B.Ed.) with 61.8% and Masters of Education (M.Ed.) with 11.8% totaled to the highest percentage. No untrained teachers were involved in the study (table 4.2). The percentage of teachers in terms of qualification is also presented in the pie chart (figure 4.1).

Figure 4.1 Professional qualifications of teachers involved in the study.

This distribution indicates that the teachers involved in the study were highly qualified and therefore capable of giving relevant information regarding chemistry school- based tests.

4.1.3 Teaching experience of chemistry teachers

In the questionnaire, the teachers indicated their chemistry teaching experience in years.

Table 4.3 Teaching experience in Chemistry

Teaching experience (years)	0-5	6-10	11-15	16-20	Over 20
Number of teachers	3	10	8	9	4

N=34

A range of Chemistry teaching experience was involved in the study with 6-10 years being the highest. A total of twenty one (21) teachers indicated an experience of more than ten years. The long experience in Chemistry teaching is an indication that the teachers involved in the study had a long experience in the use of chemistry school based tests.

4.1.4 Chemistry teachers' second teaching subject

The teachers were asked to indicate the other subject they teach apart from chemistry.

Table 4. 4 Chemistry teacher's other teaching subject

Subject	Number	%
No other subject (Chemistry only)	5	14.7
Mathematics	8	23.5
Physics	5	14.7
Biology	14	41.2
Other	2	5.8

N=34

The results show that most Chemistry teachers (41.2%) also teach biology. Others teach mathematics (23.5%) and physics (14.7%). Biology and physics are science subjects. This indicates that teachers involved in teaching and testing of these subjects have an experience in science testing and are conversant with the domains of science learning in general. A good number of teachers (14.7%) were found to currently teach Chemistry only in their schools which implies that their focus is mainly in Chemistry teaching. This gives them time for more concentration in Chemistry teaching and testing.

4.2 Aims of Chemistry School based Tests

Using the questionnaire, teachers were asked to give reasons for assessing their students in chemistry. Table 4.5 shows a summary of reasons the teachers gave for testing learners in chemistry. It shows mean scores based on a five point Likert scale. A score of three (3) was viewed as the mean score. A score above three was viewed as an agreement with the stated reason while a score below three was viewed

as a disagreement with the given reason. The scores are grouped according to school type; boys', girls' and mixed schools.

Table 4.5. Reasons for Chemistry assessment in secondary schools.

	AIM OF TEST	Boys' Schools		Girls' Schools		Mixed Schools		Overall Sample	
		\bar{x}	%	\bar{x}	%	\bar{x}	%	\bar{x}	%
a.	Assessment is done to determine learners' readiness to learn a topic.	3.14	62.8	2.80	56.0	3.12	63.3	3.02	60.4
b.	Assessment is done to determine the extent to which learners have understood a given content.	4.57	91.4	4.20	84.0	4.76	95.2	4.51	90.2
c.	Assessment is done to measure students' achievement at the end of a course.	4.71	94.3	4.80	96.0	4.06	81.2	4.52	90.5
d.	Assessment is done to provide feedback to the learners on their progress.	4.43	88.6	5.00	100.0	4.59	91.8	4.67	93.5
e.	Assessment is meant to motivate learners to work hard.	4.14	82.8	4.30	86.0	4.35	87.0	4.26	85.2
f.	Assessment is done to judge the effectiveness of a teaching method.	4.00	80.0	3.20	64.0	3.71	74.0	3.64	72.7
g.	Assessment is done to group learners.	3.10	62.0	3.10	62.0	2.65	53.0	2.96	59.0
h.	Assessment is used to predict courses and careers that learners will take in future.	3.71	74.3	1.80	36.0	3.06	61.2	2.86	57.2
i.	Assessment is done to prepare learners for KCSE examination.	4.29	85.7	4.80	96.0	3.88	77.6	4.32	86.4
j.	Assessment is done to determine creativity and social characteristics of the learner.	2.57	51.4	2.60	52.0	2.88	57.6	2.68	53.6
k.	Assessment is done to arouse and maintain interest in learners.	3.14	62.9	3.10	62.0	3.71	74.1	3.32	66.4
l.	Assessment is done to train learners to answer questions.	3.14	62.8	4.00	80.0	3.94	78.8	3.69	73.8
m.	Assessment is done to measure student's academic progress.	4.71	94.2	4.80	96.0	4.05	81.0	4.52	90.4

N=34

The standing out preferences for reasons of testing in chemistry as indicated in table 4.5 are b, c, d, e, i and m. At the top of the list is (d) which is to provide feedback to the learners. Many teachers (93.5%) seem to attach a lot of importance on feedback to learners as a key role of testing in chemistry. The least in preference for assessment is (j) which is assessing to determine creativity and social characteristics of the learners.

In boys schools, the preference for assessment of learners in chemistry was given in the order of reasons c, m, b, d and i. Again the least in preference was assessment to determine creativity and social characteristics of the learner. Teachers in girls schools indicated their most preferred reason for testing chemistry learning was to provide learners with feedback on their academic progress. The order of preference was reasons d, c, i, m and e. The teachers in girls schools however disagreed with use of tests to predict courses and careers learners would take in future. They also indicated less preference for assessment to determine creativity and social characteristics of the learner.

For mixed schools teachers tested the learners mainly to determine the extent to which learners understood the taught content (95.2%) and to provide feedback on progress to the learners. The order of preference for reasons of testing is b,d,e,c and m. It is interesting to note that the preferred reasons for assessment of chemistry learning were similar in the three categories of schools.

The reasons for testing presented can be classified into three categories depending on when assessment is done. According to Chiapetta 2010, Liversidge 2009 and Kempa 1986, reasons for assessment can be grouped into; assessment before instruction is done (diagnostic assessment), assessment during instruction (formative assessment) and assessment after instructional process (summative assesment). Reasons a, g and h were classified as diagnostic, reasons d, e, f, i, j, k, and l were classified as formative while reasons b, c and m were classified as summative. The results (table 4.6) show the mean scores and percentages of reasons for assessment based on when the assessment was done.

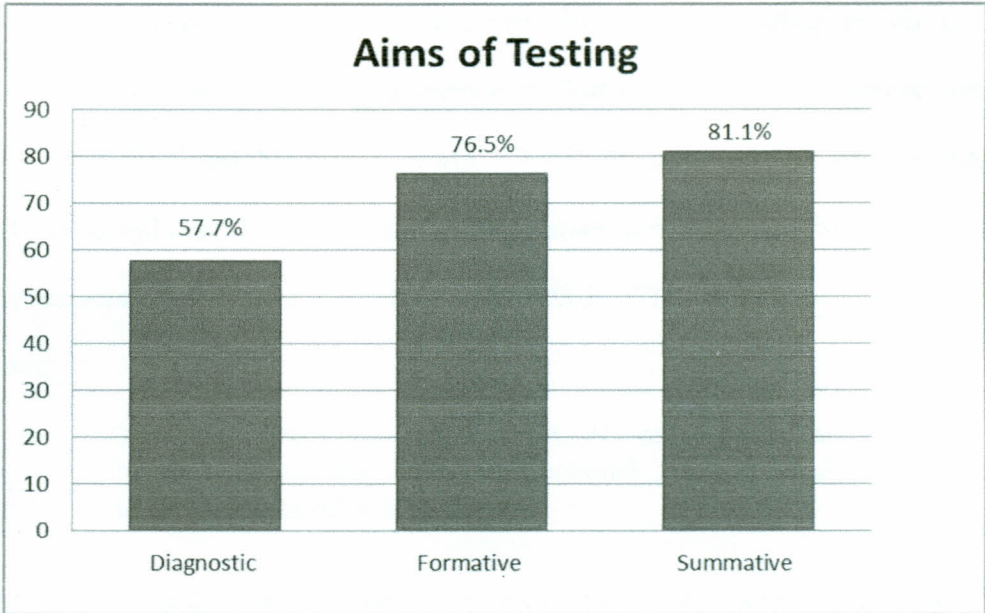
Table 4.6 Reasons of assessment based on time of assessment

Type of assessment	\bar{x}	%
Diagnostic	2.89	57.7
Formative	3.82	76.5
Summative	4.06	81.1

N=34

With a score of three (3) viewed as the mean score, the scores indicated that the teachers rarely test learners for diagnostic purposes. Most testing is done during instruction (formative) and after the instructional process (summative). The percentage of teachers who preferred use of each type of assessment is also represented in figure 4.2.

Figure 4.2 Reasons for assessment in schools based on time of assessment



The high percentage (81.1%) for preference of summative testing indicates that the teachers mainly view assessment as a measure of learning outcome. This was similar to what has been reported by Ochanji (2000) on tests made and used by physics teachers to assess their learners in Kakamega district. It was found that only 55.4% of teachers did diagnostic assessment on physics learners.

The low percentage of preference to assessment at diagnostic level could be because the teachers may not have considered assessment before the instructional process necessary. This could have been because the Kenyan education assessment structure is uniform. When learners are promoted from one class to the next the levels of competence are assumed to be similar. It is however necessary for the teacher to determine the entry behaviour and prior knowledge of a learner. The information on

prior knowledge is very important to the teacher when formulating the instructional method and choosing instructional resources for a particular group of learners. It also guides the teacher in grouping learners for instructional purposes (Bennet 2003, Chiapetta 2010 and Stenhouse 1981). Lack of such information can affect instruction and thus the achievement of the learner. It is important for the teacher to test learners at all the three levels. Kwaka (2003, p71) emphasized this when he stated;

Teachers who put more emphasis on assessment before, during and after instructional process lead to better results of their students.

The world trend towards use of process model of science learning and constructivism (Cornelius and Harbaugh, 2010) cannot be attained without determination of the learners entry behaviour. It is therefore possible that the low levels of diagnostic assessment in chemistry affects the learning process and could be one cause of poor performance in chemistry.

4.3 Assessment Methods used by Chemistry Teachers

The teachers were provided with a variety of methods commonly used in assessment of chemistry learning. They were asked to indicate how frequently they used each method of assessment. Table 4.7 gives the number and percentage of teachers who used a given method either once, twice, thrice or more than three times per term. The total percentage of teachers who at least used a given method is also given.

