EFFECTS OF GRAPHIC ORGANIZERS EXPERIENTIAL TEACHING APPROACH ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND SELF CONCEPT IN CHEMISTRY IN NAKURU NORTH SUB-COUNTY, KENYA

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EGERTON UNIVERSITY

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DECLARATION AND RECOMMENDATION

DECLARATION

This research thesis is my original work and has not been presented for award of a Degree in any other University.

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RECOMMENDATION

This thesis has been submitted for examination with our recommendation as University supervisors.

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DEDICATION

This thesis is dedicated to my husband Wilson Gitonga, my two sons Mutwiri and Mawira, and daughter Mellisa.

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ABSTRACT

Secondary school students' achievement in Chemistry in Kenya has been poor. Among the reasons advanced for this is the traditional teaching approaches mainly used by chemistry teachers. The application of Graphic Organizers Experiential Teaching Approach (GOETA) may help improve learners' achievement and self-concept in Chemistry. This study aims at investigating the effects of GOETA on students' achievement and self-concept in Chemistry. The study involved quasi experimental research in which Solomon Four Non–Equivalent Control Group Research Design was used. The study sample comprised Form Two chemistry students in four secondary schools in Nakuru North Sub-County. Purposive sampling technique was used to select the four schools from which a single stream per school was selected by simple random sampling. The streams comprised 53, 51, 57 and 55 students in a class making a sample size of 216 students. The four schools were randomly assigned to two experimental and two control groups coded as E1 & E2, C1 & C2, respectively. In the experimental groups, GOETA was used while Traditional Teaching Methods (TTM) were used in control groups for a period of four weeks. The teachers of E1 & E2 were trained by the researcher on the techniques of GOETA before the treatment. Pre-test was administered to two groups before treatment and a post-test after treatment to all groups. The instruments used for data collection were Chemistry Achievement Test (CAT) and Students' Self-Concept Questionnaire (SCSQ) to measure Student's achievement and Self-Concept in Chemistry respectively. The validity of the instruments was ascertained by a panel of five experts in the Faculty of Education and Community Studies before use for data collection. The instruments were pilot-tested to estimate their reliability. Reliability coefficients of 0.846 for CAT and 0.861 for SCSQ were obtained and were accepted since they are above the threshold of 0.7. Data were analysed using t-test, one way ANOVA and ANCOVA. Hypotheses were tested at $\alpha = 0.05$ level of significance. The findings show that the students exposed to GOETA had higher achievement and chemistry self-concept than those taught through TTM, while student gender had no significant influence on both achievement and chemistry self-concept. This implies that if the new approach is incorporated into chemistry teaching, the imbalance in performance between boys and girls would be checked hence improving overall achievement of students. The findings may be useful to the Kenya Institute of Curriculum Development, provide for improvement of in-service and pre-service training programmes and may enhance learners' interests in chemistry and subsequent entry into careers that require chemistry skills and knowledge.

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LIST OF ABBREVIATIONS AND ACRONYMS

AAAS: American Association for Advanced Sciences

ACT : American College Testing

AEE : Association for Experiential Learning

ANCOVA : Analysis of Covariance

ANOVA : Analysis of Variance

ASEI : Activity, Students, Experiment and Improvisation

CAT : Chemistry Achievement Test

CSC : Chemistry Self-Concept

GOETA : Graphic Organizers Experiential Teaching Approach

KCSE : Kenya Certificate of Secondary Education

KICD : Kenya Institute of Curriculum Development

KLB : Kenya Literature Bureau

KNEC : Kenya National Examinations Council

NACOSTI : National Commission for Science, Technology and Innovation

SCSQ : Student Chemistry Self- Concept Questionnaire

SMASSE : Strengthening Mathematics and Science in Secondary Education

SPSS : Statistical Package for the Social Sciences

SSSCE: Senior Secondary School Certificate Examinations

TIMSS : Third International Mathematics and Science Study

TTM : Traditional Teaching Methods

WASSCE: West African Secondary School Examinations

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Chemistry is a practical subject which equips students with concepts and skills that come in handy in solving problems in life (Derek, 2007). Chemistry is one subject that interfaces with practically all the other science subjects. It is therefore a universal dynamic and practical oriented subject that arouses interests of students when working in laboratory environment. Chemistry is bedrock of science and technology which every nation strives to attain and advance in. It is one of the basic subjects for the physical science, agriculture, biochemistry, microbiology, pharmacy, medicine, metallurgy and all the fields of engineering. Despite the important potentials embedded in learning chemistry and its importance to mankind, the efforts of researchers to improve the quality of its teaching and learning especially at the secondary level has not been very fruitful (Oluwatson & Ongechi, 2014). The performance of students in Secondary Chemistry in Kenya Certificate of Secondary Education (KCSE) in recent times is not impressive.

A research survey conducted in the United States of America shows that in the past decade, from Third International Mathematics and Science study (TIMSS) shows that high school students' performance was low in final year of Secondary School Survey by Lavina (2000). According to Lavina (2000) the interpretation of the dismal results of the TIMSS indicated a much needed wakeup call for this countries. According to TIMSS results the Philippines last year high school students ranked 36th out of 38 countries in science and mathematics. The TIMSS indicated that among the science subjects, Chemistry seems to be poorly done when compared with Physics and Biology in the same examination.

Analysis of TIMSS conducted in 2003 similarly indicated no improvement by South African Mathematics and science Learners (Reddy, 2004). The research by Howie (2003) shows a poor state of the teaching and learning of Mathematics and Science in South Africa with the status of literacy in the subjects generally being poor in the entire schooling system.

Findings from American College Testing (ACT, 2003), suggest that although standardised test scores have improved in the past few years, mathematics and science preparation in high school appears to be weak.

However, it is disappointing to note that the students' performance in chemistry at internal and external examinations has remained considerably poor despite the relative importance of chemistry (Saage, 2009). Research has shown that students in developing countries such as Nigeria who register Chemistry at West African Secondary school Examinations (WASSCE) perform poorly despite the world-wide attention on improving students outcomes in Chemistry (Obamanu & Ekenobi, 2011; Ogwe, Odhiambo & Kibe, 2008; Okebukola, 2007).

Although Chemistry is a key science subject in secondary school curriculum in Kenya, Kenya National Examinations Council (KNEC, 2014) reports that there is low achievement in chemistry at Kenya Certificate of Secondary Education (KCSE). This is an indication that mastery of scientific concepts has been faced with challenges with a major concern being in Chemistry. Though chemistry knowledge has the potential of making positive contributions to a nation's social and economic development the performance has been poor and this may be a challenge to the achievement of vision 2030 in Kenya. Table 1 indicates low achievements in science subjects at KCSE (KNEC, 2012). Chemistry students continue to perform dismally and there is a worrying gender disparity in favour of boys in the National Examinations. Table 1 gives a summary of candidates' performance in KCSE in Chemistry per paper in the years 2010, 2011, 2012, 2013 and 2014.

Table 1

Candidates National Performance in KCSE Chemistry per Paper in the Years 2010, 2011, 2012, 2013 and 2014

Year	Paper	Candidature	Max. Score	Score	Mean %	Standard Deviation
2010	1		80	18.78	23.48	14.48
	2		80	16.19	20.24	13.25
	3		40	14.87	37.18	5.60
	Overall	347,364	200	49.79	24.90	31.57
2011	1		80	8.43	10.24	14.86
	2		80	16.99	21.24	13.95
	3		40	11.91	29.78	6.30
	Overall	403,070	200	47.31	23.37	33.51
2012	1		80	22.3	27.88	14.17
	2		80	17.18	21.48	14.50
	3		40	16.34	40.85	6.73
	Overall	427,386	200	55.86	27.93	34.10
2013	1		80	16.68	20.85	13.89
	2		80	18.31	22.89	14.25
	3		40	14.67	36.68	5.68
	Overall	439,847	200	49.00	24.50	32.10
2014	1		80	25.44	31.80	15.79
	2		80	21.33	26.66	13.46
	3		40	17.57	43.93	6.19
	Overall	472,582	200	64.31	32.16	35.65

Source: KNEC report (2011- 2015)

Table 1 indicates fluctuating Chemistry percentage mean scores for the years 2010 to 2014. The performance remains below average both in theory and practical paper. The dismal performance in Chemistry could be as a result of learners not mastering Chemistry concepts. Table 2 also shows students achievement by gender in 2009, 2010, 2011, 2012 and 2013 KCSE examinations in Science subjects. It shows the number of students who sat for the examination and the mean percentage for girls and boys in the three subjects, namely Biology, Chemistry and Physics.

Table 2

Candidate's National Performance by Gender in, 2009, 2010, 2011, 2012 and 2013 KCSE Science Examinations.

Year	Subject	Female		Male	
		No. Sat	Mean %	No. Sat	Mean %
2009	Biology	143,359	25.15	155,943	29.08
	Chemistry	149,755	17.56	179,167	20.43
	Physics	29,233	29.93	74,955	31.88
2010	Biology	148,729	26.99	166,334	31.24
	Chemistry	155,725	22.80	191,653	26.62
	Physics	29,964	33.46	79,108	35.76
2011	Biology	170.764	30.07	193.053	34.53
	Chemistry	179.645	21.47	223.462	25.42
	Physics	32.489	34.55	87.604	37.42
2012	Biology	183,595	24.36	205,926	27.86
	Chemistry	193,426	25.95	237,293	29.54
	Physics	32,295	36.22	87,329	38.48
2013	Biology	190,334	30.15	206,980	32.99
	Chemistry	200,735	23.08	239,206	26.30
	Physics	32,703	38.19	87,159	40.82

Source: KNEC report, (2010- 2014).

Analysis of candidate's performance in KCSE in the years 2009, 2010, 2011, 2012 and 2013 shows low achievement in Chemistry. The performance in chemistry has low scores compared to other Science subjects while boys seem to perform better than the girls. This poor performance in Chemistry may be attributed to lack of use of innovative teaching approaches by teachers, inadequate skills and understanding of chemistry concepts and inability to use technical terms in scientific communication (KNEC, 2012). The report of KCSE annual report (KNEC, 2014) also cites the inability of students to use technical terms in answering questions and writing practical reports as a course of the poor performance in Chemistry. According to KNEC, this is an area in which students experience a lot of difficulties. There is therefore a need to seek other effective methods of instruction over the traditional ones so that pupils could better understand Chemistry concepts and this may improve performance in the subject.

The factors contributing to low achievement in chemistry in KCSE includes ineffective teaching approaches that are teacher-centred rather than student-centred, inadequate mastery of subject content by some teachers, inadequate teaching and learning resources such as text books, audio-visual and laboratory equipment and apparatus (Muraya & Kimamo, 2011). Table 3 shows candidates performance in KCSE Chemistry per sub-county in Nakuru County in the years 2010, 2011, 2012, 2013 and 2014

Table 3

Candidate's Performance in KCSE Chemistry per Sub-county in Nakuru County in the Years 2010 – 2014.

SUB-COUNTY		2010	2011	2012	2013	2014
Naivasha	Candidature	1954	2234	2335	2416	3693
	Mean points	3.125	3.520	4.025	3.393	3.350
Subukia	Candidature	968	1028	1145	1376	1598
	Mean points	2.478	3.173	4.345	3.513	2.660
Njoro	Candidature	1367	1542	1743	1914	2227
	Mean points	4.260	4.471	4.630	4.313	4.80
Rongai	Candidature	2067	2185	2362	2697	3257
	Mean points	3.460	3.626	4.301	3.874	3.22
Gilgil	Candidature	1592	1789	2056	2655	3322
	Mean points	3.178	3.364	4.687	4.23	3.78
Kuresoi	Candidature	967	1108	2090	2644	2972
	Mean points	3.179	4.128	3.980	3.663	3.570
Nakuru	Candidature	2967	3156	3368	4293	4736
	Mean points	3.378	4.074	3.548	4.157	2.98
Molo	Candidature	1432	1589	1835	2143	2462
	Mean points	3.620	3.986	4.323	4.703	3.410
Nakuru North	Candidature	3050	3195	4186	3585	3477
	Mean points	3.700	4.423	4.56	4.096	4.211

Source: KNEC report (2011- 2015)

The table indicates poor mean points achieved by students being way below the maximum 12 points. Table 3 indicates general poor performance in chemistry in the different sub-counties of Nakuru County. The mean points achieved by students being way below the maximum 12 points and fluctuating from one year to another. These results indicate that there could be several factors that cause the poor performance in the subject. These factors may lack of learner centred teaching approach, the learning environment, teacher student ratio and learning resources among others. Table 4 shows overall students achievement in KCSE in Nakuru North Sub- County in the years 2010, 2011, 2012, 2013 and 2014.

Table 4

Candidates Performance in KCSE Chemistry in Nakuru North Sub-County in the Years 2010 – 2014

Year	Total Enrolment	Mean points	Maximum points
2010	3050	3.700	12
2011	3195	4.423	12
2012	3233	4.560	12
2013	3585	4.096	12
2014	3477	4.211	12

Source: KNEC (2011- 2015)

Table 4 indicates fluctuating chemistry mean scores in the Sub-County. These mean scores are not only poor but, there is a drop for the year 2012-2013 from 4.560 to 4.096. These results indicate lack of mastery of chemistry concepts hence the poor performance thus raising the concern to educators. TTM are predominant in teaching chemistry in secondary schools. Innovative learning strategies could be used by teachers at all levels of chemistry education to enhance the student's self-concept to learn chemistry (Hanson & Wolf Skill, 2000; Eybe & Schmidt, 2004).

Graphic Organizers Experiential Teaching Approach (GOETA), strategy is a learner centred approach presented in this study. This approach could be used by teachers to provide a smooth transformation from TTM to learner centred teaching strategies. GOETA may then enhance positive self-concept in students who can apply them to improve achievement and their self-concept in learning chemistry in secondary schools. GOETA is a teaching strategy where the learners use graphic organizers and experiential learning to get actively involved in the process of learning. GOETA could be of particular interest to Chemistry teachers to try and improve achievement in chemistry. This would help learners to remember, analyse relationships, comprehending, problem solving, gain conceptual and holistic understanding more quickly (Johnson, 1992a; Johnson & Thomas, 1992; Satchwell, 1996; West, Fanner & Wolf , 1991). The students learn more deeply when they construct their own graphic organizers thereby learning by doing than when graphic organizers are provided (Stull & Mayer, 2007). The GOETA teaching approach encourages learning by doing rather than by viewing.

Graphic Organizers are series of visual charts and tools used to represent and organize a student's knowledge or ideas (Cassidy, 1991). Graphic Organizers are super ordinate concepts with which learners can subsume the new material and relate it to what they already know. They are presented at the introductory stage of a lesson. In general, advance organizers can be presented in the form of written text, graphic form, utilize audiovisual support. These are especially useful when the material is not well organized and the learners' lack knowledge needed to be able to organize it well for themselves (Ausubel, 1968). The substantive content of a given advance organizer or a series of advance organizers is selected on the basis of its appropriateness for explaining and integrating the material it precedes (Ausubel,1967).

Robinson, (1998) gives an account in his review of how other educators propose that a graphic display of words showing a hierarchical organization of important concepts would improve students' understanding more than a written paragraphs that were proposed by Ausubel (1968). Weigmann (1992) focused on how to construct advance organizers to make them more effective for students. GOETA can be integrated in learning where by learners are involved in hands on activities by doing and first-hand experience.

The use of learner-centred teaching approaches results in better achievement of instructional objectives because they promote imaginative, critical and creativity skills (Ministry of Education, 2001).

Experiential learning process is a hands-on collaborative and reflective learning experience in Chemistry which helps the student to learn new skills and knowledge (Davis, 2011). During each step of the experience, students usually engage in active experimentation, gain concrete experience with the content, the instructor and with each other as well as in experiential learning situations cooperate and learn from one another in a more semi-structured approach. A report by the Association for Experiential Education explains that experiential learning is part of an educator's teaching process; the students should be actively involved in the learning process through group work discussions, hands on participation and applying information outside the classroom.

Self-concept comprises of people's attitudes, feeling and the perceptions that the individual assigns to himself and their characteristics. Students have different perceptions, background and interests are varied on Chemistry as a subject and this affects their acquisition of knowledge during learning. Self-concept is a critical factor in sustaining efforts and persistence at tasks in subjects such as Chemistry (Marsh, 1991). Self-concept is also related to Chemistry achievement (Marsh, 1990) and could contribute to gender differences in achievement. If a student's self-concept is improved, then achievement in Chemistry may be improved. According to Pastorino, Doyle & Portillo (2013), self-concept is a collection of beliefs about one's own nature, unique qualities and typical behaviour. One's self-concept is the mental picture of oneself. It is a collection of self-perceptions like beliefs, easy going, pretty or hardworking among others. Self-Concept is the total organization of the perceptions that individuals have of themselves (Dembo, 1994). In this study, it is postulated that Chemistry Self-Concept of secondary school students in Kenya is related to their ability to acquire Chemistry concepts, their interests and perception of subject, satisfaction and perceived probability of success in learning Chemistry.

1.2 Statement of the Problem

Students' performance in chemistry at the Kenya Certificate of Secondary Education (KCSE) examinations has been poor and their self-concept in Chemistry is also low. The instructional approaches used in teaching chemistry have not improved students' achievement in chemistry.

GOETA is an approach that may help to improve students' achievement and self-concept in chemistry. However, its effects on students' achievement and self-concept in the subject have not been established. This study therefore was used to investigate the use of GOETA on students' achievement and self-concept in form two Chemistry.

1.3 Purpose of the Study

The purpose of this study was to find out the effects of GOETA on students' achievement and self-concept to learn chemistry in secondary schools in Nakuru North Sub-County, Kenya.

1.4 Objectives of the Study

The objectives of the study were: -

i. To determine the effects of GOETA on students' achievement in chemistry and those not exposed to it.

ii. To compare the self-concept in chemistry of students' taught through GOETA and those not exposed to it.

iii. To determine if there is gender difference in students' achievement when they are taught using GOETA.

iv. To compare the self-concept of boys and girls in chemistry when taught through GOETA.

1.5 Hypotheses of the Study

The following hypotheses were tested during the study;

H_O1: There is no statistically significant difference in achievement in Chemistry between students taught using GOETA and those taught using TTM methods.

H_O2: There is no statistically significant difference in students' self-concept in learning Chemistry between those taught using GOETA and those taught using TTM methods.

Ho3: There is no statistically significant gender difference in achievement in chemistry among students exposed to GOETA.

H_O4: There is no statistically significant gender difference in students' self-concept in Chemistry when they are taught using GOETA.

1.6 Significance of the Study

An improvement in students' achievement in chemistry will enable them to appreciate, apply the skills and concepts taught in real life situations. This will also enable the students to join chemistry related disciplines like medicine, engineering, biochemistry, agriculture and then contribute to the economic development of our country. The findings of the study may supplement the Government efforts directed towards improving Chemistry education in Kenya's secondary schools. It is important to find out how application of graphic organizers experiential teaching approach would affect acquisition of chemistry knowledge among secondary school students.

The findings of the study may be helpful to the Kenya Institute of Curriculum Development, teachers training colleges, and secondary school chemistry teachers. The findings will also help the Ministry of Education to design appropriate interventions to minimize gender disparity observed in science achievement in KCSE and especially those observed in chemistry.

1.7 Scope of Study

This study involved secondary schools in Nakuru North Sub-County which is among the regions with a high number of secondary schools in Nakuru County. It involved students of Chemistry in the second year of Secondary School Education aged between 15 and 16 years.

Chemistry is a subject that is done by all students in all Kenyan secondary schools in forms one and two. The Chemistry content studied was structure and bonding because it is one of the areas where students perform poorly in chemistry (KNEC, 2012). This topic is taught in form two and its applications are useful in relating the properties of substances with type of structure and chemical bond. Students find this topic difficult due to some abstract concepts that challenge their understanding of the knowledge.

Concepts taught in this topic are more of application. Treatment was administered immediately after pre-test and lasted for four weeks. The schools involved in this study were four public co-educational sub-county schools where boys and girls learn in the same classroom.

1.8 Limitations of the Study

Although the Solomon four – group design was used in this study, the researcher was unable to randomly assign the students to the four groups. This is because the secondary school classes once constituted exist as intact groups and school authorities do not allow such classes to be dismantled so that they can be randomly re-constituted for research purposes. However, the possible sampling error of this design was addressed by using analysis of covariance because the initial groups were non-equivalent.

1.9 Assumptions of the Study

i. The study assumed that the learning environment for both experimental and control groups is comparable because the schools from which they were drawn belong to the same category and same Sub-County.

ii. It was assumed that the age of the learners in the experimental and control groups was comparable because all were in form two.

iii. It was also assumed that the gender of the teachers who participated had no effect on learners' acquisition of knowledge and skills.

1.10 Operational Definitions of Terms

Achievement: This is the ability to perform tasks in the area of recall, comprehension, application and higher order skills as a result of instruction (Wachanga, 2002). In this study the achievement will refer to the scores attained by students in chemistry achievement test (CAT).

Chemical Bond: Is a force which holds particles (atoms, ions or molecules) together (Ngaruiya, Kimaru, & Mburu, 2003).

Chemistry self-concept: Refers to students' self-evaluation of self-peceived personal chemistry skills, abilities, chemistry reasoning ability, enjoyment and interests in chemistry (Craven & Marsh, 2008).

Chemical Structure: Is formed when chemical bonds that holds the particles of a substance together in a regular pattern (KLB, 2010).

Co-educational School: Is a school that is integrated for education of male and female persons in the same institution (Wambugu, 2011). In this study a co-educational school refers to one with both boys and girls that learn together in the same classroom in an institution.

Effect: refers to a change produced by an action or a cause; a result or an outcome (Oxford Advanced Learners' Dictionary).

Experiential Learning: is learning through action by doing, learning through experience and learning through discovery and exploration (Wurdinger & Carlson, 2010). In this study experiential learning refers to acquisition of knowledge through hands on activities and first-hand experience through construction of graphic organizers.

Gender: These are traits or conditions that are casually linked with maleness or femaleness but are culturally biased as opposed to biological based (Gentile, 2013). In this study, gender refers to variations in social roles learned by male and female students which may have an effect in learning chemistry in secondary schools.

Graphic Organizer: A series of visual charts and tools used to represent and organize a student's knowledge or ideas (Bromley, Devitis & Modlo, 1999). In this study graphic organizers are the visual communication tools that learners will use to express ideas, concepts to achieve meaningful learning in structure and bonding in chemistry.

Graphic Organizers Experiential Teaching Approach: is a hybrid teaching strategy linking the application of graphic organizers and experiential learning in the teaching of structure and bonding in chemistry.

Learning: Is a change in behaviour as a result of an experience. Knowles, (1998) defines learning as the process of gaining knowledge or expertise. In this study, learning refers to acquisition of concepts in chemistry related to the topic of structure and bonding.

Likert Scale: This is a scale with a number of points or spaces, usually five that represents a set of related responses to a given statement, one for each point. A response to an attitude statement could be; strongly agree, agree undecided, disagree, and strongly disagree (Coolican, 1994). In this study likert scale will be a 5-point scale that will measure SCSQ the students' self-concept in chemistry.