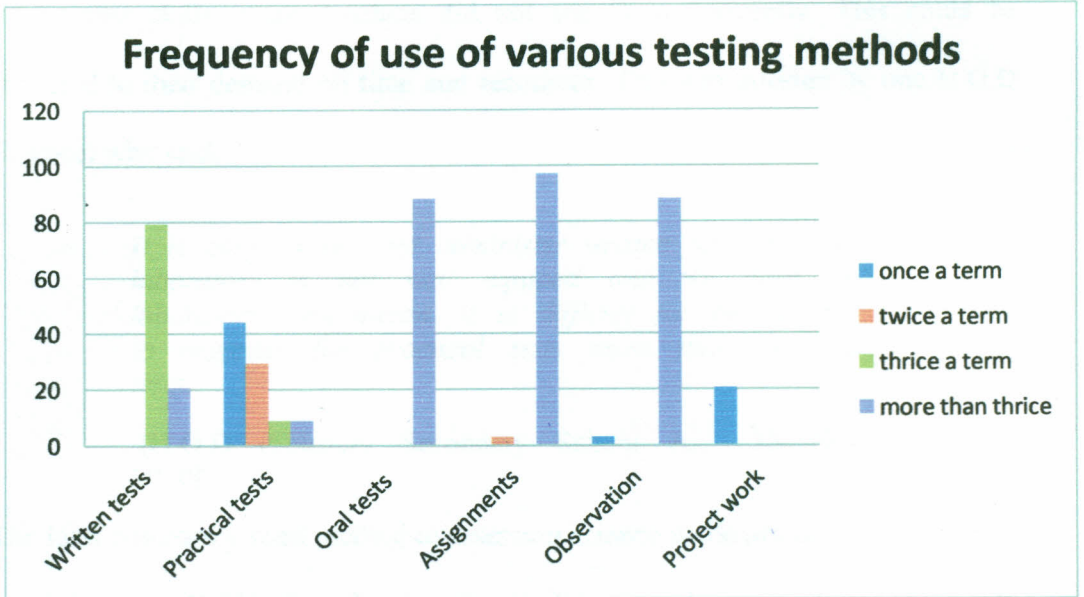
Table 4.7 Frequency of use of various assessment methods

Method		Once a term		Twice a term		Thrice a term		More than thrice		Total %
		No	%	No	%	No	%	No	%	
i.	Written tests	0	0	0	0	27	79.4	7	20.6	100.0
ii.	Practical tests	15	44.2	10	29.4	3	8.8	3	8.8	91.2
iii.	Home work/ assignments	0	0	1	2.9	0	0	33	97.1	100.0
iv.	Student observation	1	2.9	0	0	0	0	30	88.2	91.2
v.	Project work	7	20.6	5	14.7	2	5.9	0	0	41.2

N=34

These results show that all sampled teachers commonly use written tests, practical tests, student observation and homework/assignment. Most teachers used homework and student observation more than thrice a term. Although all teachers used written tests, only 20.6% used them more than thrice a term. A fairly high percentage (79.4%) of the respondents used written tests only thrice a term. Respondents indicated that they hardly use project work to assess students. This is in agreement with Kwaka (2003) who noted that the most commonly used methods of assessment in Mathematics were homework, student observation and oral questions. He noted that these methods were used daily. Figure 4.3 represents the frequency with which various assessment methods are used in schools.

Figure 4.3 Frequency of use of various assessment methods



It can be seen that the most frequently used method of testing was homework/ assignments with 97.1% of the respondents using it more than thrice a term. This could be because teachers believe that assignments have the ability to improve learning. Assignments help in better retention of factual knowledge, increased understanding, better critical thinking and greater discipline and self direction of students (Noll, 2005). These factors lead to improved learning. However Etta and John (as recorded in Noll, 2005 p331) argue that too much homework can disrupt family life, overburden children and limit learning. Homework may also not be able to tell the true educational level of the learner because the teacher has no control over who actually does it. Homework and assignments are most effective in learning if they are short and regular.

Despite the importance of practical tests in acquiring and developing manipulative and process skills, many teachers did not use them frequently. This could be attributed to their demand on time and resources. This was attested by one H.O.D (Science) who said;

It is easy to set and administer written tests but our laboratory is not well equipped and we have no laboratory technician, it is difficult for the teacher to organise for practical tests more than twice a term.

[H.O.D (Science) Secondary School A, 15 Nov 2010]

The least commonly used method in assessing science is the project method. It was found that only 41.2% of teachers used project work, and most of them used it only once a term. This implies that students creativity which can be tested through project work is rarely tested. This could be mainly due to its high demand on time. It is important that that teachers use project work in schools. Kwaka (2003) stated that students whose teachers used practical and project work in mathematic sposted better performance than those who did not.

Another interest of this part of study was the keeping of records for assessment tests done in chemistry. The teachers were asked to indicate the assessment tests for which they keep records.

Table 4.8 Assessment methods and record- keeping

METHOD	Boys' schools		Girls' schools		Mixed schools		Overall Sample	
	No	%	No	%	No	%	No	%
Written tests	7	100.0	10	100.0	16	91.3	33	97.1
practical test	6	85.7	8	80.0	11	73.3	25	73.5
Home work/ assignments	2	28.6	3	3.00	3	17.6	8	23.5
Student observation	0	0	0	0	0	0	0	0
Oral questions	0	0	0	0	0	0	0	0
Project work	0	0	3	30.0	2	11.8	5	14.7

N=35

It was observed that it is for the most commonly used methods (student observation and assignments) that records were not kept. Only 23.5% of teachers kept records for assignments and 14.7% for project work. Most teachers kept records for methods used less than thrice a term which are mainly written tests and practical work.

The lack of records on students observation and assignments could be attributed to the fact that they are used in almost every lesson to facilitate learning as an informal evaluation method. This is in agreement with Chiapetta (2010) who cite these as formative methods of evaluation. It is however very important for the teachers to keep records of these methods of assessment in order to monitor students' progress. These records also can be used to guide another teacher who could take over the class in the formulation of instructional methods. It may also be noted that written tests and practical tests consume a lot of time and resources and therefore may not

be done in every lesson. Results from these tests may also be recorded as a school requirement. Some of these results are often used as details in the student's end-of-term performance report given to parents, guardians or sponsors.

The HODs of all schools visited confirmed that teachers were guided by school policies on the number of times written and practical tests should be done in schools. However the use of project work in assessment was left for the teacher to decide. No strict policies governed the provision of assignments and projects. Only a few HODs confirmed that records for assignments were required by the department head. This explains why some teachers may not find it necessary to keep records for assignments and to use projects as a form of assessment.

4.4 Domains of Chemistry emphasized in Tests

The chemistry content emphasized in chemistry school based assessment tests was of great interest to the researcher because it shows the ability of the tests to improve learning and thus performance in chemistry at the end of the course.

4.4.1 Chemistry Content/Skills tested in written tests

To facilitate the analysis of content mostly tested in chemistry school based tests, two chemistry test papers; one theory and one practical paper which had been previously used by teachers to test their students in chemistry within the last two years were collected. A total of thirty five (35) theory papers and eighteen (18) practical papers were analysed. The number of theory test papers were almost twice that of practical test papers because most teachers use two theory test papers and one

practical test paper to assess chemistry learners at form three level. They therefore felt that one theory paper does not reflect the full content of a chemistry test. Theory test papers carry more marks than the practical test papers. The total marks for all the theory papers analysed were 2,330 while total marks for practical papers analysed were 742.

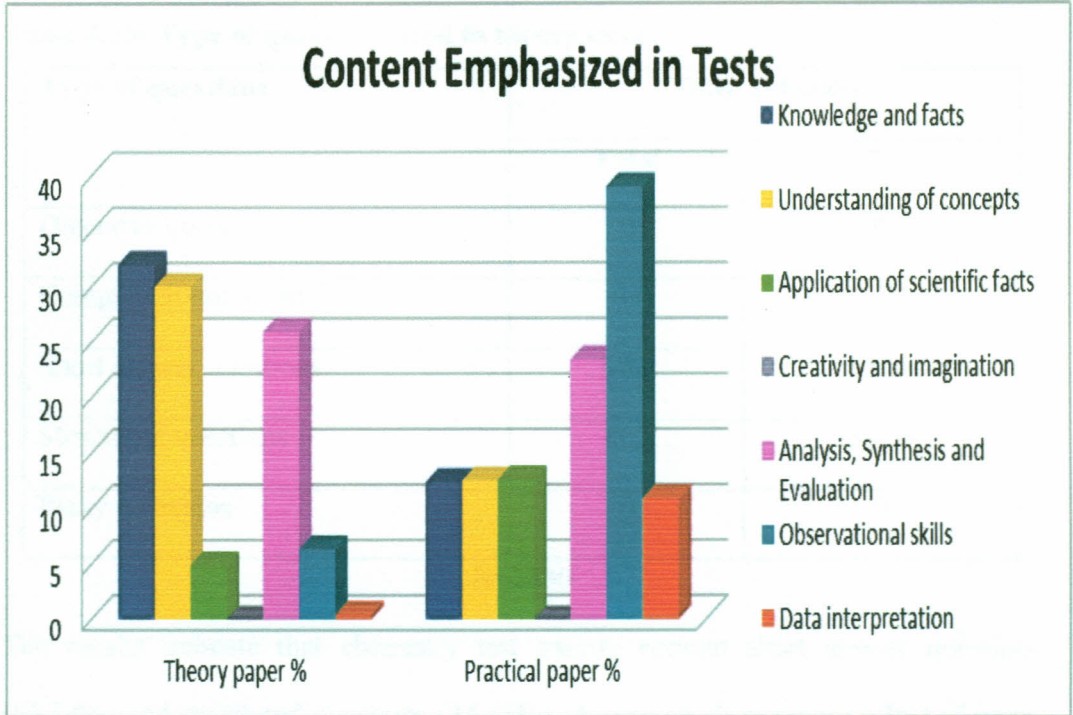
The number of questions in the theory and the practical test papers testing various aspects of chemistry content were coded. The analysis of total marks for items testing each aspect of chemistry learning out of the total marks for the papers analysed are presented in table 4.9.

Table 4.9 Content/skills assessed in theory and practical tests

	Aspect Tested	Theory paper Tally (Marks)		Practical paper Tally (Marks)	
		Total	%	Total	%
1	Knowledge and facts	747	32.06	92	12.39
2	Understanding of concepts	700	30.04	93	12.53
3	Application of scientific facts	115	4.93	12	1.62
4	Creativity and imagination	4	0.002	0	0
5	Analysis, Synthesis and Evaluation	606	26.01	174	23.45
6	Observational skills	148	6.35	290	39.08
7	Data interpretation	10	0.43	81	10.92
		N=2330		N=742	

The results (table 4.9) show that most of the test items in theory test papers focused on learners acquisition of knowledge and facts (32.06%), understanding of concepts (30.04%) and analysis, synthesis and evaluation (26.01%). All these are areas of cognitive domain of science learning. It can therefore be noted that 88.1% of items in theory test papers that teachers use emphasize the cognitive domain. The least tested item by theory test is creativity and imagination (0.002%). Practical tests mainly focused on observational skills (39.1%) which are in the process science domain. Analysis, synthesis and evaluation were also fairly tested (23.45%) in the practical paper. Testing of application of scientific facts is very low (1.62%) and no item was found to test creativity. The percentage of items for each aspect tested in the theory and practical papers are represented in figure 4.4.

Figure 4.4 Percentage of items for each aspect tested in the theory and practical papers



These results show that a lot of emphasis is put on lower level cognitive domain in the theory papers. This generally agrees with a study conducted by the Cleveland public schools (Fleming and Chambers, 1983, as cited in Stiggins, 1985, p.72) which examined over three hundred (300) teacher-made tests and found that there was need for teachers to measure skills beyond recall of facts. Young and Kim (2007) noted that, teacher-made tests appear to measure content and may leave little room to test behaviors that can be classified as ability to make judgments. The theory test papers were again analysed with an aim of finding out the type of test

formats the teachers use. Marks allocated for test items in each format were computed (table 4.10)

Table 4.10: Type of questions used in theory tests

Type of questions	Tally (Marks)	
	Total	%
Objective questions	0	0
Completion questions	63	2.70
Short answer questions	1462	62.74
Structured questions	805	34.55
Essay questions	0	0

N=2330

The results indicate that chemistry test mainly contain short answer questions (62.74%) and structured questions (34.55%). A very small number (2.7%) of items were completion type of questions. Chemistry teachers did not use objective and essay type of questions in their tests.

Chemistry teachers may not have used objective questions at secondary school level because despite their ability to test wide range of items increasing the validity of a test, they may not demonstrate the learner's ability in chemistry. They encourage guessing and measure memorization rather than understanding (Twoli, 2006). Short answer questions ensure a wide range of items are used in the test thus increasing test validity. They however tend to encourage fragmentation of scientific ideas (Kempa, 1986). It is important for teachers to include essay tests in chemistry in

order to assess the learner's ability to organize ideas and communicate them using scientific language. The practical test papers were also analysed with an aim of identifying the skills emphasized in chemistry practical tests. The marks allocated for test items testing each skill were computed (table 4.11)

Table 4.11 Type of skills assessed in practical paper

Skill emphasized by the questions	Tally (Marks)	
	Marks	%
Observation	174	23.45
Interpreting data	72	9.70
Recording data	99	13.34
Inferring	90	12.13
Manipulative skills	156	21.02
Mathematical skills	137	18.46
Non-linear skills	14	1.89

N=742

The results (table 4.11) show that the most tested skills in practical tests are the observational and manipulative skills. They indicate a balance in the testing of the basic process skills and manipulative skills. This implies that practical tests adequately assess the process domain of science learning.

The two types of tests (theory and practical) are therefore necessary in chemistry learning as they substantially test cognitive and process domain. The results agree with Twoli (2006) who observed that objectives of teaching chemistry fall into two

main categories; understanding of concepts and acquisition of manipulative and process skills. It is however clear that these two papers do not sufficiently test application and creative domains of science learning. This suggests the need for other methods of assessment to attain a more balanced assessment which involves all or nearly all domains of science learning (Chiapetta 2010).

The format of school based chemistry tests was found to resemble that used by the Kenya National Examinations Council. In Kenya, Chemistry at KCSE level is usually tested by use of three test papers that are set in different formats. Two theory test papers and one practical test paper. The first paper containing short answer questions, the second contains structured questions from selected areas of the syllabus and the third is a practical paper involving carrying out of experiments following procedures provided in the test paper (KNEC, 2002). The HODs interviewed attested that this format of testing in chemistry is modeled in the schools.

4.4.2 Methods used to test domains of chemistry learning

Teachers were asked to indicate the methods they used to test various aspects of learning derived from the five domains of science learning. Table 4.12 shows the responses obtained from teachers in boys schools in number and percentage of teachers that gave each response.

Table 4.12 Methods used to assess various aspects of chemistry learning in Boys' schools

Aspect tested		Method of Assessment											
		Written test		Oral questions		Practical test		Assignment		Observation		Project work	
		No	%	No	%	No	%	No	%	No	%	No	%
A	Knowledge and facts	7	100.0	4	57.1	3	42.8	2	28.6	1	14.3	0	0
B	Understanding of concepts	6	85.7	3	42.8	5	71.4	3	42.8	0	0	0	0
C	Application of science knowledge	3	42.8	2	28.6	6	85.7	1	14.3	1	14.3	1	14.3
D	Creativity and imagination	0	0	2	28.6	2	28.6	2	28.6	3	42.8	2	28.6
E	Analysis, Synthesis and Evaluation	6	85.7	2	28.6	3	42.8	1	14.3	0	0	1	14.3
F	Manipulative skills	0	0	0	0	7	100.0	0	0	2	28.6	2	28.6
G	Observational skills	0	0	1	14.3	6	85.7	1	14.3	3	42.8	1	14.3
H	Data interpretation	4	57.1	2	28.6	6	85.7	4	57.1	0	0	2	28.6
I	Attitude towards Chemistry	0	0	5	71.4	2	28.6	2	28.6	5	71.4	0	0

N=7

All teachers in boys schools indicated that they tested knowledge and facts in chemistry by use of written tests. They also tested manipulative skills by use of practical tests. A high percentage (71.4%) of teachers tested students' attitude towards chemistry through student observation and oral questions. The higher order skills of cognitive domain (analysis, synthesis and evaluation) were mainly tested by

use of written tests (85.7%). Practical tests were indicated as useful in testing all the aspects of learning indicated with only a variation in percentage for each aspect.

Table 4.13 Methods used to assess various aspects of chemistry learning in Girls' schools

Aspect	Written test		Oral questions		Practical test		Assignment/ homework		Observation		Project work		
	No	%	No	%	No	%	No	%	No	%	No	%	
A	Knowledge and facts	8	80	5	50	5	50	5	50	4	40	0	0
B	Understanding of concepts	8	80	5	50	4	40	5	50	1	10	0	0
C	Application of science knowledge	7	70	0		6	60	5	50	0	0	3	30
D	Creativity and imagination	3	30	4	40	2	20	0	0	2	20	3	30
E	Analysis, Synthesis and Evaluation	10	100	3	30	8	80	3	30	0	0	0	0
F	Manipulative skills	0	0	0	0	10	100	0	0	0	0	3	30
G	Observational skills	0	0	6	60	10	100	2	20	3	30	3	30
H	Data interpretation	7	70	0	0	8	80	5	50	0	0	1	10
I	Attitude towards Chemistry	0	0	3	30	2	20	1	10	6	60	1	10

N=10

Just like in boys' schools, teachers in girls' schools used written test to assess knowledge and facts. Higher order cognitive skills were tested using written tests and practical tests. Oral questions and student observation were used to measure creativity. Practical tests were used by all sampled teachers to measure manipulative

and observational skills. Similar to the results obtained from the boys' school category practical tests were used to assess all aspects of chemistry learning.

Table 4.14 Methods used to assess various aspects of chemistry learning in mixed schools

	Aspect	Method of Assessment											
		Written test		Oral questions		Practical test		Assignment/ Home work		Observation		Project work	
		No	%	No	%	No	%	No	%	No	%	No	%
A	Knowledge and facts	14	82.3	4	23.5	2	11.8	5	29.4	5	29.4	1	5.8
B	Understanding of concepts	12	70.6	8	47.1	4	23.5	5	29.4	4	23.5	2	11.8
C	Application of science knowledge	8	47.1	3	17.6	8	47.1	3	17.6	3	17.6	4	23.5
D	Creativity and imagination	2	11.8	4	23.5	4	23.5	1	5.8	3	17.6	8	47.1
E	Analysis, Synthesis and Evaluation	8	47.1	2	11.8	3	17.6	7	41.2	3	17.6	0	0
F	Manipulative skills	1	5.9	2	11.8	15	88.2	3	17.6	3	17.6	1	5.8
G	Observational skills	0	0	2	11.8	16	94.1	0	0	8	47.1	2	11.8
H	Data interpretation	10	58.8	2	11.8	17	100.0	2	11.8	0	0	0	0
I	Attitude towards Chemistry	0	0	1	5.8	1	5.8	4	23.5	4	23.5	1	5.8

N=17

These results were very similar to those obtained from boys' and girls' schools. Teachers in mixed schools used practical tests to assess all the aspects of learning. A high percentage (82.3%) also used written tests to assess knowledge and facts.

Unlike the results in girls' schools, teachers in mixed schools used oral questions to assess all aspects of chemistry learning. Another difference from the results obtained in boys' and girls' schools is that direct observation was used to test all domains except data interpretation. The higher level of cognitive domain is not as much tested as in the boys and girls schools. Only 41.7% used written tests for assessing synthesis, analysis and evaluation. Again assessment of attitude towards chemistry was found to be very low.