Self-Concept: The accumulation of knowledge about self, such as beliefs regarding Personality traits, physical characteristics, abilities, values, gaols and roles (Lewis, 1990). In this study self-concept refers to the students' perceptions, interpretations, behaviour, abilities and uniqueness in learning Chemistry in secondary schools.

Traditional Teaching Methods: These are teaching methods in which teachers maintain control of the subject matter to be learned and tests are used primarily for awarding grades to the learners. Some of these methods assign students the role of passive recipients of knowledge (Keraro et al, 2007). In this study, the teachers were assumed to use methods commonly used in chemistry which include lecture, demonstration, class experiment, Question & Answer, Field work and project methods.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter deals with review of literature on graphic organizers and meaningful learning, experiential learning and its application in learning Chemistry. Students' Self-Concept in general, academic self-concept and students' self-concept in Chemistry in particular is also discussed. The conceptual and theoretical frame works that guide the study are discussed.

2.2 Teaching Methods in Chemistry

According to Wachanga (2002), effective teaching is a significant variable of students' achievement which may be influenced by the teaching approaches that a teacher uses. Methods used by chemistry teachers mainly include the Traditional Teaching Methods which are also applicable to teaching of Chemistry. They include; Lecture, Question/Answer, Teacher Demonstration, Project, and Class Experiment method.

2.2.1 Lecture Method

According to Kelly (2014), lectures are a straightforward way to transfer knowledge to students quickly. Instructors also have a greater control over what is being taught in the classroom because they are the sole source of information. Students who prefer learning by hearing find lectures appealing to their learning style. Logistically, a lecture is often easier to develop than other methods of instruction. It is familiar to most teachers because it was typically the way they were taught and because most college courses are lecture-based, students gain experience in this predominant instructional delivery method. This is the most common form of teaching in institutions of higher learning throughout the world, and is likely to continue to be so (Taylor & Francis, 2011). Vella (1992) defines a lecture as the formal presentation of content by an educator (as subject matter expert) for the subsequent learning and recall in examinations by students. In this method, a teacher is the central focus of information transfer.

Kelly (2014) observes that students strong in learning styles other than auditory learning find lectures challenging while those who are weak in note-taking skills will have trouble understanding what they should remember from lectures. She observes that some students can find lectures boring causing them to lose interest while others may not be able to ask questions as they arise during lectures. This method limits interaction between learners and a teacher. However, GOETA is a more interactive teaching approach as learners engage in group work to achieve shared learning goals. Lecture method was applied in this study to represent TTMs.

2.2.2 Question and Answer Method

This method involves verbal interaction between a teacher and students through questions and answers. It leads to correct responses and a summary of the main points (Jekayinfa, 2005). Questioning method gives a student an opportunity to reflect on inquiries and needs for further information. Questions can be used for drill and review; they deepen impressions and embed facts in the mind and memory of the student. Engaging students in Questioning also prompts to take charge of their own learning. However, Brown and Atkinson (1994) associated this method with emphasis on lower order learning (mainly recall) and do not involve all learners. There is a tendency for teachers to rush learners into giving answers that confirm their pre-conceived ideas. Application of Question and Answer method hinders knowledge construction rendering it ineffective for meaningful learning as learners' self-expression is inhibited by teachers' pre-conceived ideas on "correct answer". GOETA engages learners in active knowledge construction of graphic organizers during concept mapping activities leading to higher order and meaningful learning.

2.2.3 Teacher Demonstration Method

Demonstration is the process of teaching through use of audio-visual aids to explain while laying emphasis on significant points of a process, product or idea (Sola & Ojo, 2007). A demonstration may be used to prove a fact through a combination of visual evidence and associated reasoning. In this method, senses of students are appealed by a teacher which really accelerates the learning process.

This method is ideal for teaching a subject in which skills relating to manual dexterity are needed. According to Kozma, Bell & Williams (1978), demonstrations may fail due to faulty equipment or lack of teacher preparedness. They limit learner participation since an explanation accompanies the actions performed learner inputs are limited. Demonstrations require prior preparations hence are time consuming. Due to complexity and structure of different topics in chemistry, demonstration method may not be appropriate for all topics especially where audio visual aids are not available. In such topics, students can be engaged in active knowledge construction through use of GOETA which helps students to discover concepts on their own.

2.2.4 Class Experiment Method

This method is also referred to as The Laboratory Method. It exposes learners to firsthand experiences with materials or facts emerging from an investigation (Wachanga, 2002). Ozay and Ocak (2009) describe it as a hallmark of learning Science and Technology-based fields. This method strengthens theoretical knowledge while learners experience the pleasure of discovery and development of their psycho-motor skills. It increases creative thinking skills, improves gains in scientific working methods and higher order thinking skills. The method requires huge investment of instructional time denying teachers time to cover as much content as they would with other instructional methods. The outlined limitations hamper effective use of experiment method in teaching biology especially in topics like Evolution which have minimal practical activities. GOETA would be the most appropriate approach as it would use less instructional time and ensure meaningful learning through active engagement of students in group-based task performance.

2.2.5 Project Method

This is a method whereby learners are assigned to groups to undertake a certain task after which they compile a group report for assessment. At times the learner does the project alone with the guidance of the teacher and makes' observations, collects and analyses data and the makes a report.

Although project-based learning is considered to be a profitable learning strategy, its implementation faces several challenges (Means & Olson, 1995; Thomas, 2000). The teacher should intervene and break the project into various phases for better implementation. Projects face the difficulty of setting clear goals for various phases and learners have problems with relating data, concept and theory. Project method is a combination of the text book, recitation and laboratory method (Smith, 2010). It is also an appealing concrete problem whose solution is planned and executed by learners. The learners are required to be objective in the project work as the method imparts some values on them. A high degree of competence is required in designing a problem-based course, design projects that support learning of specific concepts and skills.

The method requires follow up, monitoring of progress, support assessment and general classroom management (Means & Oslo, 1995). To successfully conduct an effective project, a teacher needs to be highly skilled in pedagogy, knowledgeable, alert and exceptionally gifted. GOETA would provide an alternative since it is easy to learn and apply in all topics in Chemistry. It also would provide a realistic learner centered teaching approach that is affordable and accommodated within the time allocated for teaching.

2.3 Students' Achievement in Chemistry

Research findings by American Association for Advanced Sciences have shown that many students lack the necessary knowledge and skills in Science especially chemistry and technology to function in the modern world. Meaningful learning in chemistry occurs when learners comprehend concepts and are able to connect them with previous knowledge (Ausubel, 2000; Omolade, 2008). Secondary school students knowledge in chemistry is often characterized by lack of understanding of concepts and majority of students engage in rote learning. Poor academic performance by students in chemistry has been observed in secondary schools in Nigeria (Arockiadoss, 2005).

He also found out that the academic performance of students in Chemistry is also influenced by their study habits. In spite of the central and important position of chemistry among other Sciences, studies reveal that academic achievement of students in Chemistry at senior secondary certificate Examinations (SSSCE) has consistently been very poor and un impressive (Njoku, 2005). Despite the key role of Chemistry as a central Science that forms the basic foundation to many disciplines and improves the quality of life, the poor performance of Nigeria secondary students in the subject has for many years remained a matter of serious concern. (Jegede, 2010; Oloyede, 2010). During the last four decades, Kenya's secondary school students' chemistry achievement at KCSE has remained low (KNEC, 2012). Poor performance in Chemistry in KCSE has been attributed to several factors which include, over enrolment, inappropriate syllabus, student's poor attitude towards the subject, inadequate resources and the teaching methods used (Twoli, 1986; Orodho, 1996).

Efforts made through research to discover the cause of the persistent failure in Chemistry revealed among others that secondary teachers mainly adopt the lecture method in teaching and learning of Chemistry (KNEC, 2014). The learning of Chemistry depends on the way it is presented to the learner, the interaction with learning experiences and the environment within which learning takes place. Unfortunately the poor Chemistry achievement has been attributed to poor teaching methods and techniques used by teachers. Correct use of an appropriate teaching method is critical to the successful teaching and learning of Chemistry (Grauwe, 1999; Zadra, 2000).

2.4 Graphic Organizers

A graphic organizer is a visual communication tool that uses visual symbols to express ideas and concepts, to convey meaning. A graphic organizer often depicts the relationship between facts, terms and ideas within a learning task (Bromley, Devitis & Modlo, 1999). Graphic organizers can be used to enhance students' thinking skills by encouraging brainstorming, generating new ideas, connecting parts to the whole, drawing sequence and analyzing causes and effects (Drapeau, 1998).

Thinking skills are most effectively taught within a subject matter context, which allows the use of the skills in a meaningful context and to achieve deeper learning of subject matter (Prawat, 1991).A graphic organizer is also known as a knowledge map, concept map, story map, cognitive organizer, concept diagram. These are communication tools that use visual symbols to express knowledge, concepts, thoughts or ideas and the relationship between them.

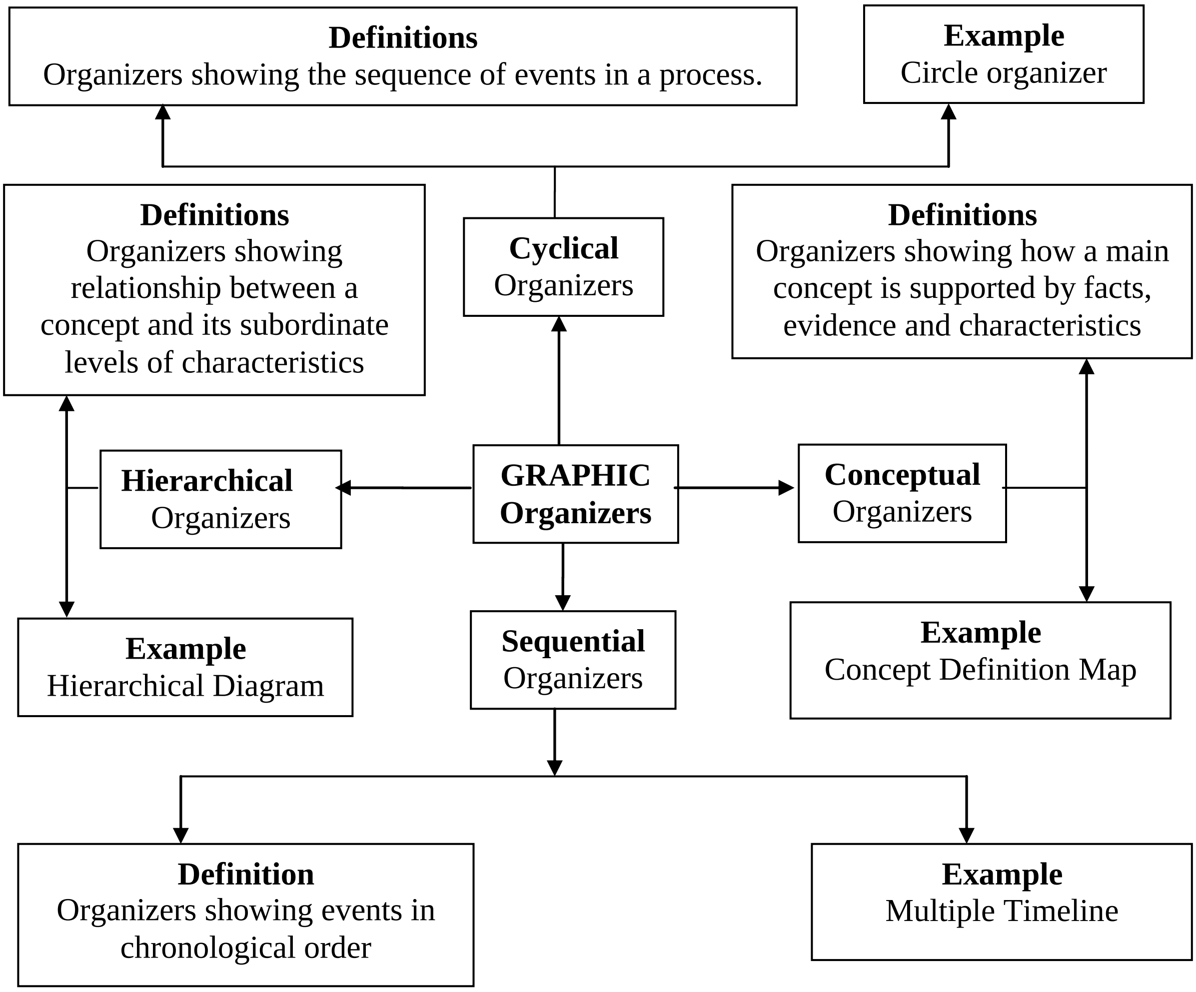
A graphic organizer consists of spatial arrangements of words or word groups intended to represent conceptual organisation of text. They consist of elements in words or word groups, relationship among elements by spatial arrangement of the elements on the page and the conceptual organization of a text. They include concept maps (Novak & Gowin, 1984), Knowledge maps (O' Donnell, Dansereau, & Hall , 2002) hierarchies (Cook & Mayer, 1988), matrices (Kiewra & Robinson , 1998) , flowcharts (Chambliss & Calfee , 1998), and even outlines (Balluerka,1995) or lists (Cook & Mayer , 1988) when they offer a spatially arranged organization of elements using blank space.

2.4.1 Importance of Graphic Organizers to Learning Chemistry.

Graphic organizers are tools for critical and creative thinking; they help organization and understanding information and relationships. Depicting and understanding knowledge can be enhanced by graphic organizers that also improve self-learning. The graphic organizers help students to focus on important concepts, the relationships among them by providing the tools for creative thinking (Bromley, Devitis & Modlo, 1995). Graphic organizers provide an optimal way of depicting knowledge and understanding graphic organizers are beneficial to student who are their independently as study tools for note taking, planning, presentation and review in self-learning (Dunston, 1992). Research studies suggest that graphic organizers may facilitate learning by helping learners organise information taken from expository text (Alverman, 1981; Robinson & Kiewra, 1995).

2.4.2 Types of Graphic Organizers

There are four basic categories of graphic organizers which include cyclical organizers, conceptual organizers, sequential organizers and hierarchical organizers. Figure 1 shows the categories of graphic organizers.

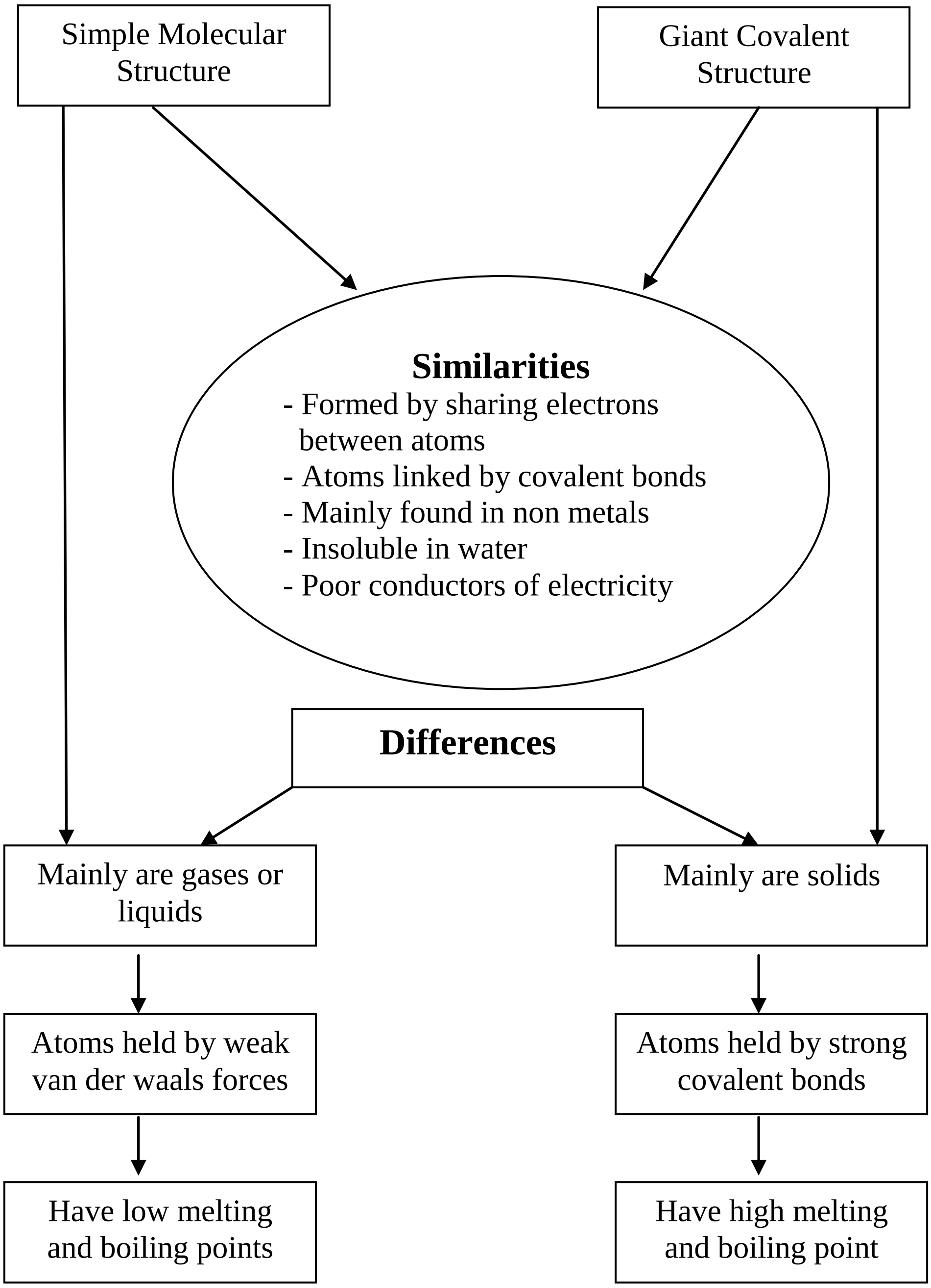


Source: Cassidy (1991)

Figure 1: Categories of Graphic Organizers

Graphic organizers used in the classroom, may fall into four basic categories, namely cyclical organizers, conceptual organizers, sequential organizers, and hierarchical organizers. Conceptual organizers show the relationships and organisation between concepts in the topic. The cyclical organizers present a flow of concepts and ideas where all are linked together from the first to the last concept. Hierarchical organizers show the relationships between concepts in a hierarchical manner from more specific to general concepts and ideas. Sequential organizers show the sequence of ideas in a certain topic or subtopic.

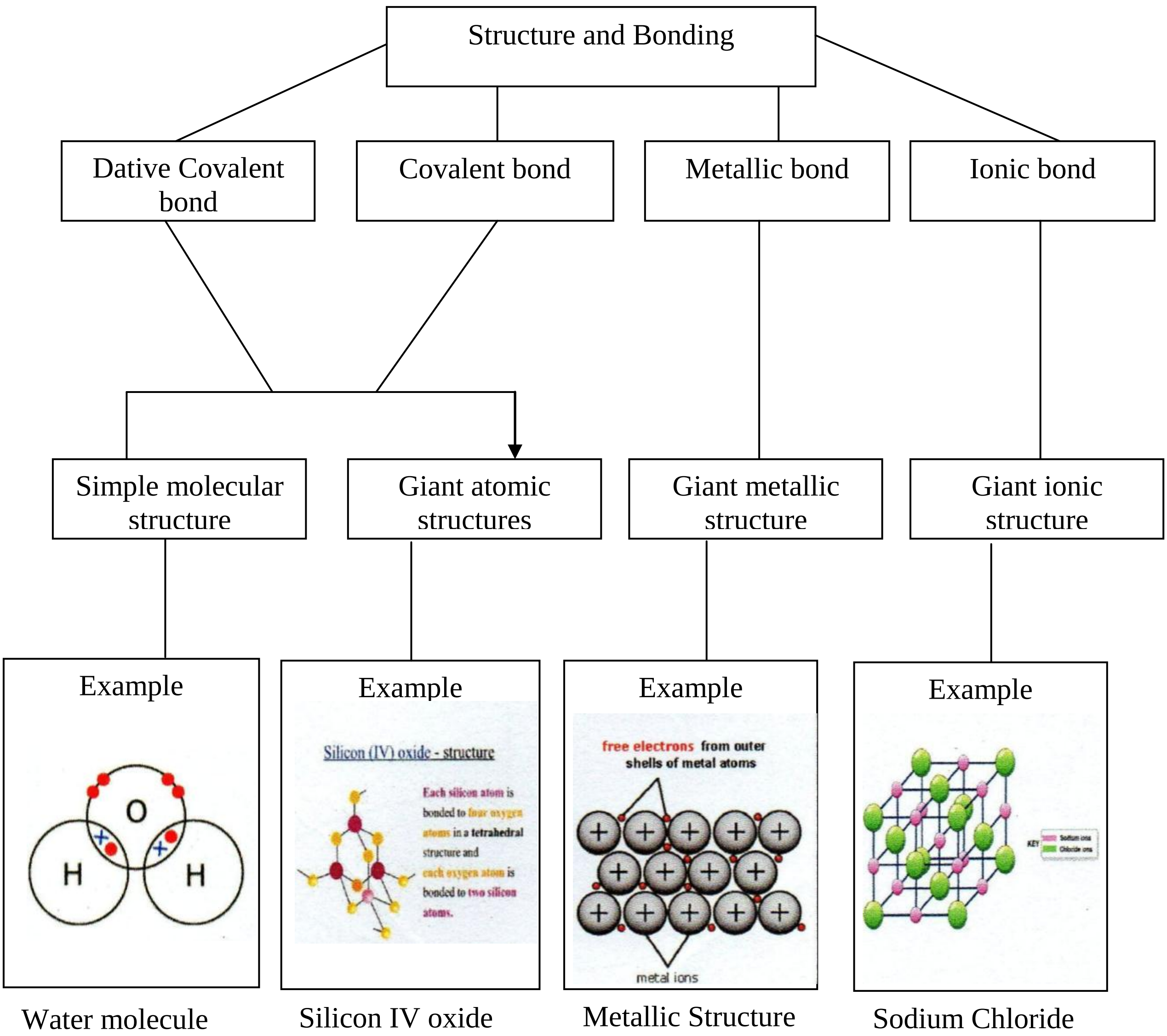
Figure 2 shows an example of a concept map that shows the types of covalent structures. A concept map shows the organisation and relationships between concepts in the main topic in chemistry and subtopics which are more specific and inclusive. The conceptual organizers can be used to help students identify the main concepts of a topic. Students are encouraged to give a broad interpretation of the components of a topic and to support the ideas with specific information from relevant source.