From the three categories of schools, it can be concluded that testing of knowledge and facts in Chemistry is done by use of all the assessment methods indicated. Practical tests and oral questions are the most versatile as they are used to test all the domains of chemistry learning.

When the aspects of learning are classified into the five domains of science learning as described by Dass (2005), Bloom (1956) Kempa (1986), and Twoli et al (2007), written tests were seen to mainly test **cognitive domain** (aspects A, B, C and E, table 4.12 - 4.14). Practical tests were mainly used to assess the **process domain** of science learning (aspects F, G and H). **Attitude domain** (aspect I) is mainly tested by use of observation (71.4% for boys, 60% for girls and only 23.5% for mixed schools). It is also assessed using oral questions (71.4% for boys, 58.6% for mixed and only 30% for girls schools). **Application domain** (aspect C) can be tested using all the assessment methods given with the highest percentage being the use of written and practical tests. **Creativity domain** of chemistry learning (aspect D) was assessed by oral questions, observation and project work.

The practical tests have been identified as having the ability to assess all aspects of chemistry learning and thus all the science domains. This is supported by Chiapetta (2010) who indicated that laboratory work is important in promoting several learning outcomes which include; scientific attitudes, conceptual development, scientific inquiry, process skills and teamwork. It was, however, earlier noted (table 4.7) that only 17.6% of all sampled teachers used this method more than twice a term.

The attitude domain of science learning was assessed through student observation and oral questions both of which teachers did not keep records (table 4.8). This implies that the teachers accord less seriousness in testing of attitudes. This seems to agree with Dass (2005) who observed that attitude domain is the most commonly neglected domain in school science. This could be because the way science content is represented by the authors of textbooks and teachers in the classrooms gives the impression that science is primarily a body of knowledge that students ought to master. It could be also due to the fact that attitudes are not tested by KNEC. Science teaching should, however reflect scientific values. If the science teaching helps students to see the importance of attitudes and practice them in school science, their attitude towards chemistry would change and performance in chemistry would improve.

The percentage of teachers who assess creativity was very low with the highest being 47.1% of teachers using project work in mixed schools. Having noted that only 41.2% of teachers use project work (table 4.7) then it is possible to conclude

that the aspect does not get much attention from teachers. Dass (2005) also noted that very little attention has been paid to creativity in the science classroom. In Kenyan curriculum, most laboratory experiments are designed towards achievement of a particular objective thus greatly limiting room for creativity. Students are rarely challenged to raise new questions on their own, formulate their own hypotheses and design their own experiments to test their hypotheses. In a school science laboratory, students are often expected to follow the direction (procedure) given and arrive at predetermined results and conclusions. The changing emphasis in the National Science Education Standards is to promote scientific inquiry in school science (Dass, 2005). This calls for science teachers to promote and reward creative innovations in the classroom.

4.4.3 Challenges in constructing chemistry school - based tests

Tests can only fulfil their role in improving performance if they are well constructed. It is with this regard that the teachers were asked to indicate the aspects they found challenging to test in school based Chemistry assessment and to give reasons why they found it challenging to test those aspects. The results of their views are presented on table 4.1.

Table 4.15 Aspects found challenging to test in chemistry learning

ASPECT		Boys		Girls		Mixed		Total	
		N _o	%	N _o	%	N _o	%	N _o	%
A	Knowledge and facts	0	0	0	0	0	0	0	0
B	Understanding of concepts	0	0	0	0	1	5.8	1	2.9
C	Application of science knowledge	0	0	0	0	4	23.5	4	11.8
D	Creativity and imagination	4	57.1	5	50.0	8	47.1	17	50.0
E	Analysis, Synthesis and Evaluation	2	28.6	3	30.0	3	17.6	8	23.5
F	Manipulative skills	2	28.6	1	10.0	7	41.1	10	29.4
G	Observational skills	1	14.3	0	0	1	5.8	2	11.8
H	Data interpretation	2	28.6	2	10.0	4	23.5	8	23.5
I	Attitude towards Chemistry	4	57.1	4	40.0	7	41.2	15	44.1

N=34

The results indicated that the most challenging aspect was creativity and imagination (50%). This was followed by testing of attitude towards chemistry (44.1%). The reasons given by teachers for this being that the curriculum did not provide a guide to testing of these aspects. All practical lessons are geared towards achievement of defined objectives. This leaves limited room for creativity. Kenya being a developing country, unavailability of resources also affects assessment of these aspects. Learners are therefore restricted to doing only specified experiments which at times may be carried out as teacher demonstrations.

The teachers indicated that the curriculum was too crowded and thus time limited testing of aspects outside the ones tested at the end of the course. Chemistry syllabus content that should be covered within the four year period of study is very wide. The teachers, therefore, may not get time to test aspects such as creativity, attitude and a great deal of manipulative skills.

Teachers did not cite difficulty in testing knowledge and facts as well as understanding of concepts. This is most probably why the tests analysed showed a large proportion of items testing knowledge and understanding of concepts (table 4.9). One main aim of instruction is to stimulate independent thinking and use of acquired factual knowledge as a basis of problem solving. However, tests constructed by teachers often stress on memorized facts and rules, the result is that learner's place undue emphasis on rote learning (Stiggins, 1985). To reduce this, teachers should base their tests on objectives of learning (Queensland Studies Authority, 2010).

4.5 Procedures in School-Based Chemistry Testing

4.5.1 Setting, moderating and marking of chemistry tests

Teachers involved in the study were asked to indicate who sets, moderates, makes the marking scheme and marks the tests they use in their schools. Their responses to the questions were organised according to school type (tables 4.16, 4.17 and 4.18).

Table 4.16 Setting, moderating, marking scheme and marking tests in boys' schools

		Subject Teacher		Team of Teachers		Head of Department		Total	
		No	%	No	%	No	%	No	%
a.	Setting Tests	5	71.4	2	28.6	0	0	7	100
b.	Moderating Tests	6	85.7	0	0	1	14.3	7	100
c.	Making Marking Scheme	4	57.1	2	28.6	1	14.3	7	100
d.	Marking Tests	7	100	0	0	0	0	7	100

N=7

All the tests in boys' schools were set, moderated and marked within the school. The results indicated that setting was mainly done by the subject teacher with only 28.6% being done by a team of teachers. A high percentage (85.7%) indicated that moderating was done by the subject teacher. Making the marking scheme was done either by the subject teacher (57.1%), a team of teachers (28.6%) or head of department (14.3%). Marking is also done by the subject teacher.

Table 4.17 Setting, moderating, marking scheme and marking tests in girls' schools

		Subject Teacher		Team of Teachers		Head of Department		Total	
		No	%	No	%	No	%	No	%
a.	Setting Tests	7	70	3	30	0	0	10	100
b.	Moderating Tests	4	40	2	20	2	20	8	80
c.	Making Marking Scheme	8	80	2	20	0	0	10	100
d.	Marking Tests	10	100	0	0	0	0	10	100

N=10

Just like in boys' schools, setting was mainly done by the subject teacher (70%). Only 40% indicated moderating was also done by subject teacher, with 20% indicating that moderating was done by a team of teachers and another 20% indicating that it was done by the head of department. This shows that 20% of tests were not moderated at all. The lack of team moderation can affect the quality of tests thus expose learners to skewed question papers with respect to cognitive domain. Unlike in boys' schools, Head of department was not involved in the making of marking scheme. It was made either by subject teacher (80%) or a team of teachers (20%). All teachers sampled indicated that the subject teachers did the marking.

Table 4.18 Setting, moderating, marking scheme and marking tests in mixed schools

		Subject Teacher		Team of Teachers		Head of Department		Total	
		No	%	No	%	No	%	No	%
a.	Setting Tests	17	100.0	0	0	0	0	10	100.0
b.	Moderating Tests	4	23.5	3	17.6	5	29.4	12	70.5
c.	Making Marking Scheme	17	100.0	0	0	0	0	10	100.0
d.	Marking Tests	17	100.0	0	0	0	0	10	100.0

N=17

The results show that tests were set by the subject teacher (100%). Most teachers indicated that moderation was done by head of department (29.4%). However, 29.5% of the teachers indicated that chemistry tests in their schools were not moderated. Preparation of marking scheme and actual marking was done by subject teacher only.

The results (table 4.16, 4.17 and 4.18) show that in all the three types of schools, 85.3% of the respondents indicated that tests are mostly set by Chemistry subject teachers and (100%) stated that the subject teachers did the marking. A class-teacher therefore carries a lot of responsibility when it comes to construction, moderation and marking of tests in chemistry. It is worth noting that the teacher who made the test cannot moderate it. It can therefore be considered that tests made and moderated by the same teacher are not moderated at all. This centralisation could lead to the test not attaining high levels of validity and reliability.

Stiggins (1985) noted that constructing a good teacher made test is very time consuming and difficult. It should, therefore, be emphasized in teacher pre-service and in-service training. Teachers who are not confident in test construction are likely to be tempted to rely on commercially made tests in textbooks or on their own often inadequate tests for evaluation. It should also be noted that though teacher made tests may have the same objective, style and format, they differ greatly from class to class (Wiggins, 1998). It is, therefore, worth noting that assessment results from one teacher have higher chances of bias.

This indicates need for team moderation as Daugherty (1995) noted that group moderation allows examiners to clarify in discussion both the objectives of the syllabus and the value of judgements from the results. Since continuous assessment is a continual updating of teacher's judgements about their pupils, The standards against which these judgements can be moderated is through the consensus judgement of fellow teachers of the same subject at the same level (Macintosh, 1976). External moderation can also be included in school based tests. This would ensure that outcomes are comparable from school to school and can also improve teachers' assessment capabilities (QSA, 2010). Results from such tests can therefore be used in determining the learner's achievement at the end of the course. This indicates need for teachers to work as a team.

A high percentage (80%) of the teachers who moderated their tests did so before administration. This was mainly to ensure that the tests contained unambiguous test items and to correct any errors that could be in the test in terms of test item

construction or awarding of marks per test item. This was attested by one head of department during an interview who said;

Teachers make errors in writing test items, others copy questions from textbooks and fail to edit them to suit the objectives of the test, it is therefore important for teachers to countercheck the tests before administering them to the students.

(HOD Science, Secondary School B, 17 Nov 2010)

Other HODs interviewed said that the schools had their policies regarding the process of setting, moderating, administering and marking written tests which the teachers followed.

4.5.2 Time for test administration

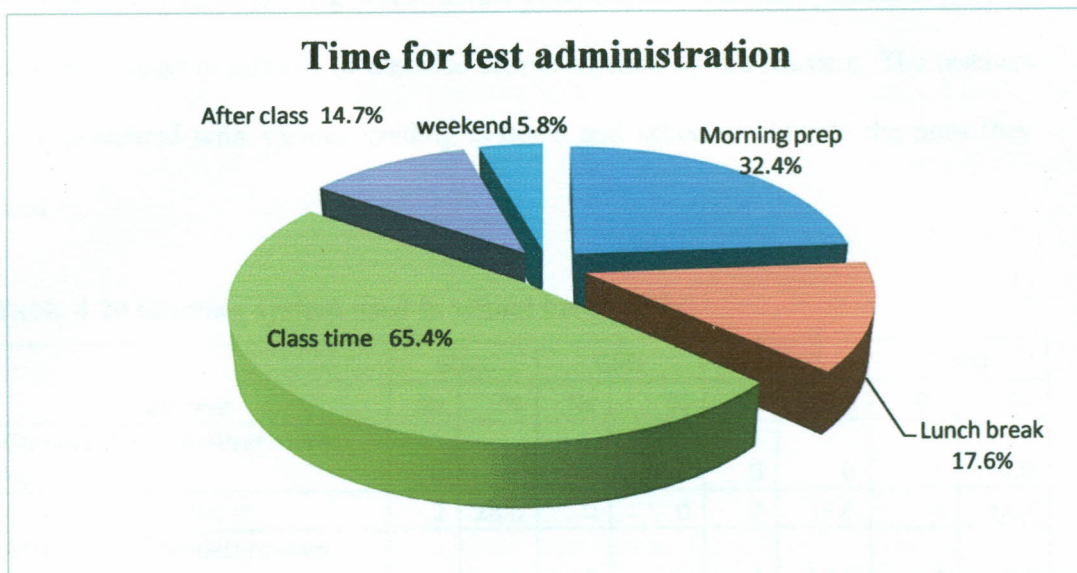
The teachers were presented with options of time when they administer written tests in their schools.

Table 4.19 The time Chemistry written tests are administered

School type	Morning prep		Lunch break		Class time		After class		Weekend	
	No	%	No	%	No	%	No	%	No	%
Boys	2	28.6	0	0	5	71.4	2	28.6	1	14.3
Girls	5	50.0	2	20.0	6	60.0	0	0	0	0
Mixed	3	17.6	4	23.5	11	64.7	3	17.6	1	5.8
Total	10	29.4	6	17.6	22	65.4	5	14.7	2	5.8

N=35

Most of the schools (65.4%) favour giving written tests during class time. This means that a lot of teaching time is used in testing. Girls' schools showed the highest percentage (50%) of their tests given during the morning prep (a period of students' personal learning before scheduled classes start) while in mixed schools the least percentage of respondents administered their tests in the morning prep (17.6%). This could have been contributed by the fact that all girls' schools involved in the study were boarding schools while most mixed schools in the sample were day schools. Time for learner's arrival in school to prepare and take a test could be a limiting factor for day schools to use morning prep for testing. The other limiting factor in administration of tests in the morning and evening preps is lack of sufficient lighting for schools that do not have electrical power supply. The total percentage of teachers who administered the test at given times of the day is shown in figure 4.5.

Figure 4.5 Time when chemistry written tests are administer

It is also important to have as much uniformity in terms of physical environment as possible during test administration. This may explain why most teachers do not prefer administering tests during weekends. It was observed by one HOD during the interview that many activities took place in the school as well as outside the school during weekends and these could adversely affect the testing programs. Lunch breaks were usually short and inappropriate for test administration while students are usually too tired after classes to take a test. Most schools also had other activities organized for the time after class. The schools had policies governing the time for administration of tests which the teachers usually followed.

4.5.3 Grading of chemistry school based tests

Most tests end up in grading which define performance. Various systems of grading have been used in schools to describe scores attained by the learners. The teachers were presented with various grading systems and asked to indicate the ones they used.

Table 4.20 Grading system used in school based tests

System	Boys		Girls		Mixed		Total	
	No	%	No	%	No	%	No	%
Comment with neither marks nor grades	0	0	1	10.0	0	0	1	2.9
Use of grades A B C D	2	28.6	0	0	2	17.6	4	11.8
Marks out of predetermined total	0	0	0	0	2	17.6	2	5.9
Combination of marks and grades	5	71.4	9	90.0	13	76.5	27	79.4

N=34

The results (table 4.4.5) show that most teachers (79.4%) prefer to use a combination of marks and grades to describe student's performance. Only 11.8% used grades only. The heads of department in an interview carried out by the researcher made it clear that end of term tests were always described in terms of a combination of marks and grades. Grades only were used in assessment that was not included in the end of term students' performance report such as the project work. HOD (Science) Secondary School C, observed that project work was done in groups with lots of student's effort and creative thinking therefore, chemistry teachers felt that students felt more encouraged when awarded grades in terms of A, B or C instead of allocating marks for their work. The grading system for the project was

chosen departmentally and could vary from the usual grading system for written tests. One HOD observed that use of comments with neither marks nor grades could only be used to describe performance in oral questions which are common during classroom instruction. Assignments and homework were commonly awarded marks out of a predetermined total. Most of the HODs interviewed viewed the system of using grades and marks as the best way to communicate performance, especially to parents and guardians. They noted that some guardians/ parents may not be in a position to correctly make an interpretation of either grades or marks if used on their own.

When asked how the grading system they used was selected, 82.4% of the teachers indicated that the grading system was part of the school policy while 17.6% said the system was selected departmentally. This points to the fact that there are school policies that govern the grading of school based tests. There are however no national policies regarding the grading. The schools grading system does not always concur with the system used by KNEC at KCSE level of chemistry testing. This makes it difficult to predict the performance of the learner at the end of the course using school based tests. Most teachers use criterion reference grading system for school based tests while KNEC uses norm - reference grading system which highly depends on the performance of the group being tested.

As observed by three HODs during the interview, the grading system used in schools can make learners to acquire a negative attitude towards some subjects including Chemistry. This is because the grading criteria set for other art subjects,

which is usually high, is the same one used for Chemistry. This might give some learners an impression that they cannot perform well in Chemistry. The grading system used for chemistry examination at KCSE level is different from that used for art subjects (KNEC, 2009). One HOD however observed;

If lower criterion is set for science and mathematics subjects, the learners would get an impression that these subjects are difficult which would lead to a negative attitude towards them.

(HOD Science Secondary School D, 18 Nov 2010)

When asked the level at which they included marks from practical tests in the end of term examination, a very large number (98%) of teachers indicated that they included them at Form Three level. This could be due to the fact that at Form Three level the learners have gained enough knowledge and skills to handle experiments on their own. At lower levels most experiments are done in large groups and with keen guidance from the teacher. They cannot adequately reflect student's individual ability in Chemistry. Using practical tests from Form Three level may however disadvantage learners as they do not get enough time to practice the skills taught. This could adversely affect performance in practical examinations at KCSE level. Teachers should therefore try to expose learners to practical tests earlier in order to perfect their skills by the time they are sitting for their KCSE at the end of the course.

4.6 Teachers' general views on Chemistry Testing

The teachers were presented with a variety of general views regarding assessment and required to indicate whether they agreed or disagreed with the view. The number and percentage of those who agreed, disagreed or were neutral regarding a particular view was tabulated (table 4.21).

Table 4.21 Teachers' general views on chemistry assessment

View		Agreed		Neutral		Disagreed	
		No	%	No	%	No	%
a	Scarcity of apparatus hinders some forms of testing.	24	70.6	0	0	10	29.4
b	Assessment tests motivate learners in chemistry	30	88.2	2	5.9	2	5.9
c	The curriculum does not provide enough time for frequent assessment tests.	31	91.2	1	2.9	2	5.9
d	There is need to have a national policy on assessment to make the assessment practices uniform in all schools.	27	79.4	2	5.9	5	14.7
e	Continuous assessment test scores should be included in the final grading of form four candidates at KCSE level.	16	47.1	4	11.8	14	41.2
f	Frequent assessment tests do not improve students' performance in chemistry.	3	8.8	1	2.9	30	88.2
g	Tests put too much demand on the teacher's time and energy.	8	23.5	5	14.7	21	61.8
h	Students should be awarded marks for every skill through direct observation during the KCSE Chemistry practical examination	17	50.0	5	14.7	12	35.3

N=34

From the results, 70.6% of the respondents agreed to the fact that scarcity of apparatus hindered some forms of assessment. Inadequate resources could limit the

ability of teachers to use practical tests more often. This could explain why most teachers use practical tests only once a term (table 4.7). A large group (88.2%) agreed that tests are meant to motivate learners to learn more. This however depends on the quality of test and the nature of feedback given to the learners. It is important to note that repeated failure in tests could lead to demotivation of the weak learners (Dass 2005). HOD (Science, Secondary School B) however pointed out that without tests most learners would not revise the work covered in class until the end of the term leading to poor retention. Most teachers (91.2%) also agreed that the curriculum does not provide enough time for frequent assessment tests. As stated earlier the wide chemistry syllabus does not leave much time for testing and thorough revision of tests. This may explain why most teachers used written test only three times a term and practical test only once a term (table 4.3.1).

A good percentage of respondents (73.4%) agreed that there is need to have a national policy on assessment in order to make the assessment practices uniform in all schools. This would help teachers use school based tests for predictive purposes. Tests governed by similar policies could also be used as part of the grade awarded at end of course examinations. In view of the world trend towards use of school based assessment to determine learners' achievement at the end of the course (QSA, 2010), teachers were asked if continuous assessment test scores should be included in the final grading of candidates at KCSE level. A total of 41.2% disagreed. This could be mainly because there are no national policies that guide school based testing and

standards used depend on individual schools. As Stiggins (1985) noted they are often subject to question and their quality is open to debate.