Source: Ngaruiya (2003)

Figure 2: Concept Map: Types of Covalent Structures; Similarities and Differences

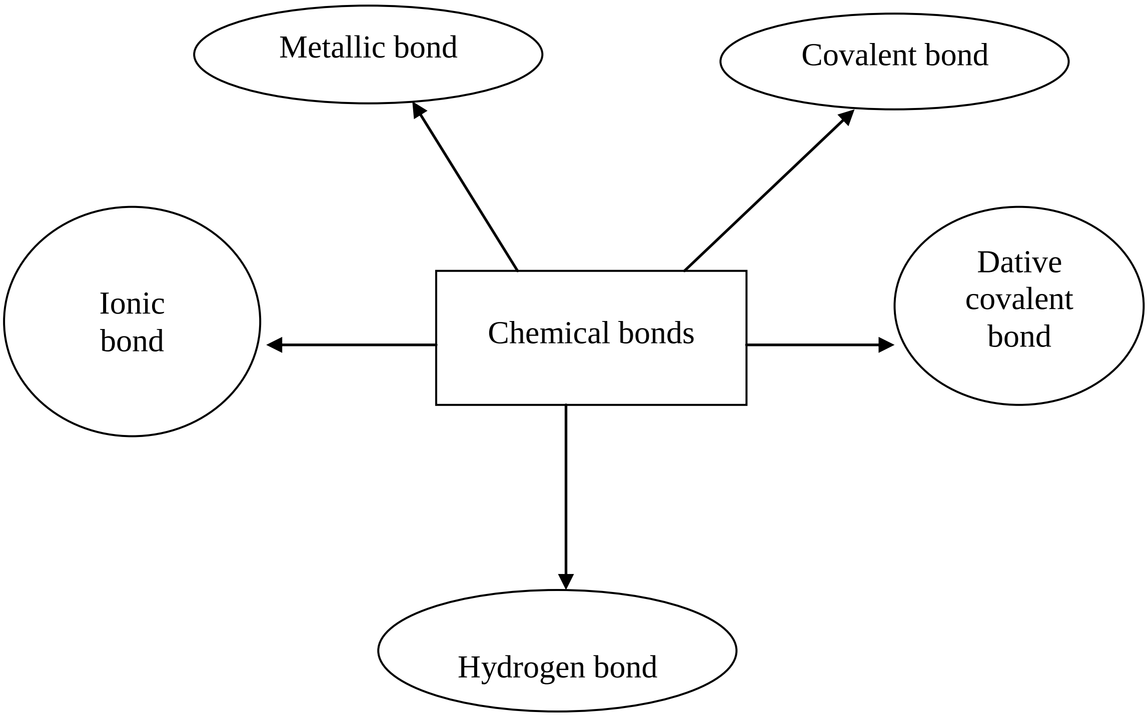
The relationship and organization of the concept of types of covalent structures is depicted in the Simple molecular structures and giant covalent structures a used as an example in a concept map by showing their similarities and differences. Figure 3 indicates an example of a hierarchical graphic organizer showing that in structure and bonding, there are four different types of chemical bonds which form specific types of structures. Hierarchical organizers are used to show relationship between concepts. The main concept is divided into parts at different levels of its characteristics



Source: KLB (2010).

Figure 3: Hierarchical Graphic Organizer

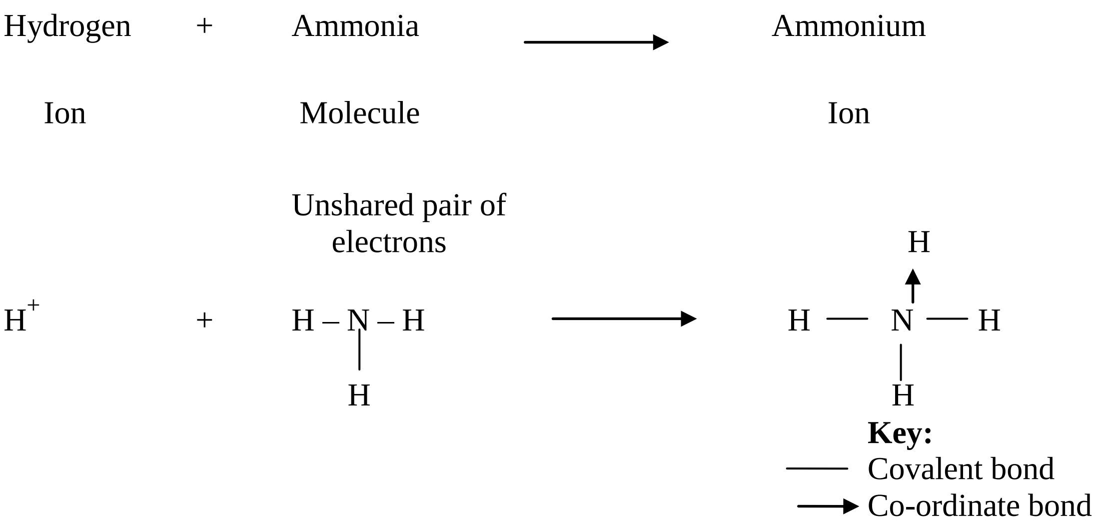
The relationship between the general concept of structure and bonding in chemistry is made more specific in the specific types of bonds, the type of structures formed and their examples linked in a hierarchical manner. Figure 4 shows an example of cyclical organizers that can be used to help students understand the sequence circle of types of Chemical bonds. They present a consecutive flow of events with the last cycling back to the first event, representing relationships of events that are continuous.

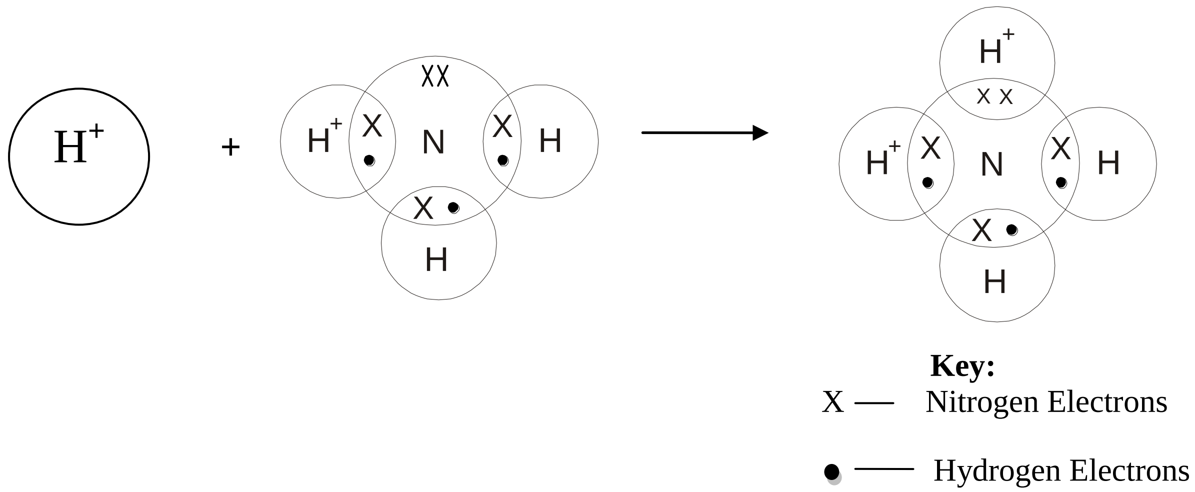


KLB (2010)

Figure 4: Cyclical Organizer: Types of Chemical bonds

The chemical bonds are linked in a flow of concepts where all types are linked together in a cyclical manner. Figure 5 is an example of a sequential graphic organizer showing the formation of a coordinate bond in ammonium ion. Sequential organizers are used to show the sequence of events in a process. The events flow in a chronological order.





(KLB, 2010)

Figure 5: Sequential Graphic Organizer: Co-ordinate bond in Formation of Ammonium ion

The formation of an ammonium ion shows the sequence of ideas where the unshared pair of electrons from ammonia molecule are shared with the hydrogen ion which lacks electrons to form a duplet structure with each atom finally having a completely filled outer most energy level. In this study the learners applied the four categories of graphic organizers to identify the main concepts, to show relationships between concepts and link the types of chemical structures and bond. Examples of graphic organizers in the structure and bonding include; models of ionic bond with giant ionic structures, covalent bonds with simple molecular and giant atomic structures, metallic bond with giant metallic structures.

Concept maps of differences in properties between substances with different bond types can also be drawn. Comparative matrix in which important conceptual distinctions form the row and column headings can also be used. This study will apply all the four categories of graphic organizers cyclical, conceptual, sequential and hierarchical organizers in the teaching of structure and bonding in Chemistry.

2.5 Benefits of Graphic Organizers

Graphic organizers facilitate learning strategies, content learning and acquisition of knowledge by learners. The content becomes easier to understand and learn and learners are likely to understand and remember the subject content more. This is because reduced information processing demands that learners become more strategic (Wurdinger and Carlson, 2010).

2.5.1 Benefits to Teachers

Graphic organizers enable the teachers to show and explain relationships between content and sub - content and how they relate to other content areas. The teacher can show and explain relationships between and among content. They make the lessons interactive. They help learners to acquire visual information more easily, motivate students, assist student in overwriting techniques and assess what students know (Neil, 2006).

2.5.2 Benefits to Students

According to O' Donnell, Dansereau & Hall, (2000) student can make more abstract comparison, evaluations and make conclusions. Graphic organizers allow students active role in their learning. The students are able to understand the concept of part to whole, record relationships, clarify and organize ideas, improve memory, comprehend texts, recognize and assimilate different points of view (Wurdinger and Carlson, 2010).

2.6 Thinking Skills and Graphic Organizers

According to Wurdinger and Carlson(2010) , many students do not have the skills necessary for the more "higher order", creative and critical thinking needed to thrive both within and beyond the lesson. There are several ways in which thinking skills enhance classroom instruction in chemistry lessons.

Thinking skills can be used to enhance students learning by generating ideas and activating relevant diagrams of chemistry concepts. This helps them connect new knowledge to the prior knowledge. Thinking skills, help in organization of ideas and components of chemistry concepts by searching for meaningful patterns, organizing information and putting things in groups or categories in order to understand.

They help students to understand the parts of a chemistry idea to the whole by seeing the structure of a concept or event. Focusing on similarities and differences, thinking skills can help students establish relationship between two or more ideas. Knowing how to use thinking skills in teaching will provide teachers with vast activities to use within any lesson (Johnson, 2000). Graphic organizers allow students to make connections among pieces of information for easy recall. The students are able to break the information into manageable units, in which they easily see the relationships among separate ideas. Graphic organizers can enhance students thinking skills, compiling information, generating ideas, analyzing or evaluating ideas and reflecting.

2.7 Experiential Learning

Experiential learning is a philosophy and methodology in which educators purposefully engage with students in direct experience and focused reflection enable students to acquire knowledge, develop skills, and clarify values (Wurdinger & Carlson, 2010). Experiential education focuses on problem solving and critical thinking rather than memorization and rote learning during the classroom activities.

The learning takes place during the experience and knowledge is gained as a result of being personally involved in this pedagogical approach. Researchers have emphasized that the purpose of a good teaching strategy is to create specific learning experience that brings about criterion performances not only for change in behaviours but also outside the class (Kayode, 1997; Nneji, 1997; Umudhe, 1998; Yewande, 2000; Atomatafa, 2003).

2.7.1 Principles of Experiential Learning

There are four principles of experiential learning which include, experiencing and exploring, sharing by reflection of what happened, generalization of experience and application of what has been taught (Davis, 2011). The learners have to integrate the four principles together in order to achieve meaningful learning.

Experiencing and Exploring by Doing

The students perform hands on activities in Chemistry with little or no help from the instructor. This may include, making models, products, role-playing, giving presentation, problem-solving or playing a game and practical Chemistry experiments. The instructions are designed to engage students in direct experiences which are tied to real world problems and situations in which the instructor facilitates progress (Davis, 2011). The experiential learning makes the learners more motivated to learn when they have a personal stake in Chemistry subject rather than being assigned to review a topic or read a text book chapter.

Sharing by Reflecting of What Happened

The students share by discussing the results, reactions, observations and feelings generated by the Chemistry experience by being actively involved with others. They then relate what they've discovered to the past experiences in Chemistry that can be used even in the future.

Generalization of Experience

The students connect the Chemistry experience with real life situations, they find trends or common truths in the experience, and identify the principles that emerged.

Application

The students apply the new experience in Chemistry to similar or different situations. They also discuss how the newly learned process can be applied to other situations and how effective behaviour can develop from what they learnt. The instructor helps each student feel a sense of ownership for what is learnt in the Chemistry lessons.

2.7.2 Instructor Roles in Experiential Learning

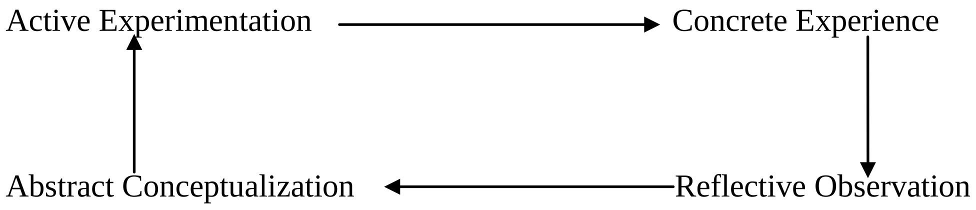
In experiential learning, the instructor guides rather than directs the learning process where students are involved in learning. The instructor assumes the role of facilitator and is guided by a number of steps crucial to experiential learning (Wurdinger & Carlson, 2010). These steps include active experimentation, concrete experience, reflective observation and abstract conceptualization (Kolb, 1984).

2.7.3 Student Roles in Experiential Learning

The student decides themselves to be personally involved in the experience. Students are not completely left to teach themselves; however, the instructor assumes the role of guide and facilitates the learning process (Davis, 2011; Wurdinger & Carlson, 2010).

2.8 Kolb's Experiential Learning Model

Experiential learning is the process whereby knowledge is created through the transformation of experience that results from being actively involved in learning (Kolb, 1984). Kolb's Experiential learning model is comprised of four elements which include the active experimentation, concrete experience, reflective observation and abstract conceptualization.



Kolb's, David (1984)

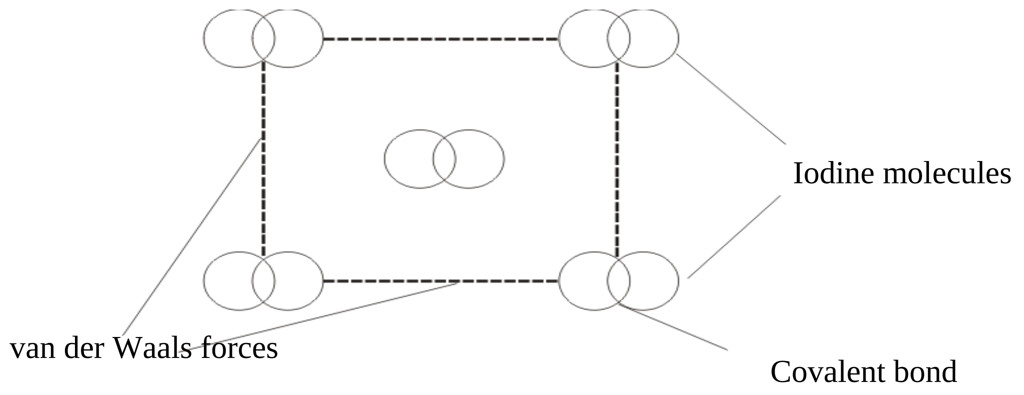
Figure 6: David Kolb's Experiential Learning Model

Kolb's, (1984) shows the four stage Learning cycle depicted in Figure 6; **Active Experimentation** involves the learners in active participation of the lesson by the learners by carrying out experiments, making of models, drawing concept maps and recording observations among others. **Concrete experiences** are whereby the experiences gained through active involvement are used for observation and reflections. **Reflective observation** is a stage where the concrete experiences developed during the lesson undergo reflections and assimilation into the learner's schemata. This is achieved through group discussions of the observations made during the experimentation process. During **Abstract Conceptualization** the concrete experiences and reflective observations are distilled into abstract concepts from which new implications for action serve as guides in creating new experience in abstract conceptualization. According to (Rogers & Frieberg, 1994), application of this model in Chemistry teaching and learning process would improve the acquisition and retention of Chemistry concepts by active participation. The lessons in experiential learning are arranged so that every student participates completely in learning process and has control over nature and direction of learning.

2.9 Graphic Organizers Experiential Teaching Approach

Graphic Organizers Experiential Teaching Approach is a hybrid teaching strategy linking the application of graphic organizers and experiential learning in teaching of Chemistry. GOETA is a teaching strategy where the learners use graphic organizers and get actively involved in the process of learning. GOETA could be of particular interest to Chemistry teachers to try and improve achievement in chemistry This would help learners to remember, analyse relationships, comprehending, problem solving, gain conceptual and holistic understanding more quickly (Johnson, 1992; Johnson & Thomas, 1992; Satchwell, 1996; West, Fanner & Wolf , 1991). The students learn more deeply when they construct their own graphic organizers thereby learning by doing than when graphic organizers are provided (Stull & Mayer, 2007).

The GOETA approach encourages learning by doing rather than by viewing and this may result in better achievement in instructional objectives. GOETA as a teaching strategy may be used to activate prior knowledge to provide conceptual frame work for integrating new information. The use of GOETA in the classroom is intended to give all students a learning environment that allows discovery and creativity through the use of graphic organizers in experiential learning. In this study GOETA was used to teach the topic of structure and bonding in chemistry. For instance, the molecular structure of Iodine molecule as shown in Figure 7 is an example of a graphic organizer that can be constructed by learners who then learn by experience and doing. This model was used as example of a graphic organizer in the application of GOETA as being an effective method of gaining the concept of structures in chemistry.



(KIE, 2009)

Figure 7: Molecular structure of Iodine molecule

Figure 7 shows a molecular structure of Iodine molecule that is formed by linking two Iodine atoms that are held by a covalent bond and several molecules are in turn held by weak van der waals forces of attraction to form a simple molecular structure of Iodine. The learners can construct the model of Iodine molecule as a graphic organizer. In the process of construction, they would be actively involved in hands on activity that allows active experimentation and development of concrete experience. During group discussion of the graphic organizers constructed, the learners would have reflective observation of the concept learnt in the experience and then develop abstract conceptualization. The engagement of the learners with the graphic organizer in experiential learning situation helps them to acquire meaningful learning. This experience would help learners to internalise the concept of covalent bond, simple molecular structure, van der waals forces and differentiate an atom and a molecule.

2.10 General Self Concept

Self-concept broadly defined, is a person's perception of himself or herself (Marsh, 1987). These perceptions are formed through one's experience with the interpretations of one's environment and are influenced especially by reinforcement's evaluations of significant others and one's attributions for own behaviour (Shavelson, Hubnes & Stanton, 1976). Although there is a considerable disagreement on the precise definition of self- concept, social psychologists seem to steer a common view that it cannot be directly observed but only inferred from a person's behaviour. Self-concept is our perception or image of our abilities and uniqueness (Marsh, 1987).

At first one's self-concept is very general but as one grows older, these self-perceptions become much more organized, detailed and specific (Pastorino, Doyle & Portillo, 2013). Lewis (1990), defined self-concept as the accumulation of knowledge and beliefs regarding personality traits, physical characteristics, abilities, values, goals and roles. Accordingly, self-process serve to provide organization, motivation and protection. Self-concept performs *organizational functions* by allowing attribution of meaning to life experience and helps to maintain a sense of coherence in the self and the world. The self-concept is the frame of reference in terms of which all other perceptions gain their meaning (Combs & Snygg, 1959). People perceive and judge not only matters, but also other people on the basis of self-relevant dimensions (Hill, Smith, & Lewicki, 1989; Lewicki, 1983).

Thus people will seek the company of the ones who make them feel good and avoid those who induce negative effect. Second, the self-concept has a *motivational purpose* in that it energizes the individual to select and pursue goals, and to define standards for improvement. The ability of mental extrapolation is crucial with regard to projecting into the future and remembering past achievements that can serve as useful guideline to increase the effectiveness of behaviour (Greve, Rothermund, & Wentura, 2005; Greve & Wentura, 2003). Thirdly, self-concept assumes a *protective function*. "Protective" can be interpreted as self-protection not only implying securing one's survival, maximizing pleasure and minimizing pain, but also ensuring the satisfaction of one's needs and goals in general.

Human beings have the capacity for self-reflection, that is, they themselves, and their own thoughts and actions can become the objects of their thinking. Self-Concept is the set of cognition and feelings that one has on one self (Borg & Gall, 1989). According to Byrne (1984) it also refers to students to attitudes, feelings and knowledge about our abilities, skills, appearance and social acceptability.

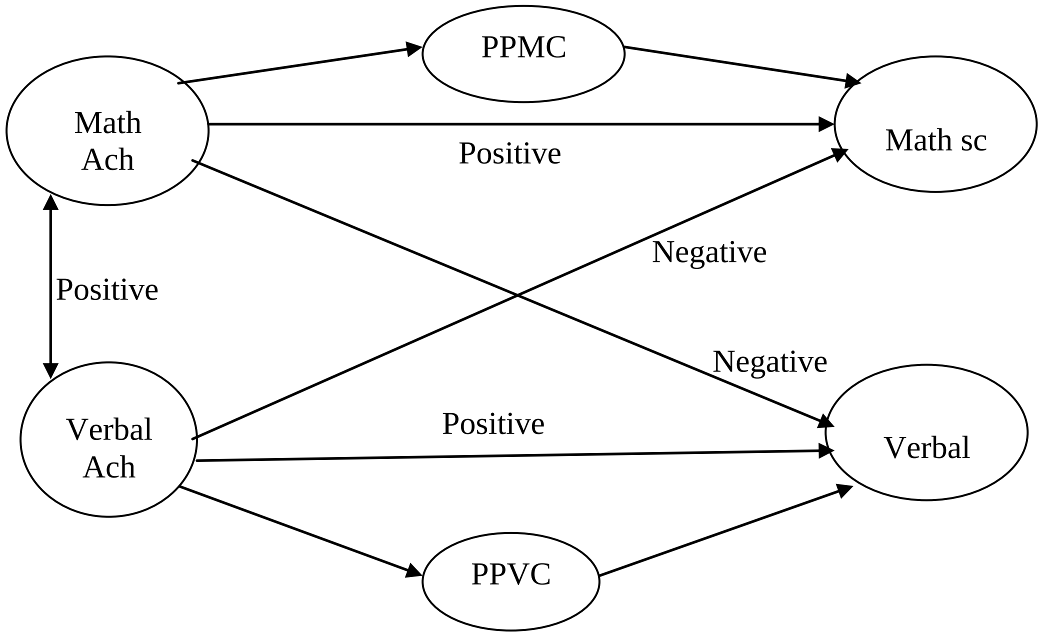
2.10.1 Academic Self-Concept

Academic self-concept is a sub-domain of general self-concept and it indicates students' perceptions of their academic ability formed in conjunction with peers, teachers and parents (Marsh, 1987; Marsh & Hau, 2003; Liu & Wang, 2008). Cokley defines academic self-concept as "attitudes, feelings and perceptions relative to one's intellectual or academic skills". This is how a student views his or her academic ability when compared to other students. Self-concept is organised in that learners collect a great deal of information on which to base their perceptions on, it depends on specific situations. Self-concept is multifaceted in that the learners categorize self-perceptions in terms of social ability, physical attractiveness, athletic ability and academic ability. Learners ability in an academic subject is a means of facilitating performance in the subject (Githua & Mwangi, 2003). Models of self-concept are generally considered to be either un-dimensional or multi-dimensional in nature, with additional classifications within each major category (Byrne, 1996; Stein, 1993).