Despite the weakness in the current conventional practical testing procedures used in Kenya where a student performs an experiment and records the results on paper for the examiner, only 50% agreed with students being awarded marks for every skill performed through direct observation during KCSE chemistry practical examination. Performance assessment where a candidate carries out the experiment under direct observation of an examiner who awards marks for skills performed is being currently tried in some countries and reports about their effectiveness are positive (Twoli, 2006). It is however important to note that with the large number of candidates in Kenyan schools the method would be very expensive and difficult. Process assessment in chemistry practical examinations would also lead to increased subjectivity in awarding of grades. Teachers indicated that frequent school based tests are useful in improving performance in chemistry. This explains why so much emphasis has been put on the frequent use of tests in schools.

4.7 Students' views on Chemistry school based test

Chemistry students' questionnaires were administered to a total of one hundred and eighty (180) Form Three students. They were asked to indicate their level of agreement or disagreement with stated views regarding school based chemistry tests. The results were analysed on a five point Likert scale. A score of three (3) was viewed as the mean score. A score above three was viewed as positive while a score

below three was viewed as a disagreement with the view. The percentage scores are also given.

Table 4.22 Students' views on assessment tests in chemistry

VIEW		Boys		Girls		Mixed		Total	
		\bar{x}	%	\bar{x}	%	\bar{x}	%	\bar{x}	%
a.	Tests help me acquire some skills in answering chemistry questions.	4.63	92.7	4.30	86.0	4.39	87.8	4.44	88.8
b.	Tests help me make decisions on my future (prospective) career.	4.13	82.7	3.53	70.5	3.68	73.6	3.78	75.6
c.	Tests make learning of chemistry difficult and unpleasant.	1.67	33.3	2.18	43.5	2.12	42.4	1.99	39.8
d.	Tests make me like learning chemistry.	3.97	79.3	4.00	80.0	3.66	73.2	3.88	77.5
e.	Tests give me a chance to show my ability in chemistry.	4.43	88.7	3.90	78.0	4.29	85.8	4.21	84.1
f.	Tests help me to know the areas I am weak in and those I am strong in chemistry.	4.67	93.3	4.43	88.5	4.36	87.2	4.49	89.7
g.	Tests help me study more on topics learnt in class.	4.33	86.6	4.15	83.0	4.27	85.5	4.25	85.0
h.	Tests give important information to parents about my academic progress.	4.03	80.7	3.90	78.0	3.63	72.6	3.85	77.1
i.	Tests are only waste of time that could be used for studies.	1.73	34.7	2.15	43.0	1.70	34.0	1.86	37.2
j.	Tests motivate me to learn more.	4.53	90.7	4.68	93.5	4.43	88.6	4.54	90.8
k.	Tests only waste teacher's time in marking	1.50	30.0	2.03	40.5	1.67	33.4	1.73	34.7
l.	Tests help me prepare for the final examination.	4.67	93.3	4.46	89.2	4.53	90.7	4.55	91.0
m.	Test help me judge if the teacher taught us well.	3.50	70.0	3.53	70.5	3.60	72.0	3.54	70.9
n.	Tests make me develop interest in learning chemistry.	3.87	77.3	3.78	75.5	3.94	78.8	3.86	77.3
		N=180							

In general the students that responded to the questions indicated that tests were useful in chemistry learning. The outstanding positive responses in the order of preference were l, j, f, a, g and e. All these measured above a mean of four. Top of the list was l (91.0%) which was the view that school based chemistry tests helped the learners to prepare for the examination at the end of the course. This indicates that tests may not encourage constructivism in learning and therefore do not necessarily improve learning. Just as noted by Noll (2005) educators tend to align the curriculum closely with assessments. This may lead to focus of classroom instruction directly on test taking strategies reducing effective acquisition of scientific knowledge and skills. He also stated that improvement in test performance may not evidence student learning.

The respondents also indicated that tests in chemistry motivate them to learn more and also helps them to identify the areas of strengths and weaknesses in chemistry learning. This is in agreement with the importance of tests as stated by Ingenkamp (1989) and Wiggins (1989). Students disagreed with statements i and l (table 4.22) which indicated that tests were a waste of learning time. This signifies that school based tests are important in learning.

The students' views (table 4.22) are in agreement with the reasons for assessments that the teachers gave (table 4.5). The leading reasons for assessment that the teachers gave were to provide feedback to the learners on their progress in learning, to measure learners understanding of the content, and to measure their achievement at the end of some learning. For the students, feedback from the tests help them

identify their areas of weakness and motivates them to work harder. A learner who performs well in tests gets motivated and put in more academic time to learning the subject content. This greatly improves performance. It is therefore important for teachers to make an effort to construct tests that stimulate learners to learn more and make allowances for individual differences (Eubanks 1986).

Summary and Conclusion

...based chemistry ...
 ...to determine the purpose of school-based testing of learners in
 ...that there are a number of reasons why teachers administer
 ...tests. These, in the order of preference are
 ...program and provide feedback to the learner on their
 ...understanding of the subject matter
 ...for the sake of testing for their knowledge

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMENDATIONS

5.0 Introduction

The study set out to establish the situation of chemistry school- based testing in Kajiado North with a view to establish their purpose, their content, the frequency with which they are used and the policies governing the testing process. This chapter summarizes the study findings that resulted from data analysis and interpretation. Recommendations are made in line with the findings. Suggestions for further study which addresses the areas the study could not cover within its limits are also made.

5.1 Summary and Conclusion

5.1.1 Aims of school based chemistry tests

The study set out to determine the purpose of school-based testing of learners in Chemistry. It was found that there are a number of reasons why teachers administer Chemistry school-based tests. These, in the order of preference are:

- a. To measure academic progress and provide feedback to learners on their progress
- b. To determine learners understanding of the content taught
- c. To prepare learners for the end of course national examination
- d. To motivate learners

- e. To evaluate the effectiveness of a teaching method used to teach a given content area

Tests were usually administered for formative and summative reasons but rarely were they used for diagnostic purposes. There is however need for teachers to test learners for diagnostic purposes. This would enable them formulate instructional activities most suited for a particular group of learners (Chiapetta, 2010). It would also enable the teacher to build learning on the ideas of the learners and correct any misconceptions.

5.1.2 Assessment methods

Teachers used written tests, practical tests, oral tests, assignments, student observation and project work to assess learners. The most frequently used methods are oral questions and assignments. It was however noted that most teachers did not keep any records for these two methods. These are mainly used in every lesson as part of formative evaluation and may be useful in determining student's understanding of taught content, evaluating teaching effectiveness and motivating the learners.

The common assessment methods for which records are kept are written tests and practical work. These are important for they assess cognitive and process domain quite well. These records are used to provide feedback to the parents, the teacher and the learner on their academic progress. It is however noted that project work is rarely used in schools regardless of its importance in evaluating creativity of the learner.

5.1.2 Domains (Content) Assessed in Chemistry Tests

From the chemistry test papers analysed, it was found that the lower levels of cognitive domain which are knowledge and comprehension are the most tested areas in the theory test paper. The practical tests mainly assess manipulative and process skills with most emphasized process skill being observation. Theory tests consist of short answer questions or structured type of questions. These types of tests cover a wide area of learnt content which improves test validity (Twoli, 2006). Short answer questions were used but as stated by Kempa (1986) they tend to fragment the content.

Creativity domain in chemistry learning was tested by project work which was rarely used in schools indicating that the aspect was not much emphasized by the teachers. Application of scientific knowledge was incorporated in written tests, practical tests and oral tests. It was however not emphasized much in the practical and theory papers analysed. Attitude domain was mainly tested through student's observation for which teachers did not keep records. It is therefore difficult to determine or monitor learners' attitudes. Lack of proper guidelines and inadequate time due to overcrowded curriculum could be the cause of low assessment of creativity and attitude domain.

5.1.3 Testing procedures and policies

The teachers prepared their own tests but did not do so as a team. However some did moderate the tests before giving them to students. It was also noted that most

teachers set and moderated their own tests, a practice which could have negative implications on validity and reliability of the tests. The teachers marked their own tests. This indicates that teachers could be able to detect learner's weaknesses and use the results to modify the instructional methods used in class. It was however noted that team moderation could lead to better use of school-based tests (QSA, 2010)

Achievement in written tests was communicated as a combination of grades and marks which is the most effective way of describing the learner's performance. Multiple mark system is more informative because it shows student progress towards achievement of set goals (Terwilliger 1971).

Tests were mainly administered during class time thus consuming lots of learning time. This timing however, indicated the seriousness with which the tests are taken. The procedures regarding setting, moderating, administering, preparing marking scheme and marking the tests usually followed school made policies. There was, however, need for national policies to govern school based testing to ensure uniformity/ standardization. Daugherty (1995) noted that with national policies in place school based tests should be a fundamental element in the judgment of the learner's achievement at the end of the course.

5.1.4 Teachers' general views on testing

It was found that lack of resources and time limitation reduced teachers' opportunity to test using practical tests and project work. There was an indication that teachers

were not confident in the use of school-based tests for determination of the learners' final achievement. This could be due to lack of standardization in school-based testing. Most teachers seemed unaware and not prepared for performance assessment where learners perform practical tests under direct observation of the examiner. It is however important that chemistry education in Kenya should be in line with world trends in education. The teachers indicated that increased school-based testing would lead to improved performance.

5.1.5 Students' general views on testing

It was clear that learners also felt that school based tests are meant to improve their performance in Chemistry. A very high percentage of learners (90.8%) indicated that tests help them in preparation for end of the course examination. This is an indication that chemistry learning in Kenya is examination oriented which may explain why the analysed tests put a lot of emphasis on memorized facts and rules (table 4.3.1). This as noted by Eubanks (1998), could have a negative effect towards the learning process. The learners also indicated that tests motivate learning and also help them recognize their areas of weakness and their level of understanding of the learnt content.

5.2 Recommendations for Action

In order to improve school based chemistry tests for better performance in chemistry learning the following recommendations are made:

1. This study found out that diagnostic form of testing was not emphasized in the school tests and yet these are very useful in the formulation instructional methods. Chemistry teachers, therefore, need to be sensitized on the importance of diagnostic form of testing which would be useful in directing instruction during learning. This can be done in seminars, workshops and in-service trainings like the Strengthening Mathematics and Science Subject Education (SMASSE) which is currently being done in Kenya.
2. Teachers used a variety of methods to test students but there are areas which were not adequately tested such as attitude, creativity and application. Pre-service and in-service teacher training should be utilized to equip teachers with a variety of assessment methods and enable teachers to develop ways of assessing all the domains of science learning. Emphasis should be put on training teachers how to formulate test items which evenly distribute over all the objectives of chemistry learning. Teachers should also be sensitized over the value of teamwork moderation.
3. Project work is very important, yet it did not feature much in assessment. It should be emphasized in chemistry assessment because it is very useful in development as well as assessment of creativity of the learners. Since chemistry school tests tend to emulate the format used by the Kenya National Examination Council at the end of the course, there is need to

introduce project work as part of national examination. This would encourage teachers to give a number of projects every term.

4. Curriculum developers should consider revising chemistry curriculum to provide enough time for teachers to conduct more assessments including those requiring much time such as practical tests and project work. The curriculum should also provide guidelines on the testing of domains such as attitude and creativity.
5. The Kenya National Examination Council need to develop a national policy to govern school based assessment. Such a policy should govern;
 - Frequency of assessment
 - Methods of assessment
 - Setting, administering, marking and grading of tests
 - Record- keeping of test results

Such policies would enable the council to use school based assessment in the determination of the final grade of the learner as the new trend in education points.

5.3 Suggestions for Further Research

This study was limited to the testing process and content of chemistry school based tests. There are other related areas which may need further consideration. The following are areas suggested for further research:

1. Further study is necessary to establish the quality of school based test in terms of test validity and reliability. Without determining these qualities of

school based tests it would be difficult to use the tests in determining the learner's performance at the end of the course.

2. In this study only written practical and theory tests were analysed. It is necessary for further research to analyse oral questioning and observation of students in class. This would provide a wider view of effect of school-based testing in the improvement of chemistry learning.
3. The study was carried out only in Chemistry and in Kajiado North district of Kenya. There is need to carry out similar study in other parts of the country to enable greater generalization. Similar study should also be carried out in other subjects to determine how school-based tests can be used to improve learning in general.

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Appendix A

TEACHER QUESTIONNAIRE (Completed by Chemistry teachers)

This study aims at finding out the characteristics of assessment tests made and used by teachers to assess learners in Chemistry at secondary school level. The following are statements related to this subject. Please answer all the questions honestly and according to the instructions given before each statement. Please indicate the situation as it is in your school. Your responses will be treated as confidential information and therefore no other person will have access to them.

Thanks in advance.

Monica G. Ituma.

SECTION 1: PERSONAL AND GENERAL INFORMATION

1. Type of school (tick one)

Boys Girls Mixed

2. Gender (tick whether you are a male or a female)

Male Female

3. Professional qualification

M.Ed B.Ed B.Sc

S1 PGDE U.T

4. Teaching experience

0-5 Years 6-10 Years 11-15 Years

15-20 Years Over 20 Years

5. Which other subject do you teach?

Mathematics Physics Biology

Other (specify) _____

SECTION II: REASONS FOR ASSESSMENT

6. The following are some statements regarding assessment of learners in Chemistry.

Please indicate with a tick (✓) against each statement the extent to which you agree or disagree with the statement.

SA = Strongly Agree

A = Agree

N = Neutral (Not sure)

D = Disagree

SD = Strongly Disagree

	AIM OF ASSESSMENT	SA	A	N	D	SD
a.	Assessment is done to determine learners' readiness to learn a topic.					
b.	Assessment is done to determine the extent to which learners have understood a given content.					
c.	Assessment is done to measure students' achievement at the end of a course.					
d.	Assessment is done to provide feedback to the learners on their progress.					
e.	Assessment is meant to motivate learners to work hard.					
f.	Assessment is done to judge the effectiveness of a teaching method.					
g.	Assessment is done to group learners.					
h.	Assessment is used to predict courses and careers that learners will take in future.					
i.	Assessment is done to prepare learners for KCSE examination.					
j.	Assessment is done to determine creativity and social characteristics of the learner.					
k.	Assessment is done to arouse and maintain interest in learners.					
l.	Assessment is done to train learners to answer questions.					
m.	Assessment is done to measure student's academic progress.					

SECTION III: ASSESSMENT METHODS

7. The following are some methods used in chemistry assessment. Indicate by ticking in the relevant position the frequency of use of each type of assessment method in your class per term.

Method		Number of times the method is used				
		Never Used	Once a term	Twice a term	Thrice a term	More often
i.	Written tests					
ii.	Practical tests					
iii.	Home work/ assignments					
iv.	Student observation					
v.	Project work					

8. For which methods named above do you keep assessment records (You can indicate by

Numbers i –vi as used in the table).

SECTION IV: ASPECTS ASSESSED IN CHEMISTRY

9. The following table shows various aspects of chemistry learning. Indicate by a tick the method you use to test each one of them. (**You can tick more than one**).

	Aspect	Method of Assessment					
		Written test	Oral Questions	Practical test	Assignment	Observation	Project work
A	Knowledge and facts						
B	Understanding of concepts						
C	Application of science knowledge						
D	Creativity and imagination						
E	Analysis, Synthesis and Evaluation						
F	Manipulative skills						
G	Observational skills						
H	Data interpretation						
I	Attitude towards Chemistry						

10. Which of the mentioned aspects do you find challenging to test and why?

Aspect _____

Reasons _____

11. At what time do you administer written tests your students.

Morning preps [] Evening preps [] after class []

Class time [] Weekend []

Other (Specify) _____

SESSION V: SETTING, MARKING AND GRADING OF TESTS

The following are statements on setting, marking and grading of school based tests.

Tick the appropriate statement as regards to these practices in your school.

12. Some chemistry teachers prefer to moderate tests before giving them to learners.

a. Do you moderate your tests?

Yes No

b. When do you moderate your tests?

Before Administration During marking

13. Indicate by ticking who does the following in your school.

		Subject Teacher	Team of Teachers	Head of Department	External Teachers
a.	Setting Tests				
b.	Moderating Tests				
c.	Making Marking Scheme				
d.	Marking Tests				

14. Indicate by ticking the grading system that you use in your school.

a. Comment with neither marks nor grades

b. Use of grades (A B C)

c. Marks out of predetermined total

d. Combination of marks and grades

e. Others (Specify) -----

15. How is the grading system indicated in (14) above selected?

- Individually by teachers []
- Departmentally []
- As part of school policy []

16. Do you have preference for any of the grading system named in (14) above.

Indicate which ones with reasons.

Preferred System _____

Reasons _____

17. a. Do marks obtained from practical tests form part of end term grade?

Yes [] No []

b. If yes, at what level do you include them?

Form 1 [] Form 2 []

Form 3 [] Form 4 []

18. Below are some general statements about assessment. Indicate the extent to which you agree or disagree with the statements by ticking in the appropriate box.

SD = Strongly Disagree **D** = Disagree **N** = Neutral (Not sure)

A = Agree **SA** = Strongly Disagree

	View	SA	A	N	D	SD
a.	Scarcity of apparatus hinders some forms of testing.					
b.	Assessment tests motivate learners in chemistry					
c.	The curriculum does not provide enough time for frequent assessment tests.					
d.	There is need to have a national policy on assessment to make the assessment practices uniform in all schools.					
e.	Continuous assessment test scores should be included in the final grading of form four candidates at KCSE level.					
f.	Frequent assessment tests do not improve students' performance in chemistry.					
g.	Tests put too much demand on the teacher's time and energy.					
h.	Students should be awarded marks for every skill through direct observation during the KCSE practical Examination					

Appendix B

QUESTIONNAIRE FOR STUDENTS

(Completed by Form Three Students)

The following are some statements regarding chemistry assessment tests done in schools. Answer the questions by ticking in the appropriate boxes the level of agreement with the statement. Note that this is not a test and there are no wrong answers. The information will be treated as confidential and no other person will have access to it.

1. Type of school:

Girls [] Boys [] Mixed []

2. Gender

Female [] Male []

Below are some general statements about Chemistry assessment. Indicate the extent to which you agree or disagree with the statements by ticking in the appropriate box.

SA = Strongly Disagree **A** = Agree **N** = Neutral (Not sure)

D = Disagree **SD** = Strongly Disagree

3. Tests help me acquire some skills in answering chemistry questions.

SA [] A [] N [] D [] SD []

4. Tests help me make decisions on my future (prospective) career.

SA [] A [] N [] D [] SD []

5. Tests make learning of chemistry difficult and unpleasant.

SA [] A [] N [] D [] SD []

6. Tests make me like learning chemistry.

SA [] A [] N [] D [] SD []

7. Tests give me a chance to show my ability in chemistry.

SA [] A [] N [] D [] SD []

8. Tests help me to know the areas I am weak in and those I am strong in chemistry.

SA [] A [] N [] D [] SD []

9. Tests help me study more on topics learnt in class.

SA [] A [] N [] D [] SD []

10. Tests give important information to parents about my academic progress.

SA [] A [] N [] D [] SD []

11. Tests are only waste of time that could be used for studies.

SA [] A [] N [] D [] SD []

12. Tests motivate me to learn more.

SA [] A [] N [] D [] SD []

13. Tests waste teacher's time in marking.

SA [] A [] N [] D [] SD []

14. Tests help me prepare for the final examination.

SA [] A [] N [] D [] SD []

15. Test help me judge if the teacher taught us well.

SA [] A [] N [] D [] SD []

16. Tests make me develop interest in learning chemistry.

SA [] A [] N [] D [] SD []

Appendix D**DOCUMENT ANALYSIS SCHEDULE FOR THE TESTS**

(Tallied by the researcher)

Aspects tested in chemistry

	Aspect Tested	Theory paper Tally (Marks)	Practical paper Tally (Marks)
1	Knowledge and facts		
2	Understanding of concepts		
3	Application of scientific facts		
4	Creativity and imagination		
5	Analysis, Synthesis and Evaluation		
6	Observational skills		
7	Data interpretation		

Type of questions used in theory tests

Method of Assessment	Tally (Marks)
Objective questions	
Completion questions	
Short answer questions	
Structured questions	
Essay questions	

Type of skills assessed in practical paper

Skill emphasized by question	Tally (marks)
Observation	
Interpreting data	
Recording data	
Inferring	
Manipulative skills	
Mathematical skills	
Non-linear skills	

Appendix E

SAMPLE THEORY TEST PAPER

Secondary School E

FORM THREE END OF YEAR EXAMINATION 2010

Chemistry paper 1

Name.....Class.....Adm No.....