Researchers in the multi-dimensional tradition have differentiated general "academic self-concept" into mathematics and verbal self-concepts along with "school" category (Byrne, 1996).

These components are often arranged in hierarchical diagram with general self-concept at the apex of the model. Mathematics and verbal self-concept have been linked to achievement in school and on relevant tests; students who feel better about their mathematics or verbal ability tend to demonstrate higher achievement in the corresponding subject area (Marsh, Parker & Barners, 1985; Marsh ,Bryne & Yeung, 1999).

Figure 8 illustrates the comparison between internal and external framework of development of academic self-concept as proposed by Marsh and colleagues (Marsh et al., 1999). According to the model students base their self-concept on two simultaneous comparison processes. The *internal* comparison which includes an individual student's appraisal of their ability in one academic domain (e.g. chemistry) in comparison to his ability in other academic areas. The *external* comparison which is the student's evaluation of competence in that academic domain relative the perceived ability of peers. Figure 8 considers the multi-dimensional approach of self-concept as internal and external frame. The Mathematics and verbal self-concept are linked to achievement in school on tests to indicate students' ability in the corresponding subject area.



(Marsh 1987)

Figure 8: Internal/External frame of Reference proposal
Key:
Match Ach – Mathematics Achievements;

Verbal Ach – Verbal achievements

Math Sc – Math self-concept

Verbal Sc – Verbal self-concept

Match Ach – Maths Sc and Verbal Ach – Verbal Sc Paths represent external comparison. While verbal Ach – Math Sc and Math Ach – Verbal Sc paths represent internal comparisons.

PPVC-Positive Verbal Comparison

PPMC-Positive Math Comparison

According to the model, students base their self-concept on internal and external comparisons. Therefore a student's self-concept in Chemistry is derived from the perceived Chemistry competence relative to competence in other subjects as well as from an evaluation of math competence relative to that of the peers. Many of the successes and failure that people experience in many areas of life are especially academic achievements are closely related to the ways that they have learned to view themselves and their relationships with others. Research studies have shown that academic achievements and self-concept were interrelated which has an input on academic effort (Muijs, 1997; Gottlieb &Rogers, 2002; Marsh et al., 1999; Marsh 2003; Popoola, 2002). It has also been found out that individuals with a low self-concept have low commitment to school (Hay et al., 1998; Maruscsak, 2008).

Having good self-concept is an important psychological factor that is relevant to achieving success in science subjects, therefore, teachers and counsellors should encourage students in developing good self-concept towards their chosen subject (Oluwatosin & Ongeci, 2014). This study will examine the relationship between is an important mediating factor that facilitates the attainment of behavioural and educational outcomes that support human potential. Is important for science teachers to always verify the entry behaviour of their students and compliment the students' self-confidence with appropriate teaching and learning strategies that would produce the expected performance. If students have good self-concept of their ability to perform in Chemistry is an indication they are motivated to strive for success in the face of difficulty.

A student with low self-concept would like give up easily in time of stressful scientific task (Marsh, 1993; Hamachek, 1995). The study used Students' Self-concept Questionnaires (SSCQ) to measure students' self-concept in the learning and achievement in Chemistry in secondary schools.

2.10.2 Self Concept and Achievement

Academic achievement is a key mechanism through which students learns about their talents, abilities and competencies which are an important part of developing career aspirations (Lent, et al, 2000). In an investigation of academic achievement in African-American College Students (Cokley, 2000) found out that there was strong correlation between academic self-concept and grade point average (GPA) scores. It was also found that students with higher academic self-concept score more than those with lower academic self-concept in GPAs. Gesinde in Muolo (2010) argues that the urge to achieve varies from one individual to another and adds that those who have higher achievers as their role models in early life experience would develop a high need for achievement while those who have low achievers as role models will hardly develop the need for achievement.

Academic experiences of success or failure significantly affect the pupil's self-concept and self-image more than vice versa this being explained by the role of evaluation by significant others, or by theory of social comparison (Tajfel and Turner, 1986). The beneficial effects produced by a good level of academic self-concept have been sustained. In studies by Hay, Ashman and Van-Kraayenoord, 1998), where subjects with a high self-concept were compared to others with low self-concept, teacher reports show that they consider the high self-concept students as more supportive families and higher expectations of future success. Joshi and srivastava (2009) found out there were significant differences with regard to academic achievements of rural and urban adolescents. Urban adolescents Scored higher in academic achievements as compared to rural adolescents. Boys would score significant higher on self- esteem as compared to girls. Significant gender differences were found in academic achievement Girls were significantly higher on academic achievement as compared to boys.

2.10.3 Chemistry Self Concept

Students' Chemistry self-Concept refers to students' self-evaluation of self-perceived personal Chemistry skills, abilities, Chemistry reasoning ability enjoyment and interests in Chemistry (Marsh, 1990 & 1996). Self-Concept is the total organization of the perceptions that individuals have of themselves (Dembo, 1994). Chemistry Self-Concept of secondary school students may be related to their ability to acquire Chemistry concepts, their interests and perception of subject, satisfaction and perceived probability of success in learning Chemistry. The application of this is that any intervention programmes designed to enhance learners' Chemistry Self-Concept would positively affect their learning the subject and the students' perceived probability of success in Chemistry. The use of GOETA a teaching approach provided interactions and experiences that will improve student self-concept in chemistry. However, the effect of GOETA upon students' self-concept in Chemistry has not been established. This study tried to investigate the effect of GOETA on students' Chemistry self-concept.

2.11 Theoretical Framework

The theoretical framework that was used in the study was based on the cognitive and constructivist theories of learning.

2.11.1 Cognitive Theory of Learning

Cognitive theorists Piaget, Gestalt and Kurt believe that learning involves the integration of events into an active storage system comprised organisational structures termed as schemata. Cognitive theory roots can be traced on systems of ancient philosophy of Plato's idealism of 400BC, who believed that one should constantly exercise the mind by studying mathematics and the classics (Bell–Gredler, 1986). Descartes and his 17th century philosophy of rationalism built on Plato's concepts of innate knowledge that emphasised on logical thought and deductions. This concept of these two philosophers influenced the development of cognitive pychology (Bell-Gredier, 1986). Darwins theory of evolution, James emphasised the process of cognition as it related to environmental adaption (Larser, 2013). According to Gestalt theory, stimuli only have meaning as they are cognitively organised by the person.

Learning is based on changes in the perceptual process where true learning occurs when the individual perceives new relationships with the field (Bell- Gledler, 1986). Although all cognitive theorists examine these functions to discover more about human behaviour, they often differ regarding emphasis. Some approaches deal with detailed analyses of information-processing skills while others focus on mental models or cognitive growth and development. Cognitive learning theories advance that one's ability to learn stems from the way one perceives, organises, stores and retrieves information.

Cognitive theory focuses on the mental constructs and organizational patterns and learners assimilate new knowledge into existing schemas. The system chooses, arranges and encodes for storage of new information based on the individuals' interests, motivations and particularly perceptions (Bell-Gredler, 1986). Cognitive learning theories explore the depths of the mind from the perspective of process. Cognitive theories grew out of Gestalt psychology which provided demonstrations and described principles to explain the way learner's organise their sensations into perception (Myers & David, 2008). Interaction between mental components and the information that is processed through this complex network involves cognitive learning.

Cognitive theorists believe that learning involves the integration of events into an active storage system comprised of organizational structures termed schemata. The cognitive theorists argue that students do not simply carry over knowledge from the classroom, but they organise it in a way that they understand themselves (Larser, 2013). Accommodation occurs when one’s internal structures adjust to the diversity of environmental stimuli. This then results in the reorganisation of structures as individuals change their way of thinking. The most important cognitive associations occur when individuals relate stored knowledge to sensory input and consequently encode the stimuli into long-term memory (Bell, 1986). Cognitive theory in this study will be applicable to learners’ in thinking skills in construction or completion of a teacher’s outline of graphic organizers. Assimilation and accommodation of the concrete experiences, reflective observation and abstract conceptualization of chemistry concepts formed part of cognitive process in application of GOETA.

2.11.2 Constructivist Theory of Learning

Prominent theorist Jean Piaget focused on how humans make meaning in relation to the interaction between their experiences and their ideas. He was interested in the genesis of knowledge where he focused on human development in relation to what is occurring within the individual as opposed to development that is influenced by other humans (Piaget, 1965). The formalization of constructivism from a within-the-human perspective is generally attributed to Piaget, who articulated mechanisms by which information from the environment and ideas from the individual interact and result in internalized structures developed by learners. The constructivist theory postulates that learning is an active process where students are actively involved in constructing meaningful learning rather than the teacher serving as a dispenser of facts and lower the level of cognitive information (Duffy, 2009). Piaget identified processes of *accommodation* and *assimilation* that are key in this interaction as individuals construct new knowledge from their experiences.

When individuals *assimilate* new information, they incorporate it into an already existing framework without changing that framework. In contrast, when individuals' experiences contradict their internal representations, they may change their perceptions of the experiences to fit their internal representations. According to the theory, *accommodation* is the process of reframing one's mental representation of the external world to fit new experiences. Accommodation can be understood as the mechanism by which failure leads to learning: when we act on the expectation that the world operates in one way and it violates our expectations, we often fail, but by accommodating this new experience and reframing our model of the way the world works, we learn from the experience of failure, or others' failure (Brownstein, 2001).

The theory of constructivism suggests that learners construct knowledge out of their experiences (Brownstein, 2001). However, constructivism is often associated with pedagogic approaches that promote active learning, or learning by doing. According to Glasersfeld (2009) without the social interaction with other more knowledgeable people, it is impossible to acquire social meaning of important symbol systems and learn how to utilize them.

From the social constructivist viewpoint, it is thus important to take into account the background and culture of the learner throughout the learning process, as this background also helps to shape the knowledge and truth that the learner creates, discovers and attains in the learning process (Eddy, 2004). Furthermore, it is argued that the responsibility of learning should reside increasingly with the learner (Glasersfeld, 2009). Whereas a teacher gives a didactic lecture that covers the subject matter, a facilitator helps the learner to get to his or her own understanding of the content. This dramatic change of role implies that a facilitator needs to display a totally different set of skills than that of a teacher (Nilson, 2010). A teacher tells, a facilitator asks; a teacher lectures from the front, a facilitator supports from the back; a teacher gives answers according to a set curriculum, a facilitator provides guidelines and creates the environment for the learner to arrive at his or her own conclusions; a teacher mostly gives a monologue, a facilitator is in continuous dialogue with the learners (Eddy, 2004). A facilitator should also be able to adapt the learning experiences by taking the initiative to steer the learning experience to where the learners want to create value.

The learning environment should also be designed to support and challenge the learner's thinking. While it is advocated to give the learner ownership of the problem and solution process, it is not the case that any activity or any solution is adequate.

The critical goal is to support the learner in becoming an effective thinker. Other constructivist scholars agree with this and emphasize that individuals make meanings through the interactions with each other and with the environment they live in. He further states that learning is not a process that only takes place inside our minds, nor is it a passive development of our behaviors that is shaped by external forces and that meaningful learning occurs when individuals are engaged in social activities. Nilson, (2010) also highlighted the convergence of the social and practical elements in learning by saying that the most significant moment in the course of intellectual development occurs when speech and practical activity, two previously completely independent lines of development, converge. Through practical activity a child constructs meaning on an intra-personal level, while speech connects this meaning with the interpersonal world shared by the child and her/his culture.

A further characteristic of the role of the facilitator in the social constructivist viewpoint is that the instructor and the learners are equally involved in learning from each other as well (Taber, 2006). Learners compare their version of the truth with that of the instructor and fellow learners to get to a new, socially tested version of truth. Learners should constantly be challenged with tasks that refer to skills and knowledge just beyond their current level of mastery. This captures their motivation and builds on previous successes to enhance learner confidence (Good and Brophy, 2003). Hilbet, (2007) contends that the more structured the learning environment, the harder it is for the learners to construct meaning based on their conceptual understandings. A facilitator should structure the learning experience just enough to make sure that the students get clear guidance and parameters within which to achieve the learning objectives, yet the learning experience should be open and free enough to allow for the learners to discover, enjoy, interact and arrive at their own, socially verified version of truth.

The teacher should serve as a facilitator who attempts to structure an environment in which the teacher organizes meaning on a personal level, rather than dispensing facts and lower the level of cognitive information. The core ideas of constructivist's theories suggest that knowledge is actively constructed by a learner, not passively from outside (Taber, 2006). GOETA, a hybridized approach combines features of graphic organizers and experiential learning to provide opportunities for learners to practice scientific skills in hands- on activities and make discoveries for themselves as they construct new knowledge (Good and Brophy, 2003). In this study the outlined features of constructivism is the active involvement of learners in construction of graphic organizers and active experimentation of experiential learning was used in GOETA as an hands on activity in construction of meaningful learning.

2.12 Conceptual Framework

The conceptual framework of the study was based on the assumption that the blame for a students' failure depends on the quality of instruction and not lack of students' ability to learn (Bloom, 1981; Levine, 1985). Figure 9 shows the relationship between the variables, the effects of GOETA on students' achievement and self-concept to learning chemistry in secondary schools in Nakuru North Sub-County.

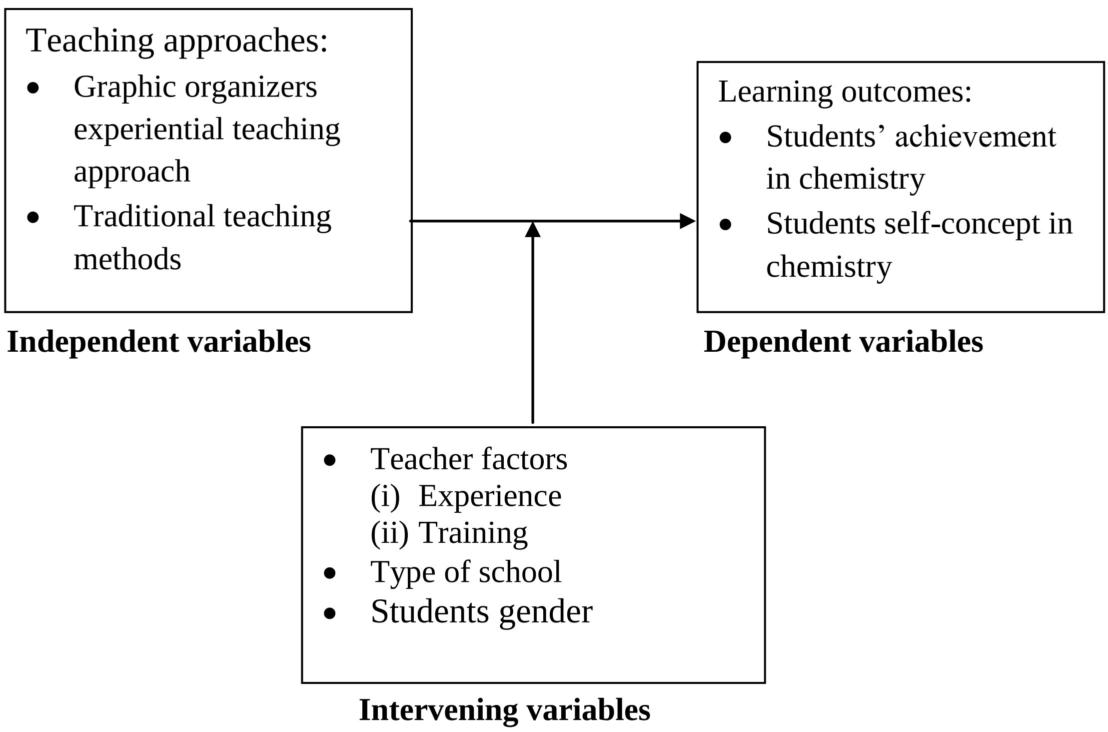


Figure 9: Conceptual framework showing how variables in the study interact.

The conceptual framework represented in Figure 9 shows the relationship between variables for determining the effect of GOETA on secondary school students' achievement and self-concept in learning chemistry. The independent variables were the teaching approaches used in the application of GOETA. The dependent variables were the learning outcomes after application of GOETA. Intervening variable are the various factors that may influence the learning outcomes and they include; teacher experience and training, type of school, learner's academic ability, student's gender, learning resources and classroom environment.

To control these variables, the study involved qualified chemistry teachers with a minimum of two years teaching experience. The classroom environment was controlled by involving co-educational schools where boys and girls learn together in the same classroom. The type of school was controlled by involving Sub-County secondary schools attended by learners of comparable academic ability in the County.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter provides the methodology that was used in the study to achieve the objectives of this study. It consists of the proposed research design, location of study, target population, sample size and sampling procedures, instrumentation, validation and use of instructional materials, data collection, and analysis procedures.

3.2 Research Design

The study involved quasi-experimental research involving the Solomon Four Non-Equivalent Control Group Design (Gall, Borg & Gall, 1996). The design was preferred because the Form Two classes involved in the study remained intact as the school authorities do not allow randomization process by reconstituting and disrupting classes during the administration of the treatment (Coolican, 1999). The design is considered sufficiently rigorous and appropriate for quasi-experimental studies (Frankel & Wallen, 2000). It assesses the plausibility of pre-test sensitization effects, that is, the mere act of taking pre-test influences scores on subsequent test administration (Clark & Elen, 2006). It also ensures that administration of pre-test to two groups and post-test to all four groups (Gall, Borg & Gall, 1996; Wachanga & Mwangi, 2004). Solomon Four-Non- Equivalent Control Group Research Design is represented by Figure 10:

The Solomon Four Non- Equivalent Control Group Research Design is as follows: -

GROUP I (E 1)	O_1	X	O_2
GROUP II (C 2)	O_3	-	O_4
GROUP III (E 1)	-	X	O_5
GROUP IV (C 2)	-	-	O_6

Source: Gall, Borg & Gall (1996)

Figure 10: Solomon Four Non-Equivalent Control Group Research Design

Key:
Where: O_1 and O_3 are pre-tests;

O_2, O_4, O_5 and O_6 are post-tests;

(O) indicates the observations or outcomes;

X is the treatment where students were taught using graphic organizers experiential teaching approach (GOETA);

(----) indicates the use of non-equivalent groups that existed as intact groups;

(-) means no treatment (Mugenda & Mugenda, 1999; Gall, Borg & Gall, 1996).

Group1 (E 1) is the experimental group. This group received the pre-test, the treatment X and the post-test.

Group II (C 1) is the control group, which received a pre-test followed by the Control condition and finally a post-test.

Group III (E 2) received the treatment X and a post-test.

Group IV (C 2) received the post-test only.

Group II (C 1) and IV (C 2) were taught using traditional teaching methods.

Although the Solomon four non-equivalent group design was used in this study, lack of random assignment in the quasi-experimental design poses many challenges for the researcher in terms of internal validity (Lynda, Harry, Shannon, Lind & Andrew, 2001). The possible sampling error due to this approach was addressed by using analysis of covariance during data analysis. Moreover, even if these threats to internal validity are looked into, causation cannot be fully established because the researcher does not have total control over extraneous variables (De Rue, 2012). The use of quasi-experimental designs minimises threats to external validity as natural environments cannot be compared to artificially well-controlled laboratory setting (Lynda *et al*, 2001).

With the use of quasi-experiments, findings may be applied to other subjects and settings, allowing for some generalizations to be made about the population. Also, this experimentation method is efficient in longitudinal research that involves longer time periods which can be followed up in different environments. According to Due Rue (2012) in natural experiments the researcher has to let manipulations occur on their own and have no control over them. Quasi-experiments allow a researcher unlimited opportunity to manipulate independent variables.

The study involved the quasi-experimental research design because the secondary school classes once constituted exist as intact groups and school authorities do not allow such classes to be broken up and reconstituted for research purposes (Mugenda & Mugenda, 2003). However, this helped to control the threats to internal validity and it was important that the groups be as similar as possible across the schools in order to control for interaction between selection and instrumentation.

3.3 Location of Study

The study was carried out in secondary schools in Nakuru North Sub-County. Nakuru County is located in the former Rift Valley Province of Kenya, about 165 km from Nairobi to the North. It borders seven Counties namely: Laikipia to the North East' Kericho to the West, Kajiado to the South, Narok to the South West, Baringo to the North, Bomet to the West and Nyandarua to the East (Nakuru Integrated Development Plan (Republic of Kenya, 2017). The approximate area of Nakuru County is 7,496.5 $km^{2.}$ The study location is easily accessible from Nairobi by road, a journey that takes about three hours. The study location was purposely selected because the Sub-County has consistently posted poor results in KCSE science, especially in Chemistry than other Sub-Counties of Nakuru. The Sub-County has a large number of public co-educational secondary schools and is mainly cosmopolitan.

3.4 Population of the Study

The target population in this study was secondary school students in Sub-County co-educational public schools in Nakuru North Sub-County, Kenya. The accessible population was Form Two students in the coeducational public schools in the Sub-County. Form two students were considered appropriate for this study because chemistry is a compulsory subject in form one and two. The students were already exposed to the secondary school chemistry curriculum for one year in form one hence are considered appropriate for the study.

3.5 Sampling Procedure and Sample Size

Purposive sampling technique was used to select four Sub-County co-educational public secondary schools in Nakuru North Sub-county to ensure that Students involved had comparable academic abilities that formed the study sample.

The topic of structure and bonding to be taught was also the reason for choice of this method of sampling. Purposive sampling was necessary to be able to select the four public co-educational Sub-County secondary schools in Nakuru North Sub-County that had similar characteristics. Simple random sampling was used in schools with more than one Form Two streams. The sample had 216 Form Two students. The streams comprised of (E1) 53, (E2) 51, (C1) 57 and (C2) 55 students in each class that participated in the study. The treatment period was four weeks.

3.6 Instrumentation

The study used two instruments for assessing students' achievements and self-concept. They included the Chemistry Achievement Tests (CAT) and the Students Chemistry Self Concept Questionnaire (SCSQ).

3.6.1 Chemistry Achievement Test (CAT)

The Chemistry Achievement Test (CAT) was developed by the researcher to measure student's achievement in chemistry. The test items offered consisted of 30 items with different scores ranging from 1-4 with a maximum score of 80 marks from the topic of structure and bonding in Form Two. The CAT was then pilot-tested in two co-educational county schools with similar characteristics as the sample schools from Nakuru Sub-County. The CAT was then administered as a post-test for comparison purposes.

3.6.2 Students Chemistry Self-Concept Questionnaire (SCSQ)

The researcher used the instrument to assess the students' self-concept towards learning chemistry. The SCSQ contained 45 items that had information on the student's self-concept in Chemistry. The questionnaire contained closed-ended items that were measured on a 5-point Likert Scale. The items with a positive stem strongly agree (SA) scored highest (5) while strongly disagree (SD) scored lowest (1). The items with a negative stem strongly agree (SA) scored lowest (1) while strongly disagree (SD) scored highest (5) (Marilyn, 2005). The SCSQ was given to experts in educational research in the faculty of Education and Community Studies for validation.

3.6.3 Validation of the Research Instruments

The two instruments the CAT and SCSQ plus their scoring keys had their content validated by five experts in educational research in the faculty of Education and Community Studies. Three experienced secondary school Chemistry teachers who are examiners with Kenya National Examination Council (KNEC) were also involved. Experts' opinion was used to improve research items before they were used. To ensure item difficulty suitability, results between pre-test and post-test, CAT and SCSQ test items were re-organized and administered to all the groups as post-test.

3.6.4 Reliability of the Research Instruments

The two instruments used, CAT and SCSQ were pilot-tested in two secondary schools in Nakuru East Sub-County with similar characteristics. Pilot testing of the research instruments in the neighbouring Nakuru East Sub-county was done so as to minimize chances of contamination during treatment period**.** The reliability of CAT and SCSQ was estimated with the use of Cronbanch's alpha coefficient (Wiersma & Jurs, 2009). This was considered appropriate because the research instruments used consisted of items on which different scoring weights are assigned to different test items. The instruments were administered once. Cronbach's alpha coefficient is represented as;

$$\alpha = \frac{k}{k-1}\left[1 - \frac{\sum S^2 y}{S^2 x}\right]$$

Where k = number of items on the test.

s^2x = Variance of total test.

$\sum s^2y$ =The sum of variance of the individual items.

Cronbach's alpha coefficient was also used to estimate reliability of SCSQ (popham, 1990). This was then calculated with the help of SPSS programme. An instrument whose α value is ≥ 0.7 and above was considered suitable to make group inferences that are accurate enough for the CAT and SCSQ as recommended by Fraenkel and Wallen (2000). Gall *et al*, (1996) considers this technique appropriate for rating scale items on which different responses (SCSQ scores range from 1-5). Cronbach's formula is also recommended for items that are not being scored in terms of if they are right or wrong. A reliability coefficient 0.846 for CAT and 0.861 for SCSQ were obtained, hence the instruments were acceptable.

3.6.5 The Construction and use of Instructional Teaching Module

An instructional manual for chemistry teachers to use during treatment period was developed by the researcher. It was validated by teachers trained and experienced in marking of Chemistry with the Kenya National Examinations Council (KNEC). The treatment period was four weeks that was enough to teach the topic of structure and bonding after which post-test was administered to, experimental group E1 and control group C1. The scores obtained were used for data analysis. The post-test was administered to all the four groups at the end of the treatment period. The manual was based on Chemistry revised KICD syllabus (KIE, 2009). The teachers of the experimental groups were trained by the researcher on the skills of graphic organizers experiential teaching approach for one week.

The teachers of the experimental groups taught the students using GOETA approach on the topic of structure and bonding for four weeks to enable them master the skills. The teachers of the experimental groups guided the students to brainstorm the Chemistry concepts by constructing the graphic organizers in groups. The teacher then guides the students to form groups for discussion of various concepts in respective sub-topics of structure and bonding. The teacher then discussed the graphic organizers presented by different groups in the class with students before moving to a new sub topic. The control groups were taught using Traditional teaching methods. At the end of the treatment period a post-test was administered to all the groups E1, E2, C1 and C2. The sampled schools with more than one Form Two stream had all the students in that school taught using a similar teaching approach.

3.7 Data Collection Procedures

An introductory letter from Egerton University Graduate School was presented to the National Commission for Science, Technology and Innovation (NACOSTI) for them to grant a research permit for the researcher to conduct the study. The researcher approached the Sub-County director of education, the school principals and the chemistry teachers to allow the study be carried out in the sampled schools. The instruments CAT and SCSQ were used to collect data with the assistance of chemistry teachers in the schools.

The researcher administered the post-tests to the groups and then scored quantitatively. The scores obtained were used for data analysis at the end of the treatment period of four weeks.

3.8 Data Analysis Procedures

Quantitative Inferential methods of data analysis of one-way ANOVA and analysis of Covariance ANCOVA and t-test were used with the help of statistical package for social sciences (SPSS). A significance level of $\alpha = 0.05$ was used as a test significance.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

In this chapter the research data obtained, analysis, interpretation and discussions are presented. The results are presented inform of tables. ANOVA, ANCOVA and t-test are statistical procedures used to test the four hypotheses of this study. This chapter is divided into the following subsections:-

(a) Results of the pre-tests.
(b) Effects of GOETA on students' achievement in Chemistry.
(c) Effect of GOETA on students' self-concept to learn Chemistry.
(d) Achievement of boys and girls who are exposed to GOETA teaching approach.
(e) Self-concept in Chemistry of boys and girls who are exposed to GOETA teaching approach.

4.2 Pre-test Analysis

The Solomon Four Non-Equivalent Control Group Design used in this study enabled the researcher to assess the homogeneity of the groups before treatment application (Gall et al., 1996). This arrangement was preferred because it enabled the researcher to find out the effect of pre-test on the pre-tested groups, experimental group E1 and control group C1 and if the groups were similar before the administration of treatment. Differences in Chemistry Achievement Test (CAT) and Students' Chemistry Self- Concept Questionnaire (SCSQ) Pre-test mean scores between groups C1 and E1 are shown in Table 5.

Table 5

Comparison of CAT and SCSQ Pre-test Mean Scores by GOETA

Scale	Group	N	Mean	SD	Df	t-value	ρ-value
CAT	E1	50	6.93	4.58	98	4.906	.000*
	C1	50	3.08	3.14			
SCSQ	E1	53	3.29	0.35	103	721	.472
	C1	52	3.23	0.52			

The t-test results in Table 5 show that the achievement mean score (M= 6.93, SD = 4.58) for E1 was higher than that (M = 3.08, SD = 3.14) for C1.

The results further indicate that difference between the two means was statistically significant at .05 level, t (98) = 4.906, p<.05. The results show that performance of school E1 in the subject is high and this may be attributed to school factors like learning resources and the learning environment. There is therefore need to carry out ANCOVA in this study.

The results however show that the difference between the mean (M= 3.28, SD = 0.35) for E1 on SCSQ and that (M= 3.23, SD = 0.52) for C1 was not significantly different, t(103) = .721, p>.05. The results indicate that E1 and C1 were not comparable on CAT but similar on SCSQ before commencement of the study. Differences by Gender in Chemistry Achievement Test (CAT) and Chemistry Self Concept (SCSQ) pre-test mean scores are presented in Table 6.

Table 6

Comparison of CAT and SCSQ Pre-test Mean Scores by Gender

Scale	Group	N	Mean	SD	Df	t-value	ρ-value
CAT	Male	51	4.63	4.40	98	-.883	.379
	Female	49	5.40	4.32			
SCSQ	Male	58	3.27	0.45	103	.294	.770
	Female	47	3.24	0.43			

The results in Table 6 indicate that the mean (M= 5.40, SD = 4.32) score of the females was higher than that (M = 4.63, SD = 4.40) of their male counterparts. The results also indicate that the difference between the two means was not statistically significant, t(98) = -.883, p>0.05 . The results further indicate that the mean score (M = 3.27, SD = 0.45) of the males on SCSQ was higher than that (M = 3.24, SD = 0.43) of the females. However, the difference between the two means was not statistically significant at .05 level, t(103) = .294, p>.05. The analysis of CAT and SCSQ pre-test mean scores reveal that the male and female students' achievement and chemistry self- concept were comparable at the point of entry.

4.3 Effects of GOETA on Students' Achievement in Chemistry

Objective one was to determine the relative effects of GOETA teaching approach on students' achievement in chemistry. The corresponding hypothesis H_O1 stated that there was no statistically significant difference between secondary school students' taught using GOETA approach and those not exposed to it. To test this hypothesis the analysis of post-test CAT means scores was carried out. Table 7 shows the CAT post-test mean scores obtained by students.

Table 7

CAT Post-test Mean Scores and their Standard Deviations

Group	N	Mean Max = 80	SD
E1	47	47.27	17.70
E2	51	41.31	8.00
C1	47	25.02	9.93
C2	55	19.95	5.58

The results reveal that the mean scores of the experimental groups E1 (M = 47.27, SD = 17.7) and E2 (M = 41.31, SD = 8.00) were higher than those of the control groups C1 ((M = 25.02, SD = 9.93) and C2 (M = 19.95, SD = 5.58). The results suggest that students exposed to GOETA performed better than their counterparts taught using traditional teaching approaches. To find out whether the CAT post-test mean scores were significant, analysis of one way ANOVA was carried out. The results of the one way ANOVA based on these mean scores are shown on Table 8.

Table 8

ANOVA of Post-test Mean Scores on CAT

Scale	Sum of Squares	Df	Mean Square	F-ratio	p-value
Between Groups	25442.46	3	8480.820	69.732	.000*
Within Groups	23837.52	196	121.620		
Total	49279.98	199			

The results of the ANOVA indicate that the difference in mean scores among the four groups E1, E2, C1 and C2 was statistically significant at the .05 level. The results of ANOVA test only show differences among a group of more than three variables, it does not reveal where the differences are. There was need to conduct further analysis on the combination of means to reveal where the differences occurred (post-Hoc tests). There are several Post-Hoc procedures in use depending on the comparisons of interest. This study used Scheffe's procedure with $\alpha = 0.05$ for example, guarantees that the probability of any false rejection among all comparisons made is no greater than 0.05.

This is much stronger protection and controlling the probability of a false rejection at 0.05 for each separate comparison (Tabachnich & Fidel, 2007). The Scheffe's Post-Hoc procedure was used to try and reveal where the differences among the groups where. The results of Scheffe's multiple comparisons for CAT post-test was conducted to reveal where the differences were as indicated in Table 9.

Table 9

Scheffe's Post-hoc Pair-wise Comparison of the Four Groups

Paired Group	**Mean Difference**	**p-value**
E1 versus E2	5.95	.071
E1 versus C1	22.24	.000*
E1 versus C2	27.31	.000*
E2 versus C1	16.29	.000*
E2 versus C2	21.36	.000*
C1 versus C2	5.07	.152

*Significant at .05 level

The results of the multiple comparison show that there were significant differences between pair groups E1-C1 ($p<.05$), E1-C2 ($p<.05$), E2-C1 ($p<.05$) and E2-C2 ($p<.05$). However the differences between E1-E2 ($p >.05$) and C1-C2 ($p >.05$) were not statistically significant. Thus the Experiential groups (E1 & E2) outperformed the control groups (C1 & C2) because of exposure to GOETA as shown in Table 8.

The results of the ANOVA test revealed that there were significant differences among the groups in favour of E1 and E2. These results are not conclusive because ANOVA does not have features for levelling out initial differences. It should be noted that this study employed the Solomon four non-equivalent control group design that pre-test only E1 and C1. This means that the entry behaviour of C2 and E2 was not known. Further tests were done using the ANCOVA to mitigate for this weakness. The ANCOVA analysis was conducted using the KCPE scores as the covariate Table 10 shows the adjusted CAT post-test mean scores.

Table 10

Adjusted CAT Post-test Mean Scores with KCPE as the Covariate

Group	N	Mean	SE
E1	47	43.40	1.69
E2	51	38.02	1.59
C1	47	30.81	1.89
C2	55	21.38	1.43

The results in Table 10 reveal that the mean scores of the experimental groups E1 (M = 43.40, SE = 1.69) and E2 (M = 38.02, SE = 1.59) after adjustments by the covariate were higher than those of the control groups C1 ((M =30.81, SE = 1.89) and C2 (M = 21.38, SD = 1.43).

The main threat to internal validity of non-equivalent control group experiments is the possibility that group differences on the post-test may be due to initial or pre-existing group differences rather than to treatment effect (Gall et al., 1996). Since this groups involved non-equivalent control groups it was necessary to confirm the above results by carrying out analysis of covariance (ANCOVA) by comparing with students' Kenya Certificate of Primary Education (KCPE) scores as the covariate. ANCOVA reduces the initial group differences statistically by making compensating adjustments to the post-test means of the groups involved. (Gall et al., 1996; Borg & Gall, 1989). The results of the ANCOVA analysis that was used to determine whether the differences among the means are statistically significant are given in Table 11.

Table 11

ANCOVA Test Results Comparing CAT Post-test Mean Scores by GOETA

Source	Type III Sum of Squares	Df	Mean Square	F-ratio	p-value
KCPE Scores	2848.86	1	2848.861	26.468	.000
Learning approach	10920.67	3	3640.222	33.82	.000*
Error	20988.66	195	107.634		
Total	267212	200			

The ANCOVA test results indicate that the difference among the groups E1, E2, C1 and C2 were statistically significant at the .05 level, $F(3,195) = 33.82$, $p<.05$.

The multiple comparison (Post Hoc) test was conducted to reveal where the differences were. The multiple comparison test results are shown in Table 12.

Table 12

ANCOVA Scheffe's Post-Hoc Comparisons on CAT Mean Scores

Paired Group	Mean Difference	p-value
E1 versus E2	5.38	.011*
E1 versus C1	12.59	.000*
E1 versus C2	22.02	.000*
E2 versus C1	7.21	.009*
E2 versus C2	16.64	.000*
C1 versus C2	9.43	.000*

* - The mean difference is significant at 95% confidence level.

The results of the multiple comparison test show that there were significant differences between all the pair groups E1-E2 ($p<.05$), E1-C1 ($p<.05$), E1-C2 ($p<.05$), E2-C1 ($p<.05$), E2-C2 ($p<.05$) and C1-C2 ($p<.05$).

The results of the ANOVA and ANCOVA tests were rather contradictory. The ANOVA showed that E1 and E2 were comparable while ANCOVA revealed that the difference between the two groups was statistically significant. Consequently, further analysis was done by comparing the mean scores of the control (C1 and C2 combined) and experimental (E1 and E2 combined) groups using the t-test.

The results of comparison of the students' chemistry achievement post-test mean scores between the experimental and control groups are shown in Table 13.

Table 13

Comparison of the Students' CAT Achievement Post-test Mean Scores between the Experimental and Control Groups

Group	**N**	**Mean**	**SD**	**Df**	**t-value**	**ρ-value**
Experimental	98	44.17	13.81	198	13.539	.000*
Control	102	22.29	8.25			

The t-test results reveal that the mean (M = 44.17, SD = 13.81) of the experimental group was higher than that (M = 22.29, SD = 8.25) of the control group.

The results further reveal that the difference between the means of the two groups was statistically significant at the .05 level, in favour of the experimental group, $t(198) = 13.539$, $p<.05$.

Gain analysis - groups C1 and E1

Gain analysis examines the learning achievement levels of E1 and C1 before and after the program and tries to explain improvements in learning outcomes as measured by the mean scores in Table 14.

Table 14

Students' CAT Pre-test and Post-test Mean Scores, Standard Deviations and Mean Gains by Learning Approach

Stage	**Scale**	**Group**	
		E1 n = 47	**C1 n = 46**
Pre-test	Mean	6.93	3.08
	Standard Deviation	4.58	3.14
Post –test	Mean	47.27	25.02
	Standard Deviation	17.17	9.93
	Mean Gain	**37.34**	**21.94**

The results in Table 14 reveal that the CAT pre-test mean (M = 6.93, SD = 4.58) of E1 was higher than that (M = 3.08, SD = 3.14) of C1.

The results further shows that the difference between the two means were statistically significant. After the treatment, the mean (M = 47.27, SD = 17.17) of E1 was still higher than that (M = 25.02, SD = 9.93) of C1. The result also reveal that the mean gain of E1 (M = 37.34) was higher that (M = 21.94). This means that improvement in learning outcomes of the experimental group E1 was higher than that of the control group C1. The t-test was used to establish whether the difference in the two mean gains were statistically significant. The results of differences in mean gains of CAT between E1 and C1 are indicated in Table 15.

Table 15

Differences in Mean Gain on CAT between E1 and C1

Group	N	Mean Gain	SD	Df	t-value	ρ-value
E1	47	37.34	14.38	91	7.606	.000*
C1	46	21.94	8.19			

* Significant at .05

The t-test results show that the difference between the mean gains of E1 (M = 37.34, SD = 14.38) and C1 (M = 21.94, SD 8.19) was statistically significant at the .05 level, in favour of the experimental group, t(91) = 7.606, p<.05. This means that the experimental group had a higher improvement in learning outcomes as measures by the mean gain. That high improvement in the experimental group can be attributed to the treatment. The results of CAT post-test analysis revealed that the difference among the means scores of groups C1, E1, C2 and E2 were statistically significant. On the basis of these results the first hypothesis H_O1 was therefore rejected.

4.4 Effects of GOETA on Students Chemistry Self-Concept in Learning Chemistry

To determine the effects of GOETA approach on students' self-concept in Chemistry, SCSQ mean scores were analysed using ANOVA and ANCOVA. This was to test hypothesis two, H_O2 which stated that there is no statistically significant difference in self-concept of students who are taught Chemistry through GOETA approach and those who are not exposed to it.

After the students were exposed to the treatment they were given questionnaires to fill what they thought about the teaching approach they were exposed to. The questionnaires were then scored by the researcher.

The SCSQ post-test scores were analysed to determine the relative effects of GOETA approach on students' chemistry self-concept to learn chemistry. This was done using one-way ANOVA and ANCOVA. Table 16 shows the SCSQ post-test scores of the students in the four groups.

Table 16

SCSQ Post-test Mean Scores and their Standard Deviations

Group	**N**	**Mean** **Max = 5**	**SD**
E1	52	3.52	0.46
E2	46	3.69	0.47
C1	57	3.30	0.49
C2	47	3.51	0.37

The results of comparison of SCSQ post-test mean scores for students exposed to GOETA are shown in Table 17.

Table 17

ANOVA of SCSQ Post-test Mean Scores

Scale	**Sum of Squares**	**Df**	**Mean Square**	**F- ratio**	**P-value.**
Between Groups	3.955	3	1.318	6.422	.000*
Within Groups	40.643	198	.205		
Total	44.597	201			

*Significant at .05 level

The results of the ANOVA in table 17 indicate that the difference among SCSQ mean scores of groups E1, E1, C1 and C2 were statistically significant at the .05 level, $F(3, 198) = 6.422$, $p<.05$. The results of ANOVA post-Hoc for paired groups are shown in Table 18.

Table 18

ANOVA Scheffe's Post-Hoc for Paired Groups

Paired Group	Mean Difference	p-value
E1 versus E2	-0.17	.323
E1 versus C1	0.22	.100
E1 versus C2	0.01	.999
E2 versus C1	0.39	.000*
E2 versus C2	0.18	.281
C1 versus C2	-0.21	0.154

The results of the pair wise comparison in table 18 show that differences between all the groups E1-E2 (p>.05), E1-C1 (p>05), E1-C2 (p>.05), E2-C2 (p>.05) and C1-C2 (p >.05) were not statistically significant except E2-C1 (p<.05). Table 19 shows the adjusted SCSQ post-test with KCPE as the covariate.

Table 19

Adjusted SCSQ Post-test Mean Scores with KCPE as the Covariate

Learning approach	N	Mean	SE
E1	52	3.53	0.069
E2	46	3.70	0.071
C1	57	3.29	0.070
C2	47	3.50	0.067

The ANCOVA test results in table 19 show adjusted SCSQ mean scores with KCPE as the covariate by learning approach. The results of comparison of SCSQ post-test mean scores for students exposed to GOETA are shown in Table 20.

Table 20

Comparison of SCSQ Post-test Mean Scores by Learning Approach

Source	Type III Sum of Squares	Df	Mean Square	F-ratio	p-value
KCPE Scores	0.018	1	.018	.085	.770
Learning approach	3.036	3	1.012	4.907	.003*
Error	40.625	197	.206		
Total	2510.083	202			

*Significant at .05 level

The ANCOVA test results in table 19 reveal that the difference in SCSQ mean scores among the four groups C1, E1, C2 and E2 was statistically significant, $F(3, 197) = 4.907$, $p<.05$. The ANCOVA Post Hoc results are indicated in Table 21.

Table 21

ANCOVA Scheffe's Post-Hoc

Paired Group	Mean Difference	p-value
E1 versus E2	-0.17	.066
E1 versus C1	0.24	.029*
E1 versus C2	0.03	.805
E2 versus C1	0.41	.000*
E2 versus C2	0.20	.055
C1 versus C2	-0.21	.022*

*Significant at the .05 level

The results of ANCOVA Post-Hoc indicate that the differences between groups E1-C1 ($p<05$), E2-C1 ($p<05$) and C1-C2 ($p <.05$). However, the differences between E1-C2 ($p>.05$), E2-C2 ($p>.05$) and E1-E2 ($p>.05$) were not significant. This could have resulted because of sampling and school factors like differences in learning resources, implementation of treatment by teachers because the various challenges they may have faced. The results suggest that the students exposed to GOETA had a higher students' chemistry self-concept than those not exposed to it. The results of comparison of the SCSQ post-test mean scores between experimental and control groups are shown in Table 22.

Table 22

Comparison of the SCSQ Post-test Mean Scores between Experimental and Control Groups

Group	N	Mean	SD	Df	t-value	ρ-value
Experimental	98	3.60	0.47	200	3.179	.002*
Control	104	3.39	0.45			

*Significant at .05 level

The results of the comparison in Table 21 show that the SCSQ mean score (M = 3.60, SD = 0.47) of the experimental group was higher and significantly different from that (M = 3.39, SD = 0.45) of the control group, t(200) = 3.179, p<.05. The Chemistry Self-Concept Gain analysis is presented in Table 23.

Table 23

SCSQ Pre-test an Post-test Mean Scores, Standard Deviations and Mean Gains by Learning Approach

Stage	Scale	Group	
		E1	C1
Pre-test	N	53	51
	Mean	3.29	3.23
	Standard Deviation	0.35	0.52
Post –test	N	52	57
	Mean	3.52	3.30
	Standard Deviation	0.46	0.49
	Mean Gain	**0.23**	**0.07**

The results in Table 23 indicate that the difference between the mean gain (M = 0.23) of E1 was not statistically significant from that (M = 0.07) of C1, p>.05. This means that the improvement in learning outcomes of C1 and E1 after the research programme were comparable. The results of the differences in mean gain for SCSQ between E1and C1 groups are shown in Table 24.

Table 24

Differences in Mean Gain on SCSQ between E1 and C1

Group	N	Mean Gain	SD	Df	t-value	ρ-value
E1	52	0.23	0.57	102	.966	.336
C1	52	0.07	0.74			

The results in Table 24 indicate that the difference between the mean gain of E1 was not statistically significant from that of C1, t (102) = .966, p>.05. This means that the improvement in learning outcomes of C1 and E1 after the research programme were comparable. The SCSQ pre-test did not interact significantly with the treatment conditions. This is because there was no significant difference in SCSQ Mean scores between E1 and C1, both of which sat for the SCSQ pre-tests. The use of GOETA resulted in higher students' self-concept in chemistry than the traditional teaching methods since E1 and E2 obtained scores that were significantly higher than the other groups. Hypothesis H_O2 was therefore rejected.