Instructions:

Answer all the questions in the spaces provided. Mathematical tables and electronic calculators may be used.

All working **Must** be clearly shown where necessary.

1. Impure copper is purified by an electrolytic process.
- a. Write the equation for the reaction that occurs at the cathode during the purification of copper. (1mk)

- b. Give two reasons why some metals are electroplated. (2mk)

2. The table below gives the formulae of four compounds M,N,O and P

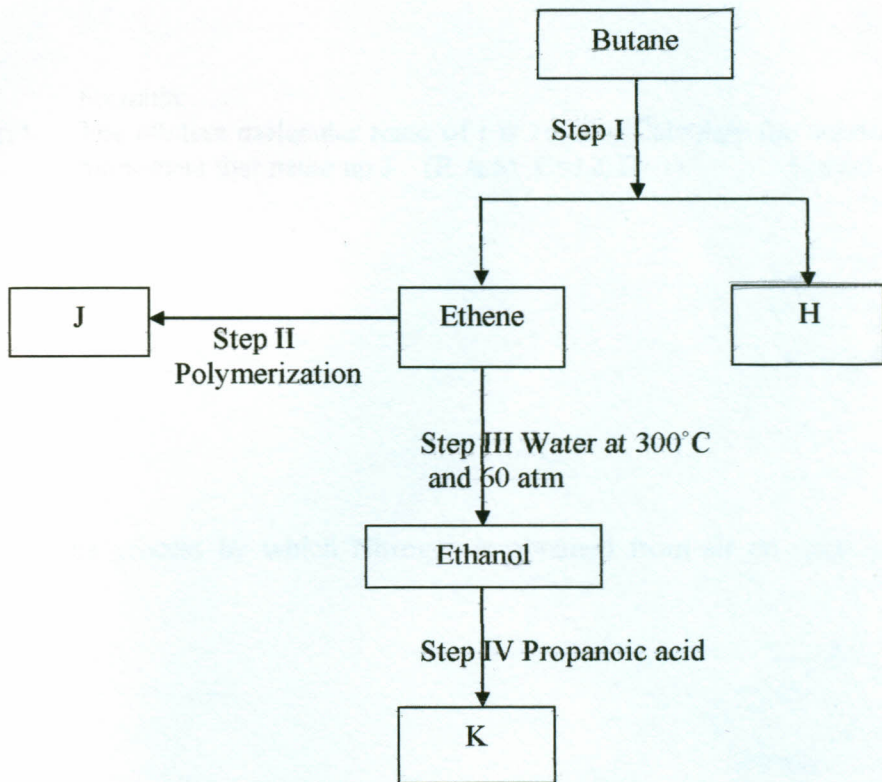
Compound	Formula
M	C_3H_8
N	C_2H_6O
O	$C_3H_6O_2$
P	C_3H_8O

- a. Giving a reason, select the letter that represents a compound that gives effervescence when reacted with aqueous sodium carbonate (2mk)

b. Write the equation for the above reaction in 2(a)

(1mk)

3. Study the flow chart below and answer the questions that follow:



(a) State the conditions for the reaction in Step I to occur.

(1mk)

(b) Give the name of substance H.

(1mk)

(c) Give;

(i) One disadvantage of continued use of substances such as J (1mk)

(ii) The name of the process that takes place in Step III. (1mk)

(iii) The name and the formula of substance K. (2mks)

Name:

Formula:

(iv) The relative molecular mass of j is 16,800. Calculate the number of monomers that make up J. (R.A.M C=12, H=1) (2mks)

4. Describe the process by which Nitrogen is obtained from air on large scale. (3mks)

5. Carbon (IV) oxide, methane, nitrogen (I) oxide and trichlorofluoromethane are greenhouse gases.

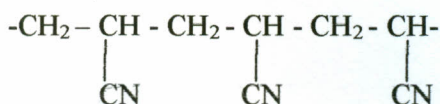
- (a) State one effect of an increased level of these gases to the environment.
(1mk)
- (b) Give one source from which each of the following gases is released to the environment.
- (i) Nitrogen (I) oxide (1mk)
- (ii) Trichlorofluoromethane (1mk)
6. Write an equation to show the effect of heat on the nitrate of:
- (i) Potassium (1mk)
- (ii) Silver (1mk)
7. The ester $\text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ was formed by reacting ethanoic acid with butan-1-ol.
- (i) State the catalyst for this reaction (1mk)
- (ii) In an experiment, 6.96 Kg of the ester was produced from 0.10 moles of butan-1-ol. Calculate the number of moles of ester produced.
(2mks)
- $$\text{CH}_3\text{COOH} + \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} \longrightarrow \text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3 + \text{H}_2\text{O}$$
- (iii) Calculate the percentage yield. (1mk)

8. A sample of a polymer below is found to have a molecular mass of 15194.

(a) Determine the number of monomers in the polymer.

(H=1, C=12, N=14)

(1mk)



(b) Draw the structure of the monomer.

(1mk)

(c) Which type of polymerization is this?

(1mk)

9. During the manufacture of rubber, raw rubber is heated with sulphur, carbon, phosphorus and manganese.

(i) What is the name given to this process?

(1mk)

(iii) Explain why the process is necessary

(2mks)

10. 20.0cm^3 of a solution containing 4g per litre of sodium hydroxide solution was neutralized by 8.0cm^3 of dilute sulphuric acid. Calculate the concentration of sulphuric acid in moles per litre.

(Na=23, O=16, H=1.)

(3mks)

11. 0.072g of magnesium were reacted with 50cm^3 of 0.1M sulphuric (VI) acid.

(a) Determine one reagent that was in excess. (2mks)

(b) Calculate the volume of hydrogen gas that was liberated at room temperature and pressure.

(Mg=24, molar gas volume at r.t.p =24 litres) (2mks)

12. Sulphur and selenium (Se) are immediately below oxygen in group 6 of the periodic table.

(a) In what periods are sulphur and selenium? (1mk)

(b) Selenium forms a solid oxide that dissolves in water. Write the probable equation for the reaction. (1mk)

(c) Hydrogen selenide contains 2.47% by mass of hydrogen. Calculate its empirical formula. (R.A.M Se=79) (2mks)

13. What is the volume in litres of each of the following gases measured at standard temperature and pressure.

(Molar gas volume at s.t.p = 22.4dm^3 RAM O=16, Cl=35.5, C=12)

(a) 16g of oxygen (1mk)

(b) 71g of chlorine (1mk)

(c) 17.6g of carbon (II) oxide. (1mk)

14. A student analysed commercial vinegar solution by titration and found that 24.5cm^3 of 0.0981M sodium hydroxide solution was required for titration of 1.0cm^3 of vinegar. Calculate the molarity of ethanoic acid in vinegar. (Na=23, H=1, O =16, C=12, N=14) (4mks)

Appendix F

LIST OF SCHOOLS IN KAJIADO NORTH DISTRICT

- | | |
|------------------------------|-----------------------------|
| 1. AIC Girls | 23. Baraka Girls Secondary* |
| 2. Dawamu | 24. Elerai MCK |
| 3. Enoomatasiani Girls * | 25. Ilbissil Girls |
| 4. Joram G. Academy | 26. Kibiko Secondary* |
| 5. Kiluani Secondary | 27. Kiserian Day Secondary* |
| 6. Kiserian Junior Seminary | 28. Kiseryan Girls |
| 7. Kitengela Boys | 29. Kitengela Girls |
| 8. Kitengela Vineyard | 30. Laiser Hill Academy* |
| 9. Maasai Boys* | 31. Maasai High School |
| 10. Magadi Secondary | 32. Magnet School |
| 11. Mashuuru | 33. Mbagathi View |
| 12. Moi Girls Isinya* | 34. Najile Secondary* |
| 13. Nakeel Secondary | 35. Nkaimurunya Secondary* |
| 14. Noonkopir Girls* | 36. Nori mixed |
| 15. Olekasasi Day Secondary* | 37. Olkejuado High* |
| 16. Olkeri Secondary | 38. Oloirien Secondary |
| 17. Oloolaiser High school* | 39. Oloolua Secondary* |
| 18. Olooseos secondary | 40. Ongata Ronkai Complex |
| 19. Orok Secondary | 41. Patterson Secondary |
| 20. PCEA Secondary* | 42. Royal Star |
| 21. Serare | 43. St. Patricks Secondary |
| 22. Upper Matasia | |

*Schools in which the study was carried out.

APPENDIX H
RESEARCH PERMIT

PAGE 2

PAGE 3

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss.....ITUMA MONICA
GAKII

of (Address) KENYATTA UNIVERSITY
BOX 43844 NAIROBI

has been permitted to conduct research in

.....Location,
KAJIADO NORTHDistrict,

.....RIFTVALLEYProvince,

on the topic ANALYSIS OF SCHOOL BASED
CHEMISTRY TESTS USED IN SECONDARY
SCHOOLS IN KAJIADO NORTH DISTRICT,
KENYA.

for a period ending.....30TH JUNE.....2011.....

NCST/RRI/12/1/SS-011/529

Research Permit No.....

Date of issue.....11/5/2011.....

Fee received KSHS.1000.....



[Signature]
Applicant's
Signature

[Signature]
Secretary
National Council for
Science and Technology

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