4.5 Difference in Chemistry Achievement Test between Boys and Girls Taught using GOETA

Objective three was aimed at finding the gender difference in achievement when students were exposed to GOETA teaching approach. The corresponding hypothesis H_O3 stated that there was no statistically significant difference in chemistry achievement of boys and girls who are taught through GOETA teaching approach. Table 25 shows the post-test CAT mean scores for boys and girls and boys who were exposed to GOETA teaching approach.

Table 25

Differences by Gender in CAT Post-test Mean Scores of Students Exposed to GOETA

Group	Gender	N	Mean	SD	Df	t-value	ρ-value
Experimental	Male	53	44.11	13.63	96	.043	.966
	Female	45	44.23	14.17			

Experimental group – The mean score (M = 44.23, SD = 14.17) of the females was slightly higher than that (M = 44.11, SD = 13.63) of the males.

The difference between the two means was however not significant at .05 level, t (96) = .043, p>.05. Further test were done using ANCOVA. Rationale used was entry behaviour of E2 was not known given that they were not pre-tested. The ANCOVA test was conducted using KCPE scores as the covariate. The adjusted mean scores are contained in Table 26.

Table 26

Adjusted CAT Post-test Mean Scores with KCPE as the Covariate

Group	Gender	N	Mean	SE
Experimental	Male	53	42.82	1.83
	Female	45	45.76	1.99

Experimental group - Adjusted mean score (M = 45.76, SE = 1.99) of the females was higher than that (M = 42.82, SE = 1.83) of the males.
The ANCOVA test was conducted to establish whether the difference between the adjusted achievement mean scores of the male and female students was statistically significant. Analysis of post-test CAT mean scores by gender using ANCOVA is shown in Table 27.

Table 27

Comparison of CAT Post-test Mean Scores of Students Exposed to GOETA by Gender

Group	Source	Type III Sum of Squares	Df	Mean Square	F-ratio	p-value
Experimental	KCPE Scores	2275.763	1	2275.763	13.335	.000
	Learning approach	193.194	1	193.194	1.132	.290
	Error	16212.36	95	170.656		
	Total	209671.3	98			

Experimental group

The ANCOVA test results indicate that the difference between the male and female students mean scores was not statistically significant at the .05 level, $F(1,95) = 1.132$, $p>.05$. From Table 25 and 26, it can be concluded that the mean scores for boys and girls exposed to GOETA are not significantly different. The results indicate that there is no statistically significant gender difference in achievement when students' are exposed to GOETA. Hypothesis H_O3 was therefore accepted.

4.6 Difference in Chemistry Self Concept between Boys and Girls Taught using GOETA

Objective four was aimed at finding out the effect of GOETA teaching approach on gender differences in students' self-concept in Chemistry. The corresponding hypothesis H_O4 stated that there was no statistically significant gender difference in students' self-concept in Chemistry when exposed to GOETA and those not exposed to it. The mean scores for boys and girls were analysed to and then compared to determine if there was a significant difference between them. Table 28 shows the t-test SCSQ Post-test analysis of experimental groups E1 and E2 combined, differences by gender using the t-test.

Table 28

Differences in Chemistry Self Concept Post-test Mean Scores of Students Exposed to GOETA by Gender

Group	Gender	n	Mean	SD	Df	t-value	ρ-value
	Male	51	3.68	0.44	95	1.773	.080
	Female	46	3.51	0.49			

The t-test results reveal that the SCSQ mean score of the males ($M = 3.68$, $SD = 0.44$) in the experimental group was not statistically different from that ($M= 3.51$, $SD = 0.49$) of their female Experimental counterparts, $t\ (95) = 1.773$, $p>.05$. Table 29 shows the adjusted SCSQ post-test mean scores by gender with KCPE as the covariate.

Table 29

Adjusted SCSQ Post-test Mean Scores with KCPE as the Covariate

Group	Gender	N	Mean	SE
Experimental	Male	51	3.68	0.07
	Female	46	3.51	0.07

Table 30 indicates the results comparisons of SCSQ post-tests mean scores by gender for student' exposed to GOETA approach.

Table 30

Comparison of SCSQ Post-test Mean Scores by Gender of Students Exposed to GOETA using ANCOVA

Group	Source	Type III Sum of Squares	Df	Mean Square	F-ratio	p-value
Experimental	KCPE Scores	4.96E-05	1	4.96E-05	.000	.988
	Learning approach	.677	1	.677	3.068	.083
	Error	20.748	94	.221		
	Total	1279.675	97			

Difference in the post-test mean scores for the experimental group by gender as shown in Table 30 indicates that the difference between the mean score of the males and that of the females in the experimental groups was not statistically significant, $F(1, 94) = 3.068$, $p>.05$. Therefore both boys and girls had higher chemistry self-concept to the same level by GOETA learning approach. The results further indicate that there is no statistically significance in level of students' chemistry self-concept when students are exposed to GOETA teaching approach. Hypothesis Ho4 is therefore accepted.

4.7 Discussion of Results

The following section presents a discussion of the results based on the pre-test and the four hypotheses.

4.7.1 Results of pre-tests

The use of Solomon four-group design enabled the researcher to assess the presence of any interaction between pre-test and the GOETA treatment, determine the effect of the pre-test relative to no pre-test and generalize to groups which did not receive the pre-test (Wachanga, 2002; Borg & Gall, 1989).

In this study, students were put in four groups such that:
Group E1 was the experimental group, which took the pre-test Group C1 was the control group, which took the pre-test
Group E2 was the experimental that did not take the pre-test
Group C2 was the control group that did not take the pre-test. The Groups E1 and C1 sat for the pre-test in CAT and SCSQ, which made it possible for the researcher to assess the homogeneity of the groups before treatment application (Gall et al., 1996).

If the pre-tests interact with the treatment condition, a greater difference in the post-test scores is expected between groups E1 and C1 than between E2 and C2. This is due to the fact that a sensitisation effect implies that the pre-test facilitates the learning of the experimental group but not the control group. In this study, the post-test achievement and students' chemistry self-concept did not indicate any interaction between the pre-test and the GOETA treatment.

A comparison of E1and C1 students' pre-test CAT mean score showed statistically significant differences $t(98) = 4.906$, $p<.05$. This shows that the groups were not similar before the treatment started. However, when the pre-test SCSQ mean scores were compared, they showed statistically no significant difference $t(103) = .721$, $p>.05$. The results indicate that E1 and C1 were not comparable on CAT but similar on SCSQ before commencement of the study. This was attributed to the fact that the study employed non-equivalence control group design. This difference in pre-test CAT mean scores may have been contributed by school factors like school culture, classroom environment, better dedicated teachers and the teaching methods they use, availability or better learning resources in the E1 school.

To address the initial differences in the groups, analysis of covariance (ANCOVA) was used to make statistical adjustments for any experimental error.

4.7.2 Effects of GOETA on Students' Achievement in Chemistry

Hypothesis $H_0 1$ sought to find out if there was statistically significant difference in achievement between those taught through GOETA and those taught through traditional teaching methods. To test the hypothesis, analysis of the students' post-test CAT scores was carried out. The main threat to internal validity of non-equivalent control group experiment is the possibility that the group differences on the post-test may be due to initial or pre-existing group differences rather than the treatment effect (Gall et al., 1996).

Since this study involved non-equivalent control groups it was necessary to confirm the results by performing analysis of covariance (ANCOVA) using the students' Kenya Certificate of Primary Education (KCPE) scores as the covariate. ANCOVA reduces the effects of initial group differences statistically by making compensating adjustments to the post-test means of groups involved (Gall et al., 1996; Borg & Gall, 1989). The results indicate that students who were taught using GOETA approach achieved significantly higher scores in CAT than those taught using TTM approaches. This then implies that the GOETA teaching approach was more effective in enhancing student's achievement than the TTM approaches.

When the two experimental groups E1 and E2 are found to be similar in the post test but dissimilar to the control groups C1 and C2, the researcher may then attribute the differences to the treatment condition (Wachanga, 2002; Gall et al., 1996). Students who had higher .achievement in KCPE, considerably improved after learning through GOETA approach. The lower achievers were assisted in learning by the higher achievers who continued doing well in their experiential learning. An earlier study by Stull and Mayer (2007) of students learning by experience shows that the students learn more deeply when they construct their own graphic organizers. This teaching approach helps to activate prior knowledge to provide conceptual flame work for integrating new information and would this would lead to meaningful learning.

The findings of Wachanga, Arimba and Mbugua (2013) that showed that the use of advance organizers in the teaching learning process has significant positive effect on students' chemistry achievement than the regular teaching methods are in agreement with this study. If secondary schools in Kenya implemented this method in learning of chemistry, the students' achievement and especially in co-educational secondary schools are encouraged to use this method in their teaching. According to Rono, Wachanga and Keraro (2014) the students would remember better what they participated in doing because they involve more science organs than just their prior knowledge in meaningful learning and knowledge construction.

4.7.3 Effects of GOETA on Students Chemistry Self-Concept in Learning Chemistry

The results of this study indicate that GOETA teaching approach resulted in higher students' chemistry self-concept than the traditional teaching approach. The results of the comparison show that the CSC mean score ($M = 3.60$, $SD = 0.47$) of the experimental group was higher and significantly different from that ($M = 3.39$, $SD = 0.45$) of the control group, $t(200) = 3.179$, $p<.05$. This may be because when students construct graphic organizers and hands on activities in their groups new concepts are developed and the information is well retained and meaningful learning takes place. The results of the pre-test showed that there was no significant difference in the means of the two groups. These results implied that the level of students' self-concept in the two groups were similar before exposure to the intervention.

The results of the study indicated that GOETA resulted in higher scores on students' self-concept in Chemistry. The findings indicate that the GOETA teaching approach enhanced students' chemistry self-concept. An important reason for this is based on the assertion made by Craven and Marsh (2008), 'that self-concept is an important mediating factor that facilitates the attainment of behavioural and educational outcomes that support human potential'. Yuksel and Geban (2014) in their research found that developing academic self-concept and logical thinking of students in the learning process is important in enhancing achievement. Studies by Bassey, Umoren and Udida (2007) also determined that academic achievement is related with academic self-concept, attitude towards course and logical thinking skill.

Research had earlier established that academic self-concept and academic achievement have been extensively studied over the years (Craven & Marsh, 2008), but research in this part of the world has not been specifically devoted to how students describe themselves and their academic achievement. By logical reasoning, experience of failure or success may significantly affect one's self-concept because of the evaluation of significant others or by the theory of social comparison.

Parent and teachers become more informed on how to relate with students on the basis of academic outcomes when they understand this connection. The findings of Oluwatosin et al. (2014) indicated that self-concept of students has positive influence on student's academic performance in chemistry. Therefore enhancing student's self-concept would likely lead to good performance in chemistry regardless of gender difference. Developing academic self-concept and logical thinking of students in the learning process is important in enhancing achievement. Many of the successes and failures that people experience in many areas of life and especially academic achievements are closely related to the ways that they have learned to view themselves and their relationships with others.

Research studies have shown that academic achievement and self- concept was interrelated which has an input on academic effort (Muijs, 1997; House, Gottlieb and Rogers, 2002; Marsh et al., 1999; Marsh, 2003; Sanchez & Roda, 2005; Popoola, 2002). It has also been found out that academic self-concept and academic achievement are strong predictors of each other (Muijs, 1997, Hope et al. 1995; Gottlieb & Rogers, 2002 and Sanchez & Roda, 2005). Individuals with a low self-concept have low commitment to school (Hay et al., 1998; Maruscsak, 2008). GOETA teaching approach integrates the new ideas by learning through experience and thus improving students' chemistry self-concept and achievement in chemistry. The higher positive self-concept gained by students exposed to GOETA teaching approach supports this idea and can be implemented in secondary school chemistry learning. The teachers will guide the learners in learning through experience and graphic organizers that would lead in better performance and enhance higher self-concept in learning chemistry.

4.7.4 Effects of GOETA on the Achievement of Boys and Girls

This study aimed at investigating the effect of GOETA on achievement of boys and girls in chemistry. Objective three of the study sought to determine if there is gender difference in students' achievement when they are taught using GOETA. The corresponding hypothesis H_O3 of the study sought to establish whether there is statistically significant gender difference in achievement in chemistry among students exposed to GOETA teaching approach. The results of these students have shown that there is no statistically significant difference between the achievement of boys and girls who are exposed to GOETA Teaching approach. However, other studies show that girls perform poorly due to their poor attitude towards sciences in Kenya (UNESCO, 2004).

In a study aimed at improving the participation and performance of girls in science and mathematics in primary and secondary schools, it was reported that one of the factors stated for keeping girls out of school is failing in mathematics and science (FAWE, 2007). The girls were discouraged by some teachers made comments knowingly or unknowingly that discourage the participation of girls' in learning (UNESCO, 2004). Teachers often consider girls as less intelligent and destined to less well-paid jobs than boys. The findings of this study disagree with the research cited above by UNSCO that girls and boys show no significant difference in chemistry achievement. A study carried out by Abungu et al (2014) indicated that boys and girls exposed to science process skills teaching approach show no significant difference in Chemistry achievement. According to Chukwuka, (2014) Self-concept of students has positive influence on academic performance in chemistry therefore enhancing students' self-concept which would likely lead to good performance in chemistry regardless of gender difference.

4.7.5 Effects of GOETA on Students' Chemistry Self-Concept of Boys and Girls

The students' self-concept in chemistry post-test mean scores for boys who were exposed to GOETA was found to be 3.68 while the mean scores for girls exposed to GOETA found to be 3.51. The difference between the boys and girls mean scores was however not statistically significant, $t(100) = 1.684$, $p>.05$.

This implies that the use of GOETA in teaching Chemistry helped in improving students' achievement in Chemistry irrespective of their gender. Perhaps this would explain the gender differences in self-concept towards chemistry noted in this study since in GOETA teaching approach the teacher only guides the learners during a chemistry lesson. Therefore, all learners should be given equal opportunity, the same level of motivation and encouragement irrespective of gender. This indicates that both boys and girls were equally motivated to learn during the treatment period.

The findings of this study are in agreement with Derek (2007), that girls were motivated to improve their self-concept toward learning Chemistry. Generally, teachers usually interact differently with boys and girls and this suggests that students benefit academically from having teachers who are of the same gender as themselves. Wachanga (2002) notes that boys and girls teachers give more attention to boys than to girls in secondary schools during learning. This makes teachers more likely to use positive reinforcement on boys than they do on girls. This practice makes girls to feel that they are less capable compared to boys hence reducing their self-esteem.

In this study, the boys and girls of mixed abilities were placed in different groups and all were treated equally by the teachers. Each student was given an equal chance to participate and contribute to learning. This raised the self-esteem of girls because they felt that they were comparable to boys. The GOETA teaching approach therefore made girls to have positive self-concept as the boys and the same effect was seen in their achievement in CAT. The teaching approach should therefore be encouraged in the teaching of chemistry in secondary schools.

In conclusion, it can be inferred from the outcome of this study that positive self-concept of student in chemistry has positive influence on student's academic performance in the subject. All students would like a good performance in chemistry regardless of gender difference. It is however necessary for science teachers and school counselors to assist students in developing positive self-concept towards their subjects especially chemistry as a subject. Teachers may resolve to use GOTEA that emphasizes interactive hands on activities that encourage student learning by experience. Also their self-concept improved and this means therefore that there is a likelihood of chemistry performance rising above average when GOETA is used in learning of chemistry in secondary schools.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusions drawn from the study. It also gives the implications, recommendations from the findings of the study and suggestions of further research areas.

5.2 Summary

Based on this study, the results indicate that students who were taught using GOETA approach achieved significantly higher scores in CAT than those taught using TTM approaches. The results of CAT post-test analysis revealed that the difference among the means scores of groups C1, E1, C2 and E2 were statistically significant. The use of GOETA resulted in higher students' self-concept in chemistry than the traditional teaching methods since E1 and E2 obtained scores that were significantly higher than the other groups. The results indicate that there is no statistically significant gender difference in achievement when students' are exposed to GOETA. Therefore both boys and girls had higher chemistry self-concept to the same level by GOETA learning approach. The results further indicate that there is no statistically significance in level of students' chemistry self-concept when students are exposed to GOETA teaching approach. The results have shown that positive self-concept improves the level of students' self-concept in chemistry which consequently increases achievement levels in the subject. The findings reported in this study justify the importance of positive self-concept in academic performance and achievement.

5.3 Conclusions

Based on the results of this study the following conclusions have been arrived at, with regard to co-educational secondary schools.

(i) The GOETA approach enhances students learning and achievement in chemistry than TTM teaching approach.

(ii) Students taught through GOETA have higher chemistry self-concept to learn chemistry than those taught through TTM.

(iii) Gender does not affect students' achievement in chemistry when they are taught using GOETA approach.

(iv) Gender does not affect students' chemistry self-concept to learn chemistry when they are taught using GOETA approach.

5.3 Implications of the Study

The graphic organizers experiential teaching approach results in higher students' achievement and chemistry self-concept. The approach should therefore be used in Chemistry teaching at secondary school level to improve performance in chemistry. Girls have been performing dismally compared to boys in chemistry at KCSE examinations. When students are taught using GOETA approach, gender does not affect achievement and self-concept in chemistry.

This implies that GOETA strategy is likely to improve the low achievement of girls at KCSE chemistry examination. Consequently, improved girls' achievement would lead to better female representation in scientific and technological fields that are currently male dominated. GOETA approach would lead to development of higher students' chemistry self-concept towards learning of chemistry. Results of this study indicate that boys and girls at Form two level have comparable characteristics in terms of achievement and students' chemistry self-concept.

5.4 Recommendations

The findings of this study indicate that GOETA approach enhanced a higher students' achievement and chemistry self-concept than the traditional teaching approaches. This implies that GOETA approach if adapted can be used to address the low performance in chemistry. Since the boys and girls had comparable achievement in the study gender disparity in chemistry performance would be addressed by use of GOETA approach.

(i) The teaching approach should therefore be used to supplement other teaching approaches because the findings indicated that it can improve student' achievement and their chemistry self-concept.

(ii) Chemistry educators in universities and colleges should incorporate GOETA approach in teacher education curriculum. This will help develop programmes aimed at producing teachers that would encourage hands on activities by experiential learning of chemistry in secondary schools.

(iii) Kenya Institute of Curriculum Development (KICD) should include GOETA approach when preparing learning materials like teachers' guides and text books for use in chemistry syllabus implementation in secondary schools.

(iv) The In-service courses for teachers organized by NACOSTI and SMASSE should incorporate GOETA approach for effective application of the teaching approach.

The skills of GOETA should be studied and mastered by the education inspectors to apply during supervision of curriculum implementation and ensure that teacher use on hand on activities that are learner centered in learning of chemistry in secondary schools in Kenya.

5.5 Suggestions for Further Research

This study indicates that GOETA approach can effectively improve chemistry instruction in co-educational secondary schools. However, there are areas that require further investigations. However, the researcher identified some areas that warrant further investigation. These include the following:

(i) A study on the effects of GOETA approach of on acquisition and retention of science skills by secondary school students.

(ii) There is need for more research to test further effects of GOETA on achievement of students in other science subjects other than the one used in the present study.

(iii) A study to determine teachers' perceptions of the classroom environment while teaching through GOETA approach in chemistry in secondary schools.

(iv) A comparative study to establish the achievement of students' when GOETA is used in rural and urban setting to establish whether the findings apply to all socio-cultural and economic regions.

(v) A Study to find out if there is gender difference in achievement and self-concept in single sex - secondary schools when GOETA is used.

REFERENCES

Abungu, H. E., Wachanga, S. W. & Okere, M. O. (2014). Effects of Science Pocess Skills Teaching Approach on Secondary School Students' Self-concept in chemistry in Nyando District, Kenya. *International Journal of Social Science & Interdisciplinary Research, 3 (6) 23-35.*

Association for Experiential Education (AEE). Northern Illinois University, Faculty of Development and Instructional Design Center. facdec niu.ed, www.niu.edu/ facdev,81*5. 753. 0595.[Retrieved on 5th March 2015]*

Alvermann, D.E. (1981). The Compensatory Effects of Graphic Organizers on Descriptive Text. *Journal of Educational Research*, 75(2), 44-48.

Arockiadoss, S. (2005). *Study habits and academic performance of college students, Experiments in Educatiom*. Printed in Abuja: Nigeria.

Atomatofa, R. (2003). Effect of advance organizers on attainment and retention of students' concepts on gravity in Nigeria: *International Journal of Research*, 2(1), 81-90.

Ausubel, D.P. (1967). *Learning Theory and Classroom Practice.* The Ontario Institute for Studies in Education, Toronto: Canada.

Ausubel, D.P. (1968). *Educational Psychology*. *A cognitive view.* Printed in the U.S.A : Holt, Rinehart and Winston.

Ausubel, D. P. (2000). *The acquisition and retention of knowledge*: a cognitive view, Kluwer Academic publishers.

Balluerka, N. (1995). The Influence of Instructions, Outlines, and illustrations on the comprehension and recall of scientific texts. *Contemporary Educational Psychlogy 20, 369-375.*

Bassey, S. W., Umoren, g. & Udida, L. A. (2007). *Cognitive styles, secondary school students' attitudes and academic performance in chemistry in Ikwa Ibom state – Nigeria. Proceedings of epiSTE 2 – International conference to Review Research in SCIENCE, Technology and Mathematics Education, India.*

Bell-Gredler, M. E. (1986*). Learning and instruction: Theory into Practice and Istruction*: New York: Macmillan.

Best, J.W & Kahn, J.V. (2003). *Research in education. Ninth Edition*. Prentice-Hall of India Private Limited, Prentice- Hill.

Bloom, B. S. (1981*). All our childrenlLearning*: New York, NY: McGraw-Hill.

Borg W.R. & Gall M.D. (1989*). Education research* (5th ed.) New York & London; Longman.

Bromley, K., Devitis, L. I. & Modlo, M. (1999). *50 Graphic organizers for reading, writing & more*. New York: Scholastic Professional Books.

Brown, G. & Atkinson, M., (1994). *Effective teaching in higher education*, London: Routledge 7-17

Byrne, B.M. (1996). *Measuring self-concept across the lifespan: issues and instrumentation*. London: American psychological Association.

Byrne, B. M. (1984). The general/academic self-concept nomological network: A review of construct validation research. *Review of Educational Research,* 54(3), 427-456.

Cassidy, J. (1991). Using graphic organizers to develop critical thinking. *Gifted Child Today.* 12(6), 34-36.

Chambliss, M.J. & Calfee , R.C. (1988). *Text books for learning: Nurturing children's minds.* Malden, MA : Blackwell Publishers.

Chukwuka, C. U. (2014). *Influence of Emotional Intelligence on Secondary School Students' Achievement in Chemical Quantitative Problem Solving.* Univesity of Nigeria, Nsukka.

Clark, R.E., & Elen (2006). *When less is more; Research and theory insights about instructions for complex learning*. Oxford; Elesivier science limited.

Cokley, K, (2000). An investigation of academic self-concept and its relationship to academic achievement in African-American college students. *Journal of Black psychology, 26 (2): 148-164.*

Combs, A. W; & Snygg, D. (1959). *Individual behaviour: A perception approach to behaviour* (Rev. Ed). Oxford, England: Harpers.

Coolican, H. (1994). *Research methods and statistics' in psychology* (2nd ed.) London: Hodder Stoughton, the Bath press.

Cook, L.K; & Mayer, R.E. (1988). Teaching readers about the Structure of Scientific text. *Journal of Education Psychological, 80, 448-456.*

Craven, R. G & Marsh. H.W. (2008). The centrality of the self-concept construct for psychological wellbeing and unlocking Human potential: Implications for child and Educational Psychologists. *Educational & Child Psychilogy*, 25(2). The British Psychology Society.

Davis, (2011*). Experiential learning.* Northern Illinois University, Faculty of Development and Instructional Design centre, USA.

De Rue, S. (2012). "A Quasi Experimental Study of After-Events Reviews*". Journal of Applied Psychology* 97 (5): 681-689.

Dembo, M. H. (1994). *Applying educational psychology* (5th ed.) White plains, NY: Longman Publishing Company.

Derek, C. (2007). Students' altitudes towards chemistry lessons: the interaction effect between grade level and gender. *Journal of Research in Education*, 5, 1573-1898.

Duffy, T. M. (2009*). Constructivist instruction: Success or failure*? New York: Taylor & Francis.

Duit, R. & Teagust, D.F. (1998). Conceptual change. A Powerful Framework for Improving Science Teaching and Learning. *International Journal of Science Education*, 25(6), 671-688.

Dunston, P.J. (1992). "A critique of graphic organizers research". *In reading research and institution*, 31(2), pp. 57-65.

Drapeau, P. (1998), *Great teaching with graphic organizers: Lessons and fun-shaped templates that motivate kids of all learning styles*. New York: Scholastic Professional Book.

Eddy, M. D. (2004). " Fallible or inerrant? A Belated review of the " Constructivist Bible" *British Journal for the History of Science*, 37: 93-98.

Eybe, H. & Schmidt, H.J. (2004). Group discussions as a tool for investigating students' concepts. *Chemistry Education Research and Practice, 5(3), 265-280.*

Forum for African Women Educationist(FAWE, 2007). *Bringing Gender responsiveness to African Education, Advocasy, Action and Impact*. Annual report: Nairobi, Kenya.

Fraenked, J.R. & Wallen, N.E. (2000). *How to design and evaluate research in education.* New York, NY: MacGraw Hill companies Inc.

Gall, P.J. Borg, R.W., & Gall, D.M. (1996). *Educational Research; An Introduction,* New York: Longman Publishers.

Glasserfield, E. (2009). Relativism, Fascism and the Question of Ethics in constructivism. *Journal of Constructivism Foundations*. 4(3) 117-120.

Gentile, D.A. (2013). Just what are sex and Gender Anyway. A call for a New Terminological Standard. *A Journal of the Association for Psychological Science*, 24 (b).

Grauwe, A. D. (1999). The challenges for the school of the future: *International Institute for Educational Planning,* 17 (4) 10-11.

Greve, W; Rothermund, K; & Wentura, D. (2005). *The adaptive self: personal continuity and internal self-development.* Ashland, OH: Hogrefe & Huber publishers.

Greve, W; & Wentura, D. (2003). Immunizing the self-concept stabilization through reality-adaptive self-definitions. *Personality & Social Bulletin*, 29, 39-50.

Goitleib, R. J . & Rogers, Janet. L. (2002). Academic Self-concept Achievement and Leadership in University Students Studying in Physical Therapy Programme. *Journal of Allied Health*, 31, 99-102.

Good, T. L. & Brophy, J. (2003). *Contemporary education psychology*, (5th ed. 179-180). White Plains, NY: Longman Publishers.

Republic of Kenya (2017). *Nakuru Integrated Development Plan*. Government Printer. Nairobi.

Hanson,D. & Wolfskill, T. (2000). Process Workshops-A new model for Instruction. *Journal of Chemical Education; 77(1), 120-1129.*

Harmacheck, D. (1995*).* Self-Concept and School Achievement: Interaction dynamics and a tool for assessing the self-concept component. *Journal of Humanity Counselling Education and Development.* 38(4), 230-243.

Hay, I; Ashman, A.F., Vankraayenoord, C.E. (1998). Educational Characteristics of students with High or Low Self-concept*. Psychology in the Schools*, 35(4): 391-400.

Hilbert, T.S. & Renkl, A. (2007*). Learning how to learn by concept mapping: A worked-Example Effect.* Oral presentation at the 12th Biennial conference EARL, in Budafest, Hungary.

Hill, T. ; Smith, N. D; & Lewicki, P. (1989). The development of self-imege bias: A real-world demonstration. *Personality and Social Psychology Bulletin,* 29, 39-50.

Hope, D. R., Smith, E. K., Crist, J. T. (1995). Reciprocal Effects of Self-concept and Academic Achievement in Sixth and Seventh Grade. *Journal of Youth and Adolescence*, 24, 295 – 314.

Jegede, S. A. (2010). Nigeria Students Perception of Technical Words in Senior Secondary School Chemistry Curruculum. *Pakistan Journal of Social Sciences, 7 (2), 109-111.*

Jekayinfa, A. A. (2005). *Fundamentals of instructional methods.* 1. Ilorin. Olives Productions Ltd. pp. 1-12.

Johnson, A.P. (2000). *Up and out: using creative and critical thinking skills to enhance learning*. Massachisetts, Aylan & Bacon, pp. 10-15.

Johnson, S.D (1992). *Cognitive Science and technology education.* Paper presented at the 79th Mississipi Valley Industrial Teacher Education Conference, Chicago.

Jonson, S.D; & Thomas, R. (1992). Technology Education and the cognition revolution. *The Technology Teacher*, 51(4), 7-12.

Kayoed .A.O. (1997). *The Nigerian* teacher education curriculum and the issue of relevance to national development. *Teacher Education Review*, 1, 111-119.

Kelly, M., (2014). About. Com Secondary Education. *Lecture as a teaching Method – Pro and Cons. http//712educators.about.com/od/lessonplans/p/lecture.htm.* Retrieved 20th April 2016.

Kenya Institute of Education (KIE 2009*). Secondary Chemistry Form Two Students' Book (5th Ed.)*. Kenya Literature Bureau, Nairobi: Kenya.

Kenya Literature Bureau (2010). *Secondary Chemistry Form 2 students' Book*. Kenya Literature Bureau, Nairobi: Kenya.

Kenya National Examinations Council (2011*). The year 2010 KCSE Examination Report.* Volume 2: Mathematics and Science. Nairobi: KNEC.

Kenya National Examinations Council (2012). *The year 2011 KCSE Examinations Report*. Volume 1: Mathematics and Science. Nairobi: KNEC.

Kenya National Examinations Council (2013). *The year 2012 KCSE Examination Report.* Volume1: Mathematics and Science. Nairobi: KNEC.

Kenya National Examinations Council (2014*). The year 2013 KCSE Examination Report.* Volume 2: Mathematics and Science. Nairobi: Kenya.

Kenya National Examinations Council (2015*). The year 2014 Examination Report. Volume 2*: Nairobi: Kenya.

Kenya National Examinations Council (2016). The year 2017 *Examination Report. Volume 2*: Nairobi: Kenya.

Keraro F. N; Wachanga S. W (2007). Effects of Co-operative Concept Mapping Teaching Approach on Secondary School Student's Motivation in Biology in Gucha District, Kenya. *International Journal for Science and Mathematics Education* Vol. 5 No. 1. p 111-124.

Kiewra, K.A ; Kauffman, D.F; Robinson, D.H; Dubois, N.F; & Stanley , R.K.(1999). Supplementing floundering text with adjunct displays. *Instructional Science, 27, 373-401.*

Knowles, M.S., Holton, E.F., & Swanson, R.A. (1998). *The adult learner: The Definitive Classic in Adult Education and Human Resource Development* (5th Ed.). Houston, TX. Gulf.

Kolb,D (1984). *Experiential learning as a science of learning and development:* Englewood cliffs, NJ: Prentice Hall.

Kozma, R. B., Belle, L. W., and Williams, G. W. (1978). Methods of teaching . *schooling, teaching and learning American education*. (pp. 210-211). St. Louis, Missouri: C. V. Mosby Co.

Lynda,S; R; Harry,S; Shannon; Linda, M. G, & Andrew, R. H. (2001). Quasi-experimental and experimental designs: more powerful evaluation designs, Chapter 4 of Guide to *Evaluating the Effectiveness of Strategies for Preventing Work Injuries: How to show whether a safety intervention really works*, Institute for Work & Health, Canada.

Lavina, G. (2000). *Trends in International Mathematics and Science Study (TIMSS*). Education Research Information Center. Columbus, Ohio.

Larser-Freeman. D. (2013). Transfer of learning transformed. Language Learning*: Journal of Research in Language Studies*, 63: SI.

Levin, D. (1985*). Improving student achievement through mastery learning Programs.* San Francisco: Jossey-Bass.

Lent, R.W; Brown, S.D & Gore, P.A. (2000). *Academic self-concept and academic achievement of African American students tranforming from urban to rural schools.* PhD thesis. Univesity of Iowa, U.S.A.

Lewicki, P. (1983). Self-image bias in person perception. *Journal of personality & social Psychology,* 45, 384-393.

Lewis, M. (1990). *Self-Knowledge and Social Development in early life.* In L.A Pervin (ed). Handbook of personality. 227-300, New York.

Liu, W.C. & Wang, C. K. J. (2008). Home Environment and Classroom Climate: An Investigation of their Relation to student's Academic Self- Concept in a Streamed Setting. *Journal of Current Psychology*. 27, 242-256.

Marilyn, J. S. C. (2005*). Breaking the chain of low self-esteem. www.getesteem.com Retreaved on 15th November 2015.*

Marsh, H.W., & Parker, J.W., (1985). Determinants of students self-concept: is it better to be a relatively larger fish in a small pond even if you don't learn to swim as well? *Journal of personality and social psychology*, 47, 213-231.

Marsh, H.W. (1987). The Big- Fish-Little Pond Effect on Academic Self- Concept. Journal of Educational Psychology. 79 (3) 280-295. Marsh, H.W. & Yeung, A.S. The (1988). liability of psychology ratings. *Journal of personality and social psychology*, vol. 75 (2), 509 – 527.

Marsh H.W. (1990). Self-Description Questionnaire (SDQ) 11*: A theoretical and empirical basis for the measurement of multiple dimensions for adolescent self-concept: An interim test manual and a research Monograph: (p.5)* San Antonio, TX: The Psychological Corporation.

Marsh, H.W. (1991). Failure of high ability high schools to deliver academic benefits Commensurate with their students' ability levels." *American Educational Research Journal*, 28(2), 445-480.

Marsh, H.W. (1993). Academic self-concept: Theory measurement and research. In J.Suls (Ed.), *Psychological Perspective on the Self (*vol.4, 59-98). Hillsdale, NJ; Erlbaum.

Marsh, H.W & Hau, K. T. (2003). Big- Fish- Little Pond Effect on Academic Self Concept. A Crass- Cultural (26- County) Test of the Negative Effects of Academically Selective Schools. *American Psychologist Journal*. 58 (5), 364-376.

Marsh, H. W, Bryne, B. M, & Yeung, A.S., Causal ordering of Academic Self-concept and Achievement: Reanalysis of Pioneering Study and Revised Recommendations. *Educational Psychologist*, 34, (1999), 154-157.

Maruscsak L. (2012). *What are the Effects of the Self-concept Theory in High School Students: https://en.m.wikipedia.org* [Retrieved on 10th February 2015]

Means, B., & Olson, K. (1995). *Technology's role in education reforms: Findings from a national study of innovating schools.* Washington, D. C.: US Department of Education.

Ministry of Education Science and Technology (2001). *National report on the development of education in Kenya.* Presented at the international conference of education 46th session, Geneva, 5-7th September.

Mugenda, M.O. & Mugenda, G.A. (1999). *Research Methods: Quantitative and Qualitative Approaches.* Nairobi, Kenya: Acts Press.

Muij, S. (1997). Predictors of academic achievement and self-concept: a longitudinal perspective. *British journal of Education Psychology,vol 67,263-277.*

Muolo, J. M. (2010). A study of the relationship between academic achievements, Motivation and home environment among standard eight pupils. *Educatonal Research and Reviews,*5(5), 213-217.

Muraya, D.N., & Kimamo, G., (2011). Effects of cooperative learning approach on biology mean achievement scores of secondary school students' in Machakos District, Kenya. *Educational Research and Reviews*. Vol. 6 (12), 726-745.

Myer, David, G. (2008*). Exploring Psychology*. New York, New York: Worth, P. 163.

Neil, J. (2006). *Experiential Learning & Experiential Education:* Philosophy, theory, practice and resources.

Nilson, L. B. (2007). *Teaching at Its Best. A Research-Based Resourse for College Instructors*. San Francisco: John Wiley and Sons.

Ngaruiya, G. Kimaru, J. & Mburu, P. (2003). *Longhorn secondary chemistry form 2.* Longhorn publishers; Nairobi, Kenya.

Njoku, Z. C. (2005). Level of Chemistry Practical Science Skills Acquired by Senior Secondary School (SSII) Students. *Nigeria Journal of Professional Teachers*, 2 (2).

Nneji, N.G. (1997). *Understanding teaching and evaluation skill acquisition*. Teachers Education Review, 1, 47-51. Northern Illinous University, Faculty Development and Instructional Design Centre.

Novak, J.D., & Gowin, D.B. (1984). *Learning how to learn.* Newyork: Cambridge University Press.

Obamanu, B.J. & Ekenobi, T.N. (2011). Analysis of learning outcomes in chemistry among SSII Students in urban and rural setting using concept mapping techniques. *Journal of Educating and practise. 2(4), 148-154.*

O'Donnell A.M; Dansereau, D.F; & Hall, R.H.(2002). Knowledge maps as scaffolds for cognitive procesing . *Educational Psychological Review, 14, 71-86.*

Ogwe, J. C. A., Odhiambo, J. & Kibe, S. (2008). Impact of SMASSE on students capacity through improved teaching and learning in classrooms. Journal of Academia Education. 2,668.

Okebukola, P.A. (2007). Students' performance in practical Chemistry: A study of related factors. *Journal of Research in Science Teaching*. 24 (2) 119-126.

Oloyede, P. (2010). *Effects of class size and students attitude in academic Performance in chemistry.* Almadu Bello University : Zaria, Nigeria.

Oluwatosin, A., & Ongeci, A. (2014) self-concept and Academic performance of secondary school students in chemistry. *International journal of social sciences & Education*, 4(4), 2223-4934.

Omolade, B. (2008). Enhancing Academic Achievement and Retention in Senior Secondary School. *Files .eric.ed.gov*. [Retrieved 28th June 2016].

Oraro, W., (2006). *Effects of cooperative concept mapping teaching approach on students' achievement and motivation in secondary school biology*. A study of selected schools in Gucha District, Kenya.

Orodho, A. J. (1996). *Factors determining achievement in science subjects at secondary school level in Kenya.* Kenyatta Univesity, un published ph. D Thesis.

Ozay, E., Ocak, I. (2009). Sequential Teaching Methods in Biology and Their Effects in Academic Achievement. *Journal of Academic Education*, 2(2), 32-43.

Howie. S. J (2003). Language and other background factors affecting secondary pupils' performance in mathematics in South Africa. *African Journal Research in Mathematics, Science and Technology Education.* 7. 1-20.

Pastorino, E.E. & Doyle-Portillo, S.M. (2013). *What is psychology*? Essentials. Belmont, C.A: Wadsworth.

Piaget, J., (1965). *The moral judgement of a child*. London: Free Pr.

Popham, W. J. (1990*). Modern educational measurement: A practitioner's perspective* (2nd ed. Pp.120-145). Englewood Cliffs, NJ; Prentice-Hall Inc. Retrieved on 14th April 2016.

Popoola, B.I. (2003). *Personality characteristics, Socio-demographic variables and work attitudes as correlates of counselling effectiveness in South Western Nigeria*. Un published Ph.D Thesis: Obafemi, Awolowo University, Ile-Ife, Nigeria.

Prawat, R. (1991). "Embedded Thinking Skill Instruction in subject matter instruction: In A. Costa (ed.). *Development minds* (vol. 1), pp. 185-186. Alexandria VI: Association of Supervision and Curriculum Development.

Reddy, Y.S .R (2004). *TIMSS media briefing*. Human Science Research Council, 14th December, Pretoria.

Robinson, D.H. (1998). Graphic Organizers as aids to text learning. *Reading Research and Instruction , 37,85-105.*

Robinson, D.H; & Kiewra K.A.(1995). Visual Argument : Graphic Organizers are Superior to Outlines in Improving Learning from text. *Journal of Educational Psychology*, 87,455-467.

Robinson, D.H. (1998). Graphic Organizers as well aids to text learning. *Reading Research and Instruction.* 37,85-105.

Rogers, C. & Freiberg, H. J. (1994*). Freedom to Learn* 3rd ed. Columbia, Ohio.

Rono, K.P; Wachanga, S.W & Keraro, F.N. (2014). Effects of computer based mastery learning approach on students' motivation to learn Chemistry. *Journal of Education and Practice*, 32.

Saage, O. (2009). *Causes of Mass Failures in Mathematics Examination among students a Commissioned paper presented at Government Secondary School.* Karu, Nigeria.

Sanchez, F. J. P. and Roda, M. D. S. (2005). Relationship Between Sel-Concept and Academic Achievement in Primary Students. *Electronic Journal of Research in Educational Psychology and Psychopedagogy*, 1910, 95 – 120.

Satchwell, R. E. (1996). Using functional flow diagrams to enhance technical systems understanding. *Journal of Industrial Teacher* Education, 34(2), 50-81.

Shavelson, R.J., Hubner, J.J. & Stranton, G.C. (1976). Validation of construct interpretations. *Review of Educational Research*, 46: 407-441.

Sharelson, R.J., & Bolus, R. (1987). Self-concept. The interplay of theory & methods. *Journal of Education Psychology*, 79, 3-17.

Smith, C. G. (2010*). The Project method in Biology. School Science and Mathematics*, 35: 83-88. John Wiley & Sons, Inc.

Sola, A. O. & Ojo, O. E. (2007*). Effects of Project, Inquiry and Lecture Demonstration Teaching Methods on Senior Secondary School Students' Achievement in separation of Mixtures Practical test. Educational Research and Review* Vol. 2(6), 124-132.

Stein, K. F. (1994). Complexity of the self-schema and responses to disconfirming feedback. *Journal of cognitive Research and Therapy*, 18, 101 – 178.

Stull, A.T & Mayer. (2007). Learning by Doing Versus Learning by Viewing : Three Experimental Comparisons of Learner-Generated Versus Author-provided Graphic Organizers. *Journal of Education psychology 2007*, 99(4), 808-820.

Tabachnich, B.G. & Fidel ,L.S. (2007). *Using Multivariate Statistics* (5th ed.). New York: Harper Collins.

Taber, K. S. (2006). Beyond Constructivism: the Progressive research programme into learning science. *Studies in Science Education*, 42, pp 125-184.

Tajfel, H.& Turnes, J.C. (1986)). The social identity theory of inter-group behaviour.Ins. Worchel & W. Austin (Eds), *psychology of intergroup relations.* Chicago : Nelson-Hall.

Taylor and Francis Group (2011). The Role of Theory in the Study of Peer Collaboration. *The Journal of Experimental Education,* 69(1) 113-127.

Thomas, J. W. (2000*). A review of research on project-based learning*. www.bobpearlman.org [Retrieved 5th March 2015].

Twoli, N. W. (1986*). Sex differences achievement among secondary school students in Kenya*. Flinders Univesity, South Australia, un published ph. D Thesis.

UNESCO (2004). *Gender and education for all.* Summary reports (pp 15). Paris: UNESCO.

Umudhe, S.E. (1998). *Science teaching methods in Nigeria. In P.O. Itedjere (Ed.) Current issues in Nigerain Education* System. Benin, Osasu Publishers.

Vella, F., (1992). Medical education: Capitalizing on the lecture method. *FASEB Journal*, 6(3): 811-812.

Wachanga, S. W., Arimba, A. M. & Mbugua, K. Z. (2013). Effects of advanced organizers teaching approach on secondary school students' achievement in chemistry in Maara District, Kenya. Interntinal *Journal of Science and Interdisplinary Research*, JSSIR, 2 (6).

Wachanga, S.W. (2002). *Effects of cooperative class experiment on students' motivation and achievement in chemistry*. Unpublished Ph.D Thesis, Egerton University, Njoro.

Wachanga, S.W & Mwangi, J.G (2004). Effects of cooperative class experiment teaching method on secondary school students' chemistry achievement in Kenya's Nakuru District. *International Education Journal*, 5 (1): 26-36.

Wambugu, P. W. (2011). *Effects of experiential cooperative concept mapping instructional approach on secondary school students' achievement and motivation in physics in Nyeri County, Kenya.* Ph.D Thesis. Egerton University.

Weighmmann D; Danserau, D; Mccagg, E; Rewey, K. & Pitre, U. (1992). Effects of Knowledge Map Characteristics on Information Processing. *Contemporary Education Psychology*, 17,136-155.

Wells, G. & Mejia – Arauz, R. (2006). Dialogue in the classroom. *Journal of the Learning Science, 15 (3), 379-428.*

West, C.K, Fanner, J.A, & Wolff, P.M (1991,) *Instructional design –Implications from cognitive science*, Englewood Cliffs, NJ: Prentice Hall.

Wiersma, W. & Jurs, S.G. (2009). *Research methods in education. An introduction, (8th ed.)* Boston: Pearson.

Wurdinger, S.D., & Carlson, J.A. (2010). *Teaching for experiential learning: Five approaches that work*. Lanham, MD: Rowman & Littlefield Education.

www.bbc.co.uk, Chemical Structures. [Retrieved on 5th January 2016].

Yewande, R.O. (2000). *The effect of problem solving technique on students' achievement in chemistry.* University of Ibadan Education and Information Studies Abstract 2000-2004.

Yuksel, M. & Geban, O. (2014). A Study of the Prediction of Academic Achievement in the Chemistry Course. *Journal of Education Science, 39 (173) 354-365.*

Zadra, E. (2000). Learning as a gate way to the 21st century. *International Institute for Educational Planning Newsletter*, 18 (2), 14.

APPENDICES

APPENDIX A: Chemistry Achievement Test (CAT)

School Code…………………………………………………………..

Admission Number………………………………………………...

Gender……………………………………………………………..

INSTRUCTIONS

Please answer ALL questions to the best of your ability.

Read the questions carefully and ensure you have understood it before writing your answer.

Write the answers in the spaces provided.

1. Define the term structure (2mks)
2. Name four types of bonds (4mks)
3. What is an ionic bond? (2mks)

   b) Draw the structure of Magnesium chloride ($MgCl_2$) (2mks)
4. Differentiate between covalent bond and co-ordinate bond (2mks)
5. Using dot (.) and (x) diagrams draw the structure of the following molecules.
   a) Water (H_2O) (2mks)
   b) Ammonia (NH_3) (2mks)
   c) Ammonia ion (NH_4^+) (2mks)
6. Molten magnesium chloride conducts electricity whereas solid magnesium chloride does not. Explain (2mks)
7. State and illustrate the bond type in each of the following compounds a)Calcium fluoride (CaF_2)

   b) Methane (CH_4)
   c) Carbon (II) oxide
   d) Sodium metal (8mks)
8. State three properties of ionic compounds (3mks)
9. Explain why molecules substances are poor conductors of electricity? (2mks)
10. Both graphite and diamond are allotropes of carbon. Graphite conducts electricity whereas diamond does not. Explain. (2mks)

11. In terms of structure and bonding, explain why water (H_2O) is a liquid at room temperature while hydrogen sulphide (H_2S) is gas (2mks)

12. Both sodium and aluminium are in the same period of the periodic table. The melting points of the metals are 97.8ºC and 660ºC respectively. (Na = 11, Al = 13)
    (i) Write the electron arrangement of sodium and Aluminium (2mks)
    (ii) Why is the melting point of Aluminium much higher than that of sodium? (2mks)

13. With reference to chlorine gas
    (i) Explain why most covalent compounds are gaseous at room temperature (2mks)
    (ii) Why do Silicon (IV) oxide, diamond and graphite exist as solid at room temperature while chlorine exists as a gas? (2mks)

14. An atom of element X has 15 protons and mass number 31 in its nucleus while an atom of element Y has 17 protons and a mass number of 35.
    (i) Write the electron arrangement of X? (1mk)
    (ii) Calculate the number of neutrons in element Y (1mk)
    (iii) Write the formula of the compound formed between element X and Y (1mk)
    (iv) What type of bond exists when X and Y combine? (1mk)

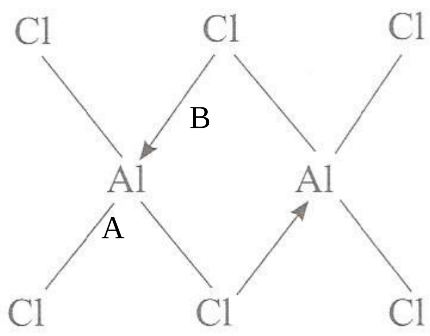
15. Name the type of bonds between the atoms/ions in the following substances. Use the table below. (5mks)

Substance	Type of Bond
Aluminium chloride vapours	
Magnesium chloride	
Calcium	
Liquid water	
Ammonia gas	

16. Explain the following
    a) Melting point increases from Sodium to aluminium in the third period of the periodic table. (2mks)
    b) Atomic radius decreases across the period of the periodic table. (2mks)

c) Explain why graphite is soft whereas diamond is the hardest natural substance known. (2mks)

17. Below is a structure of Aluminium chloride.



a) Identify the bonds labeled A & B (2mks)

A ………………………….

B ………………………….

b) Aluminium chloride sublimes. Explain why it is possible? (2mks)

c) When Aluminium chloride is dissolved in water the resulting solution has a pH of 3.0, Explain. (2mks)

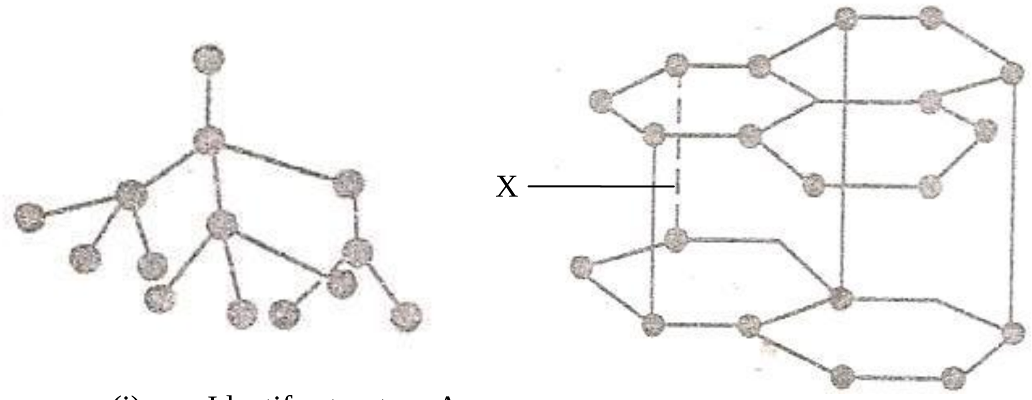
18. State two differences between molecules and giant atomic (giant covalent) structures (4mks)

Molecular Structures	Giant Atomic Structures
(i)	
(ii)	

19. The diagrams below show the structures of two allotropes of carbon.

(3mks)

A B



(i) Identify structure A ……………………………..

B ……………………………..

(ii) Identify X ……………………………...

(iii) State two properties of A and two properties of A and B in relation to the structures. (4mks)

20. Using iodine molecules, distinguish between van der waals forces and covalent bonds. (3mks)

APPENDIX B: Students Chemistry Self Concept Questionnaire

School Code……………......
Gender………………………
Adm. No……………………..

INSTRUCTIONS

The information to be given in this questionnaire will be totally confidential

II, Here are some statements that tell how people feel about themselves. Listen to each statement carefully & decide whether or not it describes the way you feel about yourself.

III Select one of the five responses next to each statements and show how exactly the extent to which you agree with the statement. Make sure the responses you have chosen describes the way you feel about yourself. If you strongly agree choose the letter SA, if you agree choose the letter A, if you are undecided or uncertain choose chose letter U, if you disagree chose letter D if you strongly disagree choose letter SD. Respond to every statement even if someone had to decide. Choose only one response for each statement; remember there are no rights or wrong answers. It is only you who tell how you feel about chemistry so I hope you will respond the way you really feel inside yourself about the subject.

Strongly agree	SA
Agree	A
Undecided	UD
Disagree	D
Strongly disagree	SD

	SA	A	UD	D	SD
1. I have always done well in Chemistry					
2. Chemistry assignments are not important					
3. I succeed in Chemistry learning through my effort					
4. Chemistry is one of my best subjects					
5. I often need help in chemistry					
6. I expect to be able to solve Chemistry questions anywhere I come across them if they are of my level of education					
7. Learning Chemistry is in itself rewarding					
8. Chemistry assignments are useful					
9. I am not sure whether there is need for me to continue learning Chemistry					
10. I would like a career that rarely requires Chemistry					
11. I am able to work independently in Chemistry exercises in an outside Chemistry classroom					
12. I find Chemistry assignments and tests easy to do					
13. I expect to get high scores in Chemistry tests					
14. Chemistry assignments are important					
15. Chemistry is frustrating to students					
16. I am rarely prepared when the Chemistry teacher comes in for the lesson					
17. I am a students who gets encouraged when the teacher uses GOETA method					
18. I seem to understand better that Chemistry will give me opportunities for personal advancement					
19. I seem to enjoy the study of Structure and Bonding					
20. I aspire to study Chemistry after KCSE					
21. I seem to love learning Chemistry					
22. I always prepare for the Chemistry lesson before the teacher comes in					
23. I seem to have confidence in the subject					
24. Learning Chemistry seems to be itself rewarding to me as a student					
25. I find it difficult to complete Chemistry assignments and tests on time					

26. I would never want to take advanced courses in Chemistry					
27. I am likely to succeed in Chemistry					
28. I look forward to Chemistry lessons					
29. I have trouble understanding anything in Chemistry					
30. I easily reason from one step to another as required when working out Chemistry questions					
31. I enjoy studying for Chemistry					
32. I get lost in the step by step reasoning which is required when working Chemistry problems					
33. I am successful in Chemistry due to my own in-born ability					
34. I rarely expect to be able to apply Chemistry in life situations					
35. I perform badly in Chemistry tests					
36. Learning Chemistry is frustrating					
37. I rarely expect to do well in Chemistry related subjects					
38. I rarely expect to be successful in Chemistry tasks given by teachers in Chemistry classrooms					
39. Learning Chemistry gives me opportunities for personal advancement					
40. I get good marks in Chemistry					
41. Praise hardly induces me to perform better in Chemistry					
42. I practice solving chemistry problems on my own during holidays					
43. The hours that I spend doing Chemistry are the ones I enjoy most					
44. I have a positive attitude towards Chemistry					
45. I am easily discouraged when I fail in Chemistry tests					

SOURCE; Adapted from Marilyn (2005).

APPENDIX C: Teaching module to Planning and Implementing Graphic Organizers Experiential Teaching Approach

The purpose of this guide is to assist the teacher of chemistry to plan and implement a teaching-learning programme based on graphic organizers experiential teaching approach. GOETA is a method of teaching where the learners will use graphic organizers and get involved in the experience of learning.

Instructional objectives are developed for the topic and at the end of the topic the learners will be tested to determine if the learners have acquired the concepts. The teachers will provide graphic organizers or the learners can construct their own graphic organizers and use them to learn by experiencing.

The guide will be organized into the following sections.

1.0 Instructional Objectives

These are statements that describe what learners will be able to do after completing a prescribed unit of instruction.

The objectives are already stated in KCSE chemistry syllabus. The teachers are encouraged to go through these objectives carefully to be guided to the teaching, learning process.

2.0 The teachers should be able to construct graphic organizers for the different types of structures, for example and ionic bond, covalent bond , coordinate bond, metallic bond and hydrogen bond help learners understand how to use the graphic organizers and use them in active involvement in introduction of Chemistry concepts.

3.0 Ask the students to construct their own graphic organizers that they use in learning by experiencing.

4.0 Construct graphic organizers on different types of structures like giant ionic structures, giant metallic structures, giant atomic structures and molecular structures.

5.0 Ask the students to list the differences between ionic structures and metallic structures by use of the graphic organizers the teacher provided or those constructed by the students.

6.0 The teacher should introduce to the learners the different types of graphic organizers to be used in the study of the topic using GOETA.

They include concept maps, knowledge maps, hierarchical diagrams, flow charts and visual aids.

7.0 Ask the students to make a spatial arrangement of words or word groups intended to represent the conceptual organization of text.

8.0 The teacher should guide the students to use the graphic organizers in experiential learning by using David Kolb’s Experiential Learning Model composed of four elements.

i. Active experimentation
ii. Concrete experience
iii. Observation of and reflection on that experience
iv. Formation of abstract concepts based upon the reflection

APPENDIX D: Teaching module on Structure and Bonding

OBJECTIVES

After covering the topic, students should be able to:-

a) State the significance of valence electrons in structure and bonding.
b) Explain qualitatively the formation of ionic, covalent and metallic bonds.
c) Diagrammatically illustrate ionic, dative, hydrogen bonds and Van der Waals forces.
d) Predict the bond type and structure of a given substance from its physical properties.
e) Explain the changes in bond type across period 3.
f) Select materials for use based on bond types and structure.
g) Predict the properties of a given substance on the basis of the bonds present.
h) Students should be divided into groups when using the provided graphic organizers or when constructing their own. Each group should construct a graphic organizer and the teacher to guide them on the GOETA approach.

   The teacher should mark the graphic organizers and give the scores to the group.

WEEK ONE

Lessons 1 & 2: Ionic bond (80 minutes)

The following are stressed by use of method; GOETA-presentation of graphic organizers (20 minutes)

Students to construct their graphic organizers in groups of ionic bonds (30 minutes)

Presentation of graphic organizers by different groups on ionic bonds by class discussion (30 minutes)

The following points should be stressed in the discussion

a) Definition of ionic bond
b) Examples of ionic bonds formed between metallic and non-metallic elements.
c) Electron transfer in ionic bonding
d) Draw a dot and a cross diagrams of examples of ionic bonds.

Group graphic organizers and experiential learning (20 minutes)

Students to move to their allocated groups to construct graphic organizers on the content already covered.

Students to identify important graphic organizers in the content and use them in group discussions.

Construction of graphic organizers in groups (30 minutes)

Teacher to move around the groups to ensure that all students participate actively in the group.

Presentation and discussion of graphic organizers (30 minutes)

One member of each group to present the graphic organizer drawn by the group to the whole class. The class to discuss about the graphic organizer guided by the teacher.

The teacher to make concluding remarks about various graphic organizers presented.

Home work

Students to draw graphic organizers on their own on the content covered

WEEK ONE

Lesson 3: (40 minutes)

Lesson Topic: Giant ionic structures

Method: Class discussion (15 minutes)

Group graphic organisers (10 minutes)

Presentation and discussion of the graphic organizers (15 minutes)

Class discussion (15 minutes)

The following points should be stressed during the discussion:-

a) Giant ionic structures
b) Solubility of ionic structures.
c) Explain why the melting and boiling points of ionic compounds are generally high.
d) Explain why ionic compounds conduct electricity in the molten state and in aqueous solution but in solid state.

WEEK TWO

Lessons 4 & 5 (80 minutes)

Lesson Topic: Covalent Bond

Method: Class discussion (30 minutes)

Class discussion (30 Minutes)

The following points are stressed in the discussion

a) Definition of covalent bond
b) Sharing of electrons in covalent bond
c) Give examples of covalent bonds formed between different elements.
d) Draw dot and cross diagrams of examples of covalent bonds.

Group graphic Organizers (20 minutes)

Students to move to their respective groups to construct graphic organizers on covalent bonds.

Presentation and discussion of the graphic organizers (30 minutes)

One student from each group to present their graphic organizers to the class for discussion.

Teacher to lead the discussion and make the concluding remarks.

Home work

Each student to draw cross and dot the diagrams of ammonia NH_3), Carbon (IV) oxide (CO_2), and water molecules (H_2O)

WEEK TWO

Lesson 6 (40 minutes)

Topic: Co-ordinate board

Method: Group graphic organizers presentation and discussion of graphic organizers.

Group graphic organizers (15 minutes)

Students to construct graphic organizers in groups on co-ordinate bond using dot and cross diagrams.

Teacher to move round to ensure all students are participating.

Presentation and discussion of the graphic organizers (25 minutes)

One student from each group to present their graphic organizer to the class: students to discuss the graphic organizer with the guidance of the teacher to make concluding remarks.

Home work

Individual students to draw the graphic organizers of carbon (ii) oxide (CO), Ammonium ion (NH_4^+) and Hydroxonium ion (H_3O^+) in their note books.

WEEK THREE

Lessons 7&8 (80 minutes)

Lesson Topic: Giant atomic structures

Method: Class Discussion (30 minutes)

Group graphic organizers (20 minutes)

Presentation of graphic Organizers for discussion (30 minutes)

Class discussion (30 minutes)

The following points are stressed during the discussion

a) Definition of giant atomic structures
b) The structure of diamond
c) The structure of graphite
d) The structure of silicon (iv) oxide
e) Solubility of giant atomic structures in water and in organic solvents
f) Melting and boiling points of giant atomic structures
g) Electrical conductivity of graphite and Diamond.

Group graphic organizers (20 minutes)

Students to move to their respective groups

Teachers to provide major graphic organizers of Diamond and graphite to the students. The students to draw and identify the differences between the structure of Diamond and graphite. The teacher to go round each group to monitor the progress.

Presentation of graphic organizer and discussion (30 minutes)

One student from each group to present their graphic organizers to the class for discussion with the help of the teacher. The teacher to give concluding remarks.

Home work

Each student to draw a graphic organizer of the structure of Diamond and graphite in their note books.

WEEK THREE

Lesson 9: (40 minutes)

Lesson Topic: Molecular structures

Method: Class discussion (15 minutes)

Group graphic organizers (10 minutes)

Presentation of graphic organizers and discussion (15 minutes)

Class discussion (15 minutes)

The following points are stressed during the discussion

a) Definition of molecular structures
b) Solubility of molecular structure in water
c) Melting and boiling points of molecular structures
d) Electrical conductivity of molecular structure
e) Define Hydrogen bond
f) Differentiate between Week van der waals forcers and Hydrogen bond

Group graphic organizers (10 minutes)

Students to move their respective groups to draw graphic organizers of molecular structures and Hydrogen bonds in their groups. The teacher to ensure that each student in the group participates actively.

Presentation of graphic organizers and discussion (15 minutes)

One student from each group to present their graphic organizers for the class to discuss them with the help of the teacher. The teacher to give concluding remarks.

Home work

Students to construct a concept map of the differences between giant atomic structures and molecular structures in their note books.

WEEK FOUR

Lessons 10& 11: (80 minutes)

Lesson Topic: Metallic Bond & Giant Metallic structures

Method: Class discussion (15 minutes)

Group graphic organizers (10 minutes)

Presentation of group organizers and discussion (15 minutes)

Class discussion (15 minutes)

The following points are stressed during the discussion:

a) Definition of metallic bond
b) Explain melting and boiling point of giant metallic structures
c) Atomic radii of metals

d) Electrical conductivity and valence electrons of metallic structures

Group graphic organizers (10 minutes)

Students to move to their respective groups.

Students to identify major graphic organizers in the metallic structure model and the properties of metallic structures.

Presentation of graphic organizers (15 minutes)

One student from each group to present their graphic organizers to the class for discussion with the help of the teacher. The teacher to give concluding remarks.

Home work

Each student to draw the graphic organizer of a model of the metallic structure.

Lessons 11 & 12: (80 minutes)

Method: Students arrange their seats for CAT test (10 minutes)

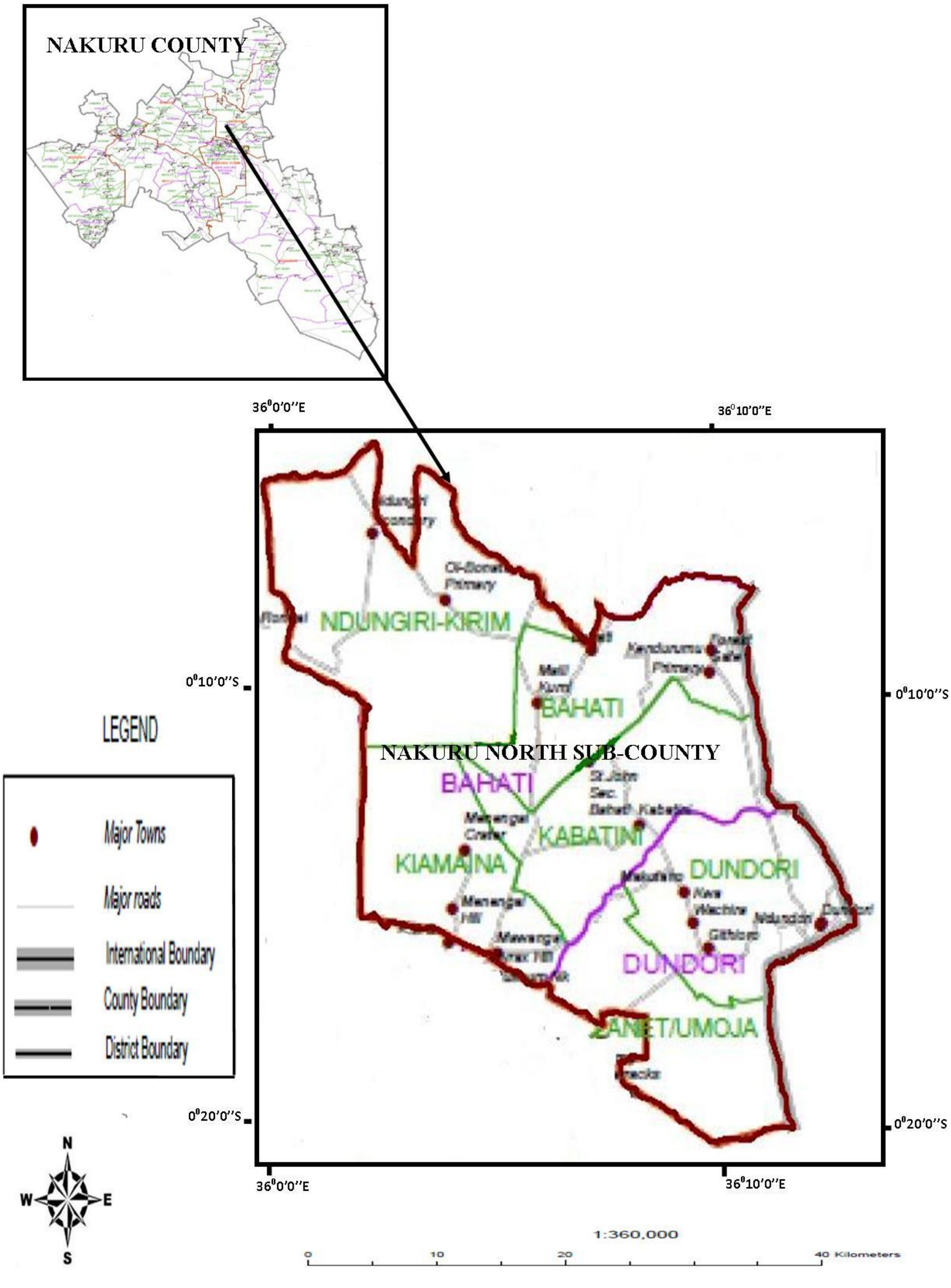
Students to give answers to CAT items (60 minutes)

Researcher / Teacher to collect test papers (10 minutes)

Chemistry Achievement Test (CAT) to be administered to the students by the researchers with the assistance of the Chemistry teacher. The teachers and the researcher to carry out close supervision to ensure that the students give their own answers to the questions.

The test to take one hour.

APPENDIX E: Map of Nakuru North Sub-County



Source: Map modified from Nakuru county integrated development Plan 2013 – 2017

APPENDIX F: Research Authorization

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email:dg@nacosti.go.ke
Website: www.nacosti.go.ke
when replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No.

NACOSTI/P/16/35012/14608

Date:

6th December, 2016

Kallen Kanini Chabari
Egerton University
P.O. Box 536-20115
EGERTON.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effects of graphic organizers experiential teaching approach on secondary school students' achievement and self concept in chemistry in Nakuru North Sub-County, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Nakuru County** for the period ending **6th December, 2017.**

You are advised to report to **the County Commissioner and the County Director of Education, Nakuru County** before embarking on the research project.

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

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nakuru County.

The County Director of Education
Nakuru County.

APPENDIX G: Research Permit

CONDITIONS

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

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEACH CLEARANCE PERMIT

Serial No.A 12191

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MS. KALLEN KANINI CHABARI
of EGERTON UNIVERSITY, 1238-20100
NAKURU,has been permitted to conduct research in *Nakuru County*

on the topic: *EFFECTS OF GRAPHIC ORGANIZERS EXPERIENTIAL TEACHING APPROACH ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND SELF CONCEPT IN CHEMISTRY IN NAKURU NORTH SUB-COUNTY, KENYA*

for the period ending:
6th December,2017

Permit No : NACOSTI/P/16/35012/14608
Date Of Issue : 6th December,2016
Fee Recieved :Ksh 1000

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation