EFFECTS OF COOPERATIVE E-LEARNING AND CONVENTIONAL TEACHING APPROACHES ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND ATTITUDE TOWARDS CHEMISTRY IN KOIBATEK SUB-COUNTY, KENYA

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A Thesis Submitted to the Graduate School in Partial Fulfilment of the Requirements for the Degree of Doctor of Philosophy in Science Education of Egerton University

EGERTON UNIVERSITY

NOVEMBER, 2019

DECLARATION AND RECOMMENDATION

Declaration

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

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DEDICATION

This work is dedicated to my family, my late husband Peter and dear daughters Esther and Sarah for their patience, encouragement and forbearance.

ACKNOWLEDGEMENTS

I thank God for His favour, mercy and grace for all it took to accomplish the study. I am grateful to the Faculty of Education and Egerton University for offering me the opportunity to study this program. I also amply thank my supervisors, Prof. S.W. Wachanga and Dr. Z.O. Anditi for the support they accorded me through the preparation and writing of this thesis. They always had time and patience for discussion on various aspects of the study and continuously encouraged me.

I am grateful to the National Commission for Science Technology and Innovation (NACOSTI) for granting me permission to carry out the study. I also thank the Teachers Service Commission for granting me study leave to work on my studies. I owe my gratitude also to the county and sub-county education offices for granting me permission to do my research in their schools in Baringo County.

I owe a special debt of gratitude to all school head teachers who allowed me to carry out the study in their schools as well as the students and teachers who participated in the study. I cannot forget to register my thanks to Mr. Ogolla of the Department of Curriculum, Instruction and Educational Management of Egerton University for his assistance in data analysis and interpretation. Thanks to all members of the Department of Curriculum Instruction and Educational Management for various forms of assistance they accorded me during the whole period of the study.

Lastly, I am indebted to my family and friends for their moral support and encouragement. To many others who assisted in one way or the other to make this work successful, I say thank you so much and may God bless you abundantly.

ABSTRACT

The study of Chemistry at secondary school level help students in developing basic scientific skills, knowledge and competence required in problem solving in their environment. However, this might not be achieved unless teachers employ effective methods of techniques during instruction. Performance of students in Chemistry in Kenya at the Kenya Certificate of Secondary Education (KCSE) examinations is poor. The poor performance may be partly attributed to teaching methods used by teachers and students' negative attitude towards the subject. Therefore, this study was designed to investigate the effect of Cooperative E-learning Approach (CELA) on students' achievement and attitude towards Chemistry. The study was carried out in Koibatek sub-county Kenya where a persistent low achievement in the subject has been registered. The study focussed on the mole concept topic in Form three Chemistry syllabus. Solomon Four Non-equivalent Control Group Design was employed in the study. Twelve county schools were purposively selected from the 40 secondary schools in the sub-county and randomly assigned to Experimental Group one (E1), Experimental Group two (E2), Control Group one (C1) and Control Group two (C2). Data was collected from a sample of 489 Form three students two instruments namely, Chemistry Achievement Test (CAT) and Student Attitude Questionnaire (SAQ) were used for data collection. The instruments were pilot-tested in two secondary schools in the county which were not part of the study, but had similar characteristics as the sample schools. This was to estimate the reliability and validity of the instruments. CAT had a reliability of 0.87 while SAQ had 0.78. Two groups the Experimental Group (E1) and Control Group (C1) were pre-tested whereas Experimental Group (E2) and Control Group (C2) were not pre-tested. All groups were taught the same course content for a period of five weeks with the experimental groups receiving their instruments by use of CELA approach and control groups using conventional methods. A post-test CAT and SAQ were administered to all groups after the treatment. Both descriptive and inferential statistics were used to analyse the data using the Statistical Package for Social Sciences (SPSS). One way ANOVA, ANCOVA and t-test were used in data analysis. Hypotheses of the study were tested at $\alpha=0.05$ level of significance. The finding of the study indicated that students in the experimental groups outperformed the control groups in achievement and in attitude towards Chemistry. Also the study found that gender factor did not affect the achievement and attitude of students towards Chemistry when CELA was used in teaching. School type did not affect the achievement of students in Chemistry. It is therefore recommended that, Chemistry teachers incorporate this method in teaching in secondary school level especially in the topic "The Mole". Government education agencies and other education stakeholders should organize teachers' workshops on the use of CELA strategy to enhance better performance. Teacher education programme in Kenya in Tertiary institutions should be improved to prepare teachers who can apply innovative approaches such as CELA which promotes effective teaching and learning. This could be achieved by practical demonstration of CELA in the classrooms during microteaching and teaching practice exercises.

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LIST OF ABBREVIATIONS AND ACRONYMS

AAAS	American Association for Advancement of Science
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
CAL	Computer Assisted Learning
CBL	Computer Based Learning
CCE	Cooperative Class Experiment
CD –ROM	Compact Disc Read Only Memory
CELA	Cooperative E-learning Approach
CL	Computer Learning
DVD	Digital Versatile Disc
GOK	Government of Kenya
H.O.D	Head of Department
ICT	Information and Communication Technology
KCSE	Kenya Certificate of Secondary Education
KICD	Kenya Institute of Curriculum Development
KIE	Kenya Institute of Education
KNEC	Kenya National Examinations Council
LAN	Local Area Network
MOEST	Ministry of Education, Science and Technology
MOHEST	Ministry of Higher Education Science and Technology
NACOSTI	National Commission for Science, Technology and Innovation
NEPAD	New Partnership for Africa's Development
OWL	Online Web Learners
SAQ	Students Attitude Questionnaire
SPSS	Statistical Package for Social Science
SSP	School Science Project
STAD	Student Teams Achievement Division
TGT	Team Games Tournament
UK	United Kingdom
UNESCO	United Nations Educational Scientific and Cultural Organization
USA	United States of America
WAN	Wide Area Network

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The word "Science" originated from the Latin word "Scientia" meaning knowledge (Hani, 2009). Science involves logical reasoning, experiments and approximations to discover the absolute truth. The role of science education in the lives of individuals and in the advancement of science and technology for the development of mankind and society in general is very crucial. Oludipe and Awokoya (2010) argued that scientific literacy is the gateway to achieve scientific and technological advancement through science education. The steps the scientist takes during scientific investigation (science process) and scientific products draw the attention of society to the fact that science makes life comfortable.

Knowledge of science and technology is therefore a requirement in all countries and all people globally, due to its ability to address the many challenges that are facing them. These challenges include emergencies of new drug resistant diseases, effect of genetic experimentation and engineering, ecological impact of modern technology and global warming (Alsop & Hicks, 2001). The integration of technology in teaching is still challenging for most teachers, even though there has been availability of technology tools in school. Teachers have not incorporated technology in their teaching for various reasons, such as lack of knowledge of technology, time and support. Use of learning technologies in science classroom has shown to increase students, attention, engagement and interest in science (Van Lehn, Graesser, Jackson, Jorden, Olney, & Rose, (2007).

Dani and Koenig (2008) noted that the use of technology has positive influence of a wide variety of student learning outcomes, including understanding of science concepts and the development of scientific reasoning skills. The best example of integration of science and technology is the Computer Based Instruction (CBI) techniques. CBI is the use of computers in teaching and learning activities (Brophy, 1999; Kiboss & Ogunniy, 2005). CBI enables the students to learn by self-evaluating and reflection on their learning process. Learners become active in the learning process in construction of knowledge and development of problem solving skills (Ozmen, 2008). Ozmen noted that advancement in technology has made it possible to integrate computers into teaching of science. Emphasis on teaching and learning should be on providing learners with the opportunities for problem solving. This they believe should include cooperative learning methods where it may not necessarily require additional special training in the part of users.

Chemistry is a branch of science that deals with the structure and composition of matter and the changes that matter undergoes under different conditions (Chang, 1998). The earliest record of mankind's interest in chemistry was approximately 3,000 BC in the fertile crescent of Egypt. At that time chemistry was considered more of an art than science. Tablet records indicate that the first known chemists as women who manufactured perfumes from various substances. By 1000 BC chemical arts included smelting of metals and making drugs, dyes and bronze. Many groups contributed to these developments, among them were ancient Egyptians, Greeks, Hebrews, Chinese and Indians (Durrant, 1980).

Chemistry has been included in secondary school curriculum for many reasons; Chemistry knowledge has been used to solve problems affecting the communities. For example, world population problems can be discussed in the light of Chemistry contribution to improved agriculture technique as well as chemical contraceptive for population control. The teaching of chemistry develops interest in learners to pursue scientific activities within and outside the school for example, read scientific literature, organise scientific clubs, apply chemistry knowledge in activities (Wachanga, 2005).

Chemistry can also foster scientific activities in learners. Learners can have deeper understanding about the relationships among science technology and society. They can learn basic skills and methods involved in chemical experiments via investigative activities. In this learners can recognise important role played by experiment in chemistry research and learning. Learners can also be knowledgeable about properties of common chemical substances in daily lives. To learn to investigate chemical phenomenal and appreciate the roles chemistry has played in improving the quality of human lives. To be conscious of using chemicals in a reasonable way and be able to solve problems by use of chemical knowledge (Wang & Wang, 2004).

Chemistry is a very important subject, although students have difficulties studying it. According to Sirham (2007) Chemistry is often regarded as a difficult subject which sometimes repels learners from continuing with studies. There are a number of difficult concepts in Chemistry such as balancing of chemical equations, redox reactions, nomenclature of hydrocarbons, mole concepts and others that pose challenges to student's progress as they study the subject. The knowledge of Chemistry is greatly needed in all chemical industries in both developed and developing countries, nonetheless many students continue to drop the subject as they progress with their studies (Yaayin, 2018). Regarding the difficult concepts in Chemistry, the mole concept in particular is still a difficult area in Chemistry for learners who do not fully understand. They experienced difficulties in understanding subsequent topics, such as stoichiometry, chemical equilibrium, acids and bases (Musa, 2009).

In science, most of the concept are interlinked and built on one another. To study one concept effectively, the foundation of another concept should have been laid for that to be possible. If a learner fail to understand certain basic or fundamental concepts in a given subject area in science, he/she would encounter difficulties in understanding subsequent concepts in the same subject area.

Brown, Lemay, Bursen and Murphy (2009) cited in Yaayin (2018) define a mole as objects (atoms, molecules, or whatever objects we are considering) as the number of atoms in exactly 12g of isotopically pure ^{12}C. This very definition of the mole as a concept is difficult for many students to understand. The terms used in the definition create confusion for some students, thus making it difficult for them to fully comprehend the mole concept.

According to Dahsah and Coll (2007), the term carbon -12 atoms causes some confusion among students owing to the fact that the numerical value (12) of the mass of carbon atoms looks identical to the value of its molar mass. Another scenario of the mole that confuses students is that this very mole is termed as a concept because its definition talks about the amount of matter. It is also referred to as a unit of measurement because in calculation there can be an expression like “Osomole”. It is also expressed as a number such that one mole is equivalent to the Avogadro’s number (6.02×10^{23}). Student’s low achievement in the mole concept has a bearing on the confusion they face with the concept. The mole concept is an area that very few students like and succeed at and which most students hate and struggle with because they find mathematics difficult (Polancos, 2009). This situation has made researchers to try and find out teaching interventions that can improve student’s achievement in the mole (Yaayin, 2018). The common approach to teaching science including the mole concept has been the conventional methods. Hirca (2011) argues that in conventional science lessons, teachers teach and learners are left without understanding. This situation leaves many learners with no alternative to learning than rote learning where concepts are simply memorised without understanding. Studies reveals that the teaching method employed by a teacher reflects on students' understanding of the subject (Akinlaye, 1998). According to Njoku (2004), prominent among the contributing factor to student's persistent poor performance or under achievement in Chemistry include ineffective teaching methods or approaches used by science teachers to teach the subject. Teaching difficult concepts like the mole concept calls for a teachings strategy or approach that is learner centred and innovative enough to facilitate learner's interest.

According to Chiu (2008), cooperative learning appears to be the most innovative instructional method which promotes learner centre. Hence there is need to adopt innovative teaching and learning strategies of the 21st century. Among this, is cooperative learning combined with E-learning strategy.

Cooperative learning is an approach of organizing classroom activities into academic and social learning experience. Students work in groups to complete a task collectively. Learners cooperatively rely on one another for information, evaluating one another ideas, monitoring one another's work. Teacher's role is to facilitate the learning. Each member of the team is responsible, not only to learning what is taught but also for helping teammates to learn, thus creating an atmosphere of achievement (Ronsin, 2000).

There are several cooperative learning strategies. The following strategies have been well researched and found to be effective.

(i) Group Investigatory (GI)
(ii) Learning Together (LT)
(iii) Jigsaw Procedures (JP)
(iv) Standard Teams Achievement Team (STAD)
(v) Teams Games Tournament (TGT)
(vi) Teams Assistant Instructions (TAI)

In this study, Student Teams Achievement Divisions (STAD) was used. Students were assigned to (4-5) member learning teams that were mixed in achievement and gender. The computers presented lessons and students work within their teams, and made sure that all team members had mastered the lessons. Finally, all students took individual quiz and group quizzes on the material. During the individual quiz they were not allowed to help one another but worked together to produce an answer sheet during group quiz. Student's scores were summed to form a team scores. The team that met certain criterion earned rewards, examples pens, exercise books (Gambari, 2010).

E-learning is a learning process created by interaction with digitally delivered content, network-based services and tutoring support. E-learning is any technically mediated learning using computers whether from a distance or in face to face classrooms setting (Computer-assisted learning).

Computer assisted instruction, distance learning uses information technologies to deliver instruction to learners who are at remote locations from a central site. Computer assisted instruction (also called computer-based learning or computer based training) uses computer to aid in the delivering of stand-alone multimedia packages for learning and teaching (Markus, 2005).

Other modes of E-learning are:-

(i) Web-based training
(ii) Computer-based training
(iii) CD-ROM based learning
(iv) We binars
(v) Virtual classrooms
(vi) Learning (M-learning)
(vii) Video based learning
(viii) Custom E-learning

In this study, computer assisted learning was used in delivering the content. E-learners have demonstrated increased retention rates and better utilization of content, resulting in better achievement of knowledge skills and attitudes. Multimedia e-learning offers learners the flexibility to select from a large menu of media options to accommodate their diverse learning styles. It has become popular because of its potential for providing more flexible access to content and instruction at any time from any place (Means *et al.* 2009). It has increased the availability of learning experiences for learners who cannot or choose not to attend traditional face to face offerings. Also E-learning has enabled instructors to handle more students while maintaining learning outcome quality that is equivalent to that of comparable face to face instruction. It also helps in assembling and disseminating instructional content more cost-efficiently.

Studies has proven that computer supported STAD cooperative learning setting has been effective in promoting students' achievements, encouraging students interaction and developing their positive attitudes towards learning outcomes in various subjects (Yusuf & Afolabi, 2010). Yusuf et al. (2012) reported that students in cooperative computer assisted in instruction group showed remarkable post-test mean differences over their respective counterpart who learned the same concept through conventional methods.

Attitude may be defined as a predisposition to respond in a favorable or unfavorable manner with respect to given attitude object (Oskamp & Schultz, 2005). Attitude towards Chemistry is an essential factor in Chemistry learning. It is the students' disposition towards "like or dislike" of Chemistry. Attitude in science means scientific approach assumed by an individual for solving problems, assessing ideas and making decisions. Students' beliefs and attitudes have the potential to either facilitate or inhibit learning (Yara, 2009; Abulude, 2009). Adesoji (2008), argued that, a number of factors have been identified as related to students attitude to chemistry including teaching methods, teacher attitude, influence of parents, gender, age, cognitive styles of pupils, career interests, social views of science and scientific social implications of Chemistry and achievement.

This study aimed at integrating Cooperative Learning and E-learning in an effort to come up with a hybrid learning approach referred to as Cooperative E-learning Approach (CELA). Hence the study investigated the effects of CELA on student's achievement and attitude towards chemistry.

The Kenyan chemistry curriculum has undergone several changes in the contents taught at different levels owing to the various changes in the systems of education that has taken place. It aimed at having a child-centred investigatory approach of teaching. The current secondary school chemistry curriculum was released in 2002 and implemented in 2003 (KIE, 2002). Chemistry curriculum incorporates many abstract concepts which are central to further learning in both Chemistry and other sciences. The teaching of Chemistry develops interest in learners to pursue scientific activities within and outside the school. Despite the importance of Chemistry, students' achievement in the subject is still generally low. Table 1 shows the students' performance in Chemistry during the 10 years (2006-2015) at Kenya Certificate of Secondary Education.

Table 1
Students Performance in Chemistry Nationally from (2006-2015) in KCSE Chemistry Examinations.

YEAR	PAPER	CANDIDATURE	MAXIMUM	MEAN MARK	MEAN %	STANDARD DEVIATIONS
	1		80	20.79		14.95
	2		80	17.56		13.82
	3		40	11.48		5.00
2006	Overall	236,831	200	**49.82**	**24.91**	**32.00**
	1		80	19.67		15.26
	2		80	19.22		13.45
	3		40	11.87		4.95
2007	Overall	267,719	200	**50.78**	**25.39**	**31.00**
	1		80	18.28		14.78
	2		80	15.74		13.00
	3		40	11.46		5.45
2008	Overall	296,937	200	**45.48**	**22.74**	**31.78**
	1		80	12.49		9.50
	2		80	14.93		12.04
	3		40	10.86		4.55
2009	Overall	329,730	200	**38.23**	**19.15**	**24.53**
	1		80	18.78		14.40
	2		80	16.19		13.25
	3		40	14.87		5.60
2010	Overall	347,364	200	**49.79**	**24.9**	**31.57**
	1		80	18.43		14.86
	2		80	16.99		13.95
	3		40	11.91		6.30
2011	Overall	403,070	200	**47.31**	**23.65**	**33.51**
	1		80	22.36		14.17
	2		80	17.18		14.50
	3		40	16.34		6.73

2012	Overall	427,386	200	**55.86**	**27.95**	**34.10**
	1		80	16.68		13.89
	2		80	18.31		14.23
	3		40	14.67		5.68
2013	Overall	439.847	200	**49.00**	**24.83**	**32.10**
	1		80	25.44		15.79
	2		80	21.35		13.46
	3		40	17.57		6.19
2014	Overall	476,582	200	**64.31**	**32.16**	**35.63**
	1		80	26.83		15.78
	2		80	22.07		13.45
	3		40	20.37		7.15
2015	Overall	515,888	200	**68.71**	**34.35**	**33.29**

Source: KNEC (2006, 2016) KCSE examination reports

Chemistry is examined using three papers. Two papers; 1 and 2 test theory, where paper 3 tests the practical syllabus. Table 1 shows that, the candidature has been growing up every year. In regard to the performance of students, the percentage mean scores have been fluctuating between 19.5% and 34.35%. The performance is low. Percentage mean score is below average as observed from the years under review. Overall performance in chemistry went up from a mean of 23.6% in 2011 to 34.35% in 2015. The improvement in performance could be attributed to an improved quality of setting and more important to improved quality of marking. Examiners were able to award marks where candidate gave partially correct responses. In the past these partially correct responses were awarded zero marks. In 2007, Kenya Certificate of Secondary Education, it was noted that balancing of equations was not an easy task for an average student. It was recommended that enough practice be given in writing equations for different type of reactions (KNEC, 2008). In 2012, Kenya Certificate of Secondary Examinations, paper 1 Question (II), candidates were not able to calculate correctly the molecular mass of the compound hence could not determine correct molecular formula. The weakness could have been caused by lack of enough practice on questions dealing with Gay-Lussac's law and molar gas volume, topics in mole concept. In 2015 Kenya Certificate Secondary Examination, examiners noted that responses given by candidates indicated that practical approach was not used in teaching. Candidates also lacked mastery of knowledge and skills expected from preparation of gases (KNEC, 2016).

In the year under review, examiners further noted that students showed weaknesses in:

i) Identification of ions present in solutions

ii) Naming of salts

iii) Writing ionic equations

iv) Giving scientific description of some of the observations.

This showed lack of exposure of experimental processes. Chemistry being practical subject, should be approached through carefully planned experimental work. Also these weaknesses could have been caused by lack of enough practice on the topic of mole concept. This topic is important in both theory and practical papers. It was noted that, students were not able to apply their knowledge on mole concept in order to calculate the concentration of solutions (KNEC 2010). The topic "MOLE" is appropriate for this study, since the learners are taught the skills on how to solve problems in chemistry. The use of CELA might help learners understand the concepts in this topic "MOLE" and other topics in Chemistry. Hence, can help in improving the general performance in Chemistry in the KCSE examinations. Performance in Chemistry in KCSE by gender shows the same trend of poor performance. Mean percentages are below average. Generally male students performed better than their female counterparts in this subject for the years (2006-2015) as indicated in Table 2.

Table 2

Candidates Performance by Gender Nationally in the Years (2006-2015) KCSE Examination in Chemistry

GENDER / YEAR	FEMALE		MALE	
	No sat	**Mean %**	**No sat**	**Mean %**
2006	111,969	22.5	124.932	27.01
2007	123.078	22.65	144,923	27.69
2008	135,950	20.93	160,410	24.27
2009	149,755	17.6	179,167	20.4
2010	155,728	22.8	191,853	26.62
2011	179,645	21.47	223,462	25.42
2012	193,426	25.95	233,293	29.54
2013	200,735	23.08	239,206	26.03
2014	221,659	30.18	255,734	33.88
2015	240,857	32.64	275,034	35.86

Source: KNEC (2009, 2016) KCSE Examination Reports

Table 2, the following observations can be made:-

(i) There was an increase in the number of candidates taking the subject. This means the subject is quite popular in most schools.

(ii) There was the highest percentage mean scores in 2015; 32.64% for girls and 35.86% for boys. Percentages are still below average hence performance is low.

In Koibatek sub-county achievement in chemistry at KCSE is low. Similar trend of poor performance which is lower than national average is observed for the years under review.

Table 3

Performance in KCSE Chemistry Examination in Koibatek Sub-county Between 2004-2013

Year	**Entry**	**A to B+**	**B to C+**	**C to D+**	**D to E**	**X**	**Y**	**Sub-County Mean Grade**	**MAX Score**
2004	1210	34	152	405	614	5	0	4.2865	12
2005	1391	67	159	374	789	2	0	4.155	12
2006	1231	39	124	341	722	5	0	3.7914	12
2007	1423	60	197	365	798	3	0	4.1439	12
2008	1540	82	168	436	848	6	0	4.1358	12
2009	1856	45	187	534	1090	0	0	3.9186	12
2010	1233	51	145	341	690	6	0	4.0933	12
2013	1322	68	149	382	723	0	0	3.9743	12

Source: Koibatek Sub-County secondary school academic committee, 2013(pages 7,8,15 and 16)

Key
X – Absenteeism
Y- Irregularities

From Table 3 the following observations can be made,

(i) The sub-county mean score is very low and that there has been a drop for the eight years from 4.2865 to 3.9743.

(ii) The number of students who attained A to B were few compared to those who attained D to E. In the year 2010 for example, 51 candidates attained grade A to B+ while 690 attained grade D to E (KNEC, 2011).

From this result, student performance in chemistry in KCSE at Koibatek sub-county has been poor. Almost half of the candidates who sat for chemistry in KCSE for the years under review failed to attain the expected subject mastery level, which might lock them out of careers where chemistry is prerequisite subject. Generally, the student performance in chemistry is poor, partially because of the teaching methods used by the teachers. It is thought the incorporations of cooperative E-learning in teaching Chemistry lessons might help curb the problem of low achievements.

Comparison of student performance in Koibatek sub-county and other schools nationally was not possible because of the abolishment of ranking of schools by the ministry of education.

In this study, the topic to be covered is the "MOLE". This topic is often perceived to be difficult because of its abstract and theoretical concepts (Oloruntegbe & Odutuyi, 2003). Science process skills that require formal reasoning ability for solving the problems related to mole, converting the mass of an element or compound to the number of atoms or molecules present and applying the definition of mole as it relates to Avogadro's number of atoms or molecules and to the molar mass of an element or compound. This skill of problem solving is tested in the KCSE examinations in practical and theory papers. If learners master these concepts then their performance can be better.

1.2 Statement of the Problem

Chemistry is a central science that forms the foundation of many disciplines such as Biology, Physics, Medicine, Plant Science, Nuclear Chemistry, Engineering, Cosmetics and Environmental Science. The effective teaching and learning of Chemistry is crucial for the better performance of students at Kenya Certificate Secondary Examinations (KCSE). Conventional methods used in the Chemistry classrooms have proven to be ineffective in promoting students understanding of concepts leading to persistent failure of students in the subject in public examinations in the country and also in Koibatek sub-county. This makes it difficult for the students to qualify for competitive job market or to enroll for science related courses in the universities after secondary education. The Cooperative E-leaning Teaching approach may help address this problem of poor performance but its effect on achievement and attitude in chemistry was not known. Therefore there was need to investigate the effect of CELA on students' achievement and attitude towards Chemistry in Koibatek sub-county, Kenya.

1.3 Purpose of the Study

The purpose of the study was to determine the effects of Cooperative E-learning Approach (CELA) on students' achievement and their attitude towards Chemistry in Koibatek Sub-county, Kenya.

1.4 Objectives of the Study

To achieve the purpose of the study, the following objectives guided it.

(i) To compare the achievement in Chemistry between students taught through CELA and those taught through Conventional Teaching Methods (CTM).

(ii) To compare students' Attitude towards Chemistry between those taught through CELA and those taught through Conventional Teaching Methods (CTM).

(iii) To investigate whether gender affects achievement in Chemistry when students are taught through CELA.

(iv) To determine whether there is a gender difference in students' attitude towards chemistry when students are taught using CELA.

(v) To compare the achievement of boys in boys schools with that of boys in co-educational schools when CELA is used.

(vi) To compare the achievement of girls in girl's schools with that of girls in co-educational schools when CELA is used.

1.5 Hypotheses of the Study

To achieve the objectives the following null hypotheses were tested at $\alpha = 0.05$.

H_O1: There is no statistically significant difference in achievement in Chemistry between those exposed to CELA and those taught through Conventional Teaching Methods.

H_O2: There is no statistically significant difference in students' attitude towards Chemistry between those exposed to CELA and those taught through Conventional Teaching Methods.

H_O3: There is no statistically significant gender difference in Achievement in Chemistry among students exposed to CELA.

H_O4: There is no statistically significant gender difference in Students' Attitude towards Chemistry among students exposed to CELA.

H_O5: There is no statistically significant difference in Chemistry achievement between boys exposed to CELA in boys' schools and those in co-educational schools.

H_O6: There is no statistically significant difference in Chemistry achievement between girls exposed to CELA in girls' schools and those in co-educational schools.

1.6 Significance of the Study

The findings of this study are expected to be valuable to teachers who are the implementers of curriculum in that, they may incorporate and adopt the approach in teaching various topics in Chemistry and other science subjects. Curriculum developers, policy makers and authors may also benefit from this study. Use of Cooperative E-learning (CELA) is important as it may contribute to wide use of educational software which may trigger active participation of the learners thus enabling them to have positive attitudes towards the subject. Chemistry education might be made more enjoyable, productive and functional. Also it might improve learners' participation and comprehension of abstract concept in Chemistry. This might activate learners in their own learning process to construct knowledge, to develop problem solving skills and to discover alternative solutions. Both learners and teachers are likely to have an attitude change in order to optimise potential innovative educational values of the computer as well as recognise the value of its robust nature in learning and teachings. If learners master the use and application of computers in their work, their performance may steadily improve hence solve the problem of low performance. CELA method involved active participation from each student in the classroom through guided structure from the teachers. If used correctly, the student learning can be drastically increased in any classroom. It is therefore the interest of the society and the responsibility of the educators to improve student's attitudes towards sciences (Chemistry) and to prepare students to live in a highly scientific and technological society. The future of our society will be determined by citizens who are able to understand and help shape the complex influences of science and technology on our world.

1.7 Scope of the Study

The study covered twelve secondary schools in Koibatek sub-county, Kenya. Form three classes from the sample schools were used during the study. Emphasis was on the topic "The Mole" in Chemistry syllabus. KNEC reports indicate that the students' performance was poor as shown in Table 1. Students responses to questions on mole concepts was poor. Also understanding of mole concept helped students' to understand other chemical topics such as molecular mass, molar concentration, molar volume and chemical equilibrium. The experimental groups used CELA, while the control groups used the conventional teaching methods.

1.8 Limitations of the Study

The following were the limitations of this study

i) The content covered was limited to one topic the mole in form three Chemistry. The study would have been expensive and time consuming if other topics were covered.
ii) The unavailability of electricity and computers in schools. The researcher choose schools with computers and electricity for the study. Also alternative source of power source such as a generator can also be used to power computers and projects.
iii) The study was limited to county secondary schools within Koibatek sub-county. The other categories of public schools included sub-county Extra county and National schools were excluded.

1.9 Assumptions of the Study

The following assumptions were made in this study.

i) Teachers in the study took the approach positively.
ii) Data that were collected from students was a true reflection of their understanding of the topic 'Mole'
iii) Since form three learners are age mates it is assumed that learners age has no effect on achievement and attitudes.
iv) Trained teachers who have experience of two years teach at the same level.

1.10 Definitions of Terms

The following were definitions of terms used in this study.

Achievement: The results of what an individual has learned from some educational experience (Willmar, 1988). In this study it refers to student attainment scores in Chemistry Achievement Test (CAT).

Attitude: This is a predisposition to respond in a favourable or unfavourable manner with respect to a given object. Attitude towards Chemistry denotes interest or feelings towards studying Chemistry (Yara, 2009). In this study, it refers to students' interest or feelings towards Chemistry after being exposed to Cooperative E-learning Approach as measured by Student Attitude Questionnaire (SAQ) (CELA).

Co-educational Secondary Schools: These are secondary schools in which boys and girls learn together in the same classroom.

Computer Aided Learning (CAL): Computer Aided Learning is an educational environment where a computer program or an application of computer is used to assist the user in learning a particular subject (Garanga et al. 2012). In this study, a computer was used by learners/teachers in learning Chemistry.

Computer Based Instruction (CBI): This is a term used to refer to multiple components (e.g. the computer equipment, the courseware materials, the instructor, the learners and other mediating variables) all working together in an instructional process to bring a desired learning outcome (Odera 2012). In this study, it refers to the use of computers in the teaching and learning of Chemistry topic the "MOLE".

Computer Learning (CL): This is the use of computers to aid the learning process. Computer learning can be used as computer based learning or computer assisted learning.

Conventional Teaching Method: Conventional Teaching Method (CTM) is a traditional instruction where the teachers normally has a total control of the entire lesson. This methods view a teacher as a sole information giver. The teacher maintains control of the subject matter to be learned. Examples of CTM are like lecture, discussion, question and answer methods (Mc Carthy & Anderson 2000). In this study CTM was used to mean the common teaching methods used by teachers to deliver the content.

Cooperative E-Learning Approach (CELA): This is an integration of Cooperative learning and E-learning in an effort to come up with a hybrid learning approach referred to as Cooperative E-learning Approach (CELA). It was the teaching approach used in teaching the experimental goals (E_1 and E_2).

Cooperative Learning: It refers to learning environments that are specifically structured to emphasise peer interaction in the context of collaborative goals as opposed to individualistic and competitive goals of the normal classroom (Liang & Gabel 2005). In this study it means teaching and learning in small groups with students of different abilities using a variety of learning activities to improve their understanding of the topic the "MOLE"

Effects: The word effect means to produce a change in something. A change that is as a result of an action or an outcome from an action. In this study, it refers to the condition of learner's level of understanding in achievement and attitude towards Chemistry after teaching them through CELA compared to the use of conventional teaching method.

E-learning: This is electronic learning. It refers to kind of instruction where a computer presents part of visual learning environment (Markus 2005). In this study it refers to the use of computers in the teaching and learning Chemistry topic 'MOLE'.

Experience: It is a particular instance of personally encountering or undergoing something; practical knowledge, skill or practice derived from direct observation of participation in events or in a particular activity. In this study it refers to the length of time a teacher has been teaching

Gender: This is state of being male or female. Typically used with reference to social and cultural differences rather than biological ones. Gender is described as socially, culturally constructed characteristics and role which are ascribed to males and females in any society (Okere, 2008). In this study it referred to the roles played by the boys and girls in this study schools.

Kenya National Examinations Council (KNEC): This is a body responsible for administering national examinations in Kenya. KNEC was established by an act of parliament (Cap 225A, Laws of Kenya) in 1980. It operates under the Ministry of Education.

Learning: The acquisition of knowledge, skills through experience, study or by being taught. In this study the learners will acquire the skills, knowledge by teaching them (Terry, 2006).

Module: A standard format organised for use in instruction of learners in a section of their course. In this study, it is the work plan to be used in CELA in learning Chemistry lessons on topic "MOLE" in the experimental secondary schools.

School Type: This is the composition of the students in terms of sex in a particular school. There are two school types: single sex students and mixed sex students (Salav, 2001).

Training: It is the action of teaching a person or animal a particular skill or type of behaviour. An organised activity aimed at imparting information or instructions to improve the recipient's performance or to help him or her attain required level of knowledge. In this study it refers to teachers who have been trained to teach students. Thus these teachers have a certain skills to impact on learners.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter represents a summary of review of the literature on definition of the term science, teaching science in secondary school, curriculum change in science education, teaching of Chemistry in secondary school, students' achievement in Chemistry, student attitudes towards Chemistry, gender and achievement in Chemistry, gender and attitude towards Chemistry, school type and achievement in Chemistry, conventional teaching methods, cooperative learning approach, effect of cooperative approach on students' learning, e-learning, cooperative e-learning and students achievement, cooperative e-learning and attitude towards Chemistry, theoretical framework and conceptual framework at the end of the chapter.

2.2 The Meaning of Science

The word science is a noun derived from a Latin term "scienta" meaning knowledge. (Hani 2009). According to Ross (2000) science is a process or way of arriving to a solution that involves testing a possible solution .One of the objectives of science education is to develop students' interest in science and technology as todays' society depends largely on the development of science and technology. Emphasis is also placed on the application of science and technology education to the needs of daily life and development of the society (UNESCO 1997). The importance of technology for science teaching and learning by expediting and enhancing work production supporting exploration, experimentation and helping students to visualize processes more clearly. Teaching the scientific method to students is teaching them how to think, learn solve problems and make informed decisions. These skills are Integral to every aspect of students' education and life from school to career. Technology in education can bring lots of improvements, whether it's an increase of student participation in class or interacting with teachers. Learning can actually become fun when used with technology. Use of technology in education can keep the student engaged and the use of multimedia can help students retain information better (Hennessy, 2006).

Generally technology in classroom related activities refers to software that enable them to function. In many countries the recruitment to science and technology studies is falling or atleast not developed as expected. This lack of science to manifest itself at school level at the age where curricular choices are made. In many countries there is noticeable decrease in the number of students choosing some of the sciences .This trend is enlarged in the enrolment to tertiary education (Menlinger & Powers, 2002). Also it is observed that there is a growing gender gap in the choice of science and technology subjects in the schools, as well as tertiary level.

Teachers are expected to device ways of making their students to develop positive attitudes towards science and science related disciplines (Sola & Ojo 2007). In science technology and society, teachers not only have to communicate the objectives to be achieved but most personally strive to lead by example .The teacher should also promote communication in the classroom, increasing students activity and autonomy.

Technology helps teachers to expand beyond linear text based learning and to engage students who learn best in other ways. Digital simulations and models can help teachers explain concepts that are too big or too small or processes that happen too quickly or too slowly to demonstrate in a physical classroom. Currently in the industrial world, the new wave of curriculum development is emphasizing “scientific literacy for all’’ ‘Curriculum development movement is often devoted as the second wave of science curriculum reforms.

Educational guidance of science technology and society facilitates innovation in the curriculum of science and technology, in accordance with the new goals for science and technology education and its requirements for the 21st century. The curriculum development wave often describe particularly the situation in the USA and UK. The two countries tend to dominate the international science education literature. The first wave emphasizes the preparatory role of secondary science education for the students. The curriculum was considered difficult by teachers and students and caused many students to run away from science studies (Walberg 1991, Ware 1992).

The second wave of science was preparation for general citizenship and science knowledge needed for life after school. Shamos (1995) advocated for a curriculum for scientific awareness which would have a technological emphasis. The new curriculum being implemented in such countries as Australia, England and New Zealand along with the proposals from natural sciences learning area committee in South Africa. All placed much greater emphasis on skills and processes than a more holistic view to science and technology, (Alamina, 2001). Technology in classroom related activities refers to computers, videos associated networks and software.

2.4 Teaching of Science in Secondary Schools

Ajaja (2007), identified the objectives of teaching science to include, knowledge of science academic discipline, to acquire the skill of scientific method, having clear explanation for societal issues through increasing interest in science literacy and societal goals, for personal needs and for career awareness. All these objectives whether general or specific are only achieved by the teacher through giving the correct instruction to the science students. No matter how well-developed and comprehensive a curriculum is, its success is dependent on the quality of the teachers implementing it (Ughamadu, 2005).

Science teaching in the United States of America has standards. These standards must be followed if the national or specific objectives of science education are to be achieved. Trowbridge and Bybee (1996), identified six components of a model for standard science teaching in United States of America: teachers of science should plan inquiry-based programme for their students, teachers should interact with students to focus and support their inquiries, recognise individual differences and provide opportunities for all pupils to learn, teachers should engage in ongoing assessment of their teaching and resulting students learning; conditions for learning should provide students with time, space and resources needed for successful science learning, teachers should foster habits of mind, attitudes and values of science by being good role models for these attributes and it is important for teachers to become active participants in on-going planning and development of the school science programme. This same standard is recommended to all science classes worldwide. The realisations of these standards vary among nations because of variation in commitment to achieve and maintain the set standards. Most poor nations lack resources to enforce standards in science teaching and learning.

The actual outcomes of instruction depend largely on what happens in classrooms. If scientific knowledge is presented in terms of proven facts and absolute truths, readily communicated through texts and lecture, then students will come to regard science as a static body of knowledge that is founded on well-defined methods (Roth & Roychoudhury, 2003). Knowledge for these students, consists of memorising a body of information for later retrieval (e.g. for a test). If on the other hand, students actively engage in science processes, they can come to recognize that scientific knowledge based on experiments in which the meaning of data is negotiated and theories are not absolute. Knowledge in this context consists of learning experimental methods and the norms and practices of scientific communities as much as it does learning known facts and current theories within a domain (Wheeler, 2003).

Odera (2011) argued that teaching and learning science subjects whether in developed or developing countries require the use of various teaching aids and apparatus. In most areas of science education, the use of technology is quite acceptable and recommended to enhance learning. Researchers have pointed out the capabilities of computers to improve student's scientific knowledge and stated that computer-based technology gives science teachers access to a rich variety of textual materials and graphic information. Many science teachers shy away from incorporating technology into their teaching and learning process despite the availability of computers in the schools. Clark (2002) pointed out that few teachers use computer-based technologies for instructional purposes and observed that the computers are not being integrated into most instructional curriculum.

The knowledge of how teaching and learning approaches affect student's learning, may help science teachers to select teaching and learning approaches that improve teaching qualities, effectiveness and accountability to learners and the public (Wachanga & Mwangi, 2004). Effandi and Zanaton (2007) noted that teachers should have the knowledge of how students learn science and how best to teach and that effort should be taken now to direct the presentation of science lessons away from the traditional methods to a more students centred approach. Similarly, Wambugu and Changeiywo (2007), noted that the teaching approach that a teacher adopts is one factor that may affect student's achievement and therefore use of an appropriate teaching approach is critical to the successful teaching and learning science. Learning is facilitated by a range of tasks that involve students in active processing such as questioning, explaining and discussion.

The findings of this study showed that CELA enhanced students achievement in Chemistry and positive attitudes towards Chemistry. Hence teachers are encouraged to incorporate CELA approach in teaching science subjects. This study is in agreement with studies carried earlier where researchers recommended the use of computers and use of student centred approaches in teaching.

2.3 Curriculum Reform in Science Education

"Science for all" as a curriculum development movement is often denoted as the second wave for science curriculum reforms, referring to the development over the past decades since

1950s (Alkenhead, 1985). The second wave of science was preparations for citizenships and science knowledge needed for life after school.

This curriculum stemmed from a concern with scientific work force development and emphasised the disciplinary that previously had heavily fact laden syllabus. During the early days of developing the curriculum, the teachers subjected all topics considered for possible inclusion to the test of whether or not the mathematics had a direct application. The emphasis was on the structure of the subject rather than its application.

Mackenzie (1964) initiated the change processes in USA. He conceptualizes the process of curriculum change. The targets for change are the component that determines the curriculum. These are teachers, students, subject matter, methods, materials, facilities and time. Changes take place in the cultural context of the school which is brought by influences from the culture. Change efforts in science have been directed to all six determiners of the curriculum. No determiner has been regarded as single key to changing the curriculum by these exerting for change in Science by means of federal resources (Campbell, 1959).

The science curricula of most African countries were adopted from the science curricula of western countries, but there has been attempts in recent years to shift away from these inappropriate imported models. In South Africa, curriculum change took its character and course from the rigidity centralized educational system which in the final analysis is determined by the authoritarian control of state. Curriculum change in state schools originate from essentially three sources; state educational authorities, independent private agencies and universities. Since 1967 the white models of education has been used in black schools and also the curriculum in black secondary schools (Weiss & Weishaupt, 1987). In Botswana Curriculum planners have tried to involve a broad range of stakeholders in the curriculum development process with teachers being considered an important group (Nganunu, 1990; Ogunniyi, 1995). For science to be accessible to learners in rural areas, learning programmes were shaped around real issues, technologies and situations found in those areas.

Knamiller (1995) in discussing these issues in relation to Tanzania, refers to the need for curriculum to become “operant with intention to transform school learning into everyday skills. There are a number of examples in Africa where such approaches have been tried from which we can learn. These include Uganda “link projects” and “the science investigation” in Botswana. Kuipper (1996), argued that science teaching has long been irrelevant to the students that graduate from high school because they were not able to apply their scientific knowledge in later life. An important reason for this inability is the teaching approach used by science teachers and also advocated through curriculum and syllabus documents.

According to Mukulu (1981), cited by Mwangi, (2012) scientific and technological literacy is a major precondition for modernization, wealth generation and development of a democratic society. He further argues that science culture is needed for innovation and problem solving as well as acquisition of transferable skills. Since independence there have been various curriculum changes in Kenya. According to Sifuna (1990), the range of subjects was increased at the secondary level after independence so as to include industrial training to enable the government to Africanize the civil services.

A major change in the educational system and the curriculum in Kenya occurred in 1985 when the 8.4.4 system was introduced as a result of recommendation of the Mackay (Mackay, 1981). By the time Mackay commission was established there was a need of changing the school curriculum so as to address the needs and interest of the school leavers and all levels of the education system in the country. To achieve this goal a different curriculum with some new subjects was developed. The new curriculum emphasised vocation and practical subjects as well as the sciences. This was to equip the learners especially with skills that would enable them to become productive and self-reliant after school (Kagema, 2005).

The introduction of the new subjects into the existing secondary syllabus made the secondary curriculum too broad which was not easy to implement since students could not manage the whole load (KIE, 1986). The subjects were organised into five major groups. Group two combined all science subjects thus; Chemistry, Physics, Biology, Biological Sciences and Physical science (physics taken with chemistry). From group two subjects a learner had to take three pure sciences, that is physics, chemistry and biology or take physical science and biological sciences.

After implementation of the 8.4.4 curriculum the system came under public criticism with general feeling that the workload was too much for students and teachers and the cost of financing the ten subjects per student was too high (Kagema, 2005). Eight years after implementation the curriculum was reviewed. The review affected two areas of the curriculum, this are; the reduction of the subject matter (context) in some subjects. Also reduction of the number of examinable subjects a student could take for Kenya of Secondary Education (KCSE) from ten to eight. In sciences a student had the options either take all the three pure sciences (physics, chemistry and biology). The other alternate was to take physical sciences and biological sciences.

Curriculum review was carried out in 2000 by Ministry of Education Science and Technology (MOEST, 2000) and implemented in 2001. The review directed that physical sciences would no longer be offered in secondary schools and all schools were to offer pure sciences. The three sciences were made optional as long as the candidate pursued at least two of them.

The Ministry of Education the then KIE developed a basic general science curriculum in 2008 for learners in secondary schools, to cater for students that would like to pursue art-related course and careers. This secondary school general science curriculum aims at equipping the learners with ability to understand their environment and acquire scientifically knowledge, skills, competence and attitude relevant to the contemporary society.

According to KIE (2008), the Secondary School General Science Curriculum course targeted learners in formal and informal education system. Learners in the formal systems, who opt to take the course, were expected to study the regular science subjects i.e. physics biology and chemistry in form one and two then take the secondary general science as an option in form three and four. Those in non-formal system may take the general science option from form one, while great emphasis has been placed on the needs of the learners for whom secondary education is terminal. It emphasises participatory and interactive learning. Contemporary and pertinent issue such as environmental conservation, drug and substance abuse, HIV and AIDS awareness, integrity, gender responsiveness, children rights and technological advancement has been addressed adequately. The pure science curriculum is designed to equip the learners with knowledge skills and attitude that are geared towards pursuing mathematics and science related course and careers. In this study the use of CELA may enhance the acquisition of these skills. Felde et al. (2007) noted that cooperatively taught students tend to exhibit higher academic achievement, higher level reasoning and critical thinking skills. Students tend to achieve a deeper understanding of learned materials. Cooperative learning also lead to greater positive attitude towards Chemistry.

Chemistry curriculum in Kenya has undergone several changes since Kenya's political independence in 1963. From that time Chemistry curriculum was formulated and developed in the African Science Centre (ASC) now called the Kenya Institute of Curriculum Development (KICD). The Chemistry syllabus produced by ASC was teacher and book centred in its approach to teaching and learning. It overlooked the fact that students had a wide range of abilities; interests and potentials. It was a content centred and did not bother about experiments (Kenya Government, 1976; Kimiti, 1984).

In 1967, another Chemistry syllabus was developed called UNESCO Pilot Project. In this the teacher did all the experiments while the pupils merely observed and wrote information. There were no enough finances, laboratories, hence relied on teacher demonstration. Teacher used centred learning method (Wachanga & Mwangi, 2004).

In 1968, another Chemistry curriculum was developed in Kenya. It was meant to be in line with curriculum changes that were taking place in USA and the United Kingdom. In UK, Science curriculum was developed by Nuffield Foundation and adopted in Kenya (Eshiwani, 1972). In the Nuffield approach, instead of the child being in front of the original discoverer as in UNESCO project, it put the child at the centre as in scientific work. It emphasises learning science by discovery or the problem solving method. Nuffield science project involved importation of huge quantities of books and apparatus. This material proved to be unsuitable for the Kenyan environment. Nuffied failed to meet the needs of a Kenyan learner.

In 1970, a new science curriculum was developed which was called School Science Project (SSP). SSP was similar to Nuffield project in teaching methodology, but aimed at using locally available materials as it required equipped laboratories and competent teachers and good school environment. Many Kenyans could not afford those requirements (Kimiti, 1984).

In 1973, an alternative syllabus was introduced called the Chemistry traditional syllabus. It had three options; pure chemistry syllabus, physical science and general science.

Traditional syllabus was offered alongside the SSP. A school could choose either the traditional syllabus or the SSP for its pupils. In 1981 the Ministry of Education came up with syllabi that could Unified and be offered in most schools called New Kenya Examinations Council Syllabi. In 1984-1985, a new syllabus called the 8-4-4 Chemistry syllabi was introduced. The syllabus was revised in 1992 and later in 2000. It aimed at having a learner-centred investigating approach in teaching. The use of project work in teaching Chemistry was emphasised. The options available in it were 8-4-4 Chemistry syllabus and the 8-4-4 physical science syllabus. The revision done in year 2000 resulted in the removal of physical science. There has been a change in the content taught at different level owing to the various changes in the system of education that has taken place. The current Chemistry curriculum was released in 2002 and implemented in 2003. The Chemistry syllabus was thus re-organised to address the following aspects: overlaps within topics and across the subject, overload within the topics, contemporary issues such as environmental pollution, industrial and technological transformation have been addressed (KIE, 2002).

2.4 Teaching of Chemistry in Secondary Schools

Chemistry is one of the most important branches of science. However, it proves to be a difficult subject for many students (Sirhan, 2007). It is a human endeavor that relies on basic human qualities like creativity, insights reasoning and skills (Banya, 2005). Chemistry is viewed as the “Central Science” as mastery of its concepts regarding the structure of matter is essential for further coursework in all sciences. It performs the function as an entry for future study in many sciences (Tai, Sadler & Loehr, 2005). Jegede (2007) cited that Chemistry is a core subject for medical sciences, textile technology, agricultural sciences, synthetic in industry, printing technology, pharmacy and chemical engineering.

The study of Chemistry at the secondary school level helps students in developing basic skills knowledge and competence required for problem solving in their environment. A poor chemistry foundation at the secondary school will jeopardize any future efforts to enhance achievement in the subject (Barneka & Viko, 2010).

Some of the objectives for teaching chemistry are: to provide students with basic knowledge in chemical concepts and principles through efficient selection of content and sequencing, show Chemistry in its interrelationship with other subjects, show Chemistry and its link with industry everyday life; benefits and hazards; facilitate a transition to the use of scientific concepts and techniques acquired in integrated science with Chemistry and provide a course which is complete for pupils not proceeding to higher education while at the same time a reasonably adequate foundations for a post-secondary Chemistry course (Ajaja, 2009).

Oloyede (2008) cited some factors that affect students’ achievement in Chemistry such as students’ factor, teacher factor and societal factor, the government infrastructural problems, language problem and instructional strategy employed by the teacher. Demide (2000) reported that such include the student factor, teacher factor, societal factor, the government infrastructural problem, language problem and instructional strategy employed by the teacher appeared overbearing because of its manipulability. Zayum (2008) noted that the instructional format provided by the teacher seems to be the medium of effective learning and that good teaching makes learning more meaningful. He argued that while good teaching helps the learner more quantitatively, poor teaching would lead to poor learning and poor performance.

Danili and Reid (2004), studied the effects of working memory space and field dependency on the learning of Chemistry by Greek students. Learning not only of Chemistry but all new information will fail if the working memory space is overloaded. This could occur if students are given too much information at once, chunking or grouping pieces of information to be held in the working memory. Mulemwa (1997) reported that in Uganda, many pupils have negative attitude towards Chemistry. The reasons students gave is that, Chemistry is hard because of the methodologies used by the teachers. Topics cited were; mole concept and ionic equations.

Researchers focused on gender studies have indicated that attitudes toward science education differ between males and females. A declining interest in Chemistry and the under representation of females in the chemical science was found (Jacob, 2000 cited in Banya, 2005). Self-confidence toward Chemistry, the influence of role models and knowledge about the usefulness of Chemistry affected the decision of young female students about the study of Chemistry (Banya, 2005). In the event of young female students finding difficulties in constructing knowledge of Chemistry, self-confidence is lowered with subsequent alternation of attitude towards Chemistry.

Wachanga and Mwangi (2004) investigated the effects of Cooperative Class Experiment (CCE) teaching method on high school students' educational achievement in the County of Nakuru, Kenya. The results of the research showed CCE caused facilitation in learning Chemistry. Gender had no effect on the students' achievement as compared with other teaching methods. In the present study, the researcher hoped to find out whether CELA could do the same. The observations were in agreement, gender had no effect on achievement of students. The kind of school had no great impact on the girls' educational achievement when CCE was used, but it was effective on the boys' achievement and they got better marks. Boys are more active than the girls, they tend to engage the teachers in more forms of interactions, especially in asking or answering questions. Also teachers have believes that participation is an indicator of learning. Hence they often ignore female students because they participate less than male students.

2.5 Students Achievement in Chemistry

Chemistry is the key role of the Central Science that forms the basic foundation to many disciplines and improving quality of life. Despite the importance of Chemistry in the curricula, the achievement of students in the subject in Kenya has remained consistently poor over the years. Annual KCSE examination report by the Kenya National Examinations Council (KNEC) as shown in Table 1, shows the mean scores attained by students in Chemistry in KCSE have been below average over the last 10 years 2006-2015 (KNEC, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Researchers have explained the effects of teacher qualification (Landu, 2003), instructional materials and laboratory (Darerg and Agendo, 2002), attitudes of teacher and students towards the teaching and learning of science (Ese, 2003) and the effects of peer group (Briggs, 1995) on student's academic achievements.

Students' achievements are affected by other factors like; school location, school type, laboratory adequacy and frequency of practical classes.

Schools located in urban areas are better positioned and attract more qualified students and teachers who exhibit the readiness to take academic business seriously (Odinko, 2002). School location also contributes to an enriched environment which could result in better performance of students (Capron, 1992). Environment in which a school is located brings about different responses and behaviour from learners.

Studies have shown that location of a school can affect performance in Biology and at least by deduction could affect performance in Chemistry, mathematics or other science subjects (Frazer et al. 1992). Unlike previous studies which suggests that the effect of location is in favour of urban students. The result in Okonkwo's study contradicts earlier researchers. According to him the effect of location is not absolute. The notion that learners in private schools are better academic achievers than their counterparts in public schools. This depends on the assumption that private schools are adequately equipped with human and material resources.

Type of school affects achievement, if the schools are not adequately equipped with human and material resources. The resources should be channelled towards purposeful educational objectives. Wong and Frazer (1996) found a significant association between the nature of the Chemistry laboratory, classroom environment and the student's learning outcomes. Students who report more instances of repeating laboratory enhance their understanding and they earn higher Chemistry grades than their peers who reported few (Tai et al. 2005). Inadequacy resources materials in science teaching especially Chemistry which is central in Science becomes very difficult to teach (Okafor, 2001). In this case a teacher who is creative, dedicated or resourceful can resort to improvisation of scarce resource. Okonkwo's (2002), found that children who attended private schools generally come into secondary schools more ready for junior secondary mathematics than their counterparts in public schools. From his studies, he concluded that some 10% of variance in subjects, mathematics scores was uniquely accounted by the type of school after the location effect had been statistically controlled.

Frequency of practical classes is also an important school factor, since scientific processes skills such as observation, prediction involves doing practical activity. It is assumed frequent use of laboratory for practical lessons by the teacher can translate to chemical knowledge to the understanding of scientific facts, laws and theories.

The place of laboratory in science teaching is not a neglected issue (Donnelly, 1998). Tai Sandler and Loehr (2005) pedagogical experiences that append to be linked with varying laboratories for understanding associated with higher students grades. They also affirmed that students reporting more instances of repeating laboratories to enhance their understanding earned higher Chemistry grades than their peers who reported few or no instances of repeating laboratory for understanding. They emphasized therefore that laboratory work holds greater promise in helping to prepare students for higher level of studies.

Inadequate resources materials in science teachers affects the grades in Chemistry subject. This is because where the materials are not available in large quantities to meet the demand effective teaching and learning of science become difficult. Other studies reported that to avoid the prospect of possible negative background, there should be provision of adequate laboratory and equipment.

It is observed that students develop conceptual understanding through engagement in hands on activity. Learners are expected to do a variety of hand-on experiences where they understand what they do and are able to construct new level of understanding. Pellegrine and Hilton (2012) from their studies said that meaningful learning occurs when learners comprehend concepts and are able to connect them with previous knowledge. When students learn chemistry meaningfully, their ability to reflect on their own learning and make adjustment accordingly and foster deeper learning.

Deeper learning is the strategy through which students find meaning and understanding from course material and experiments. Student's active participation, their interaction in groups and their teachers' role as provider of provoking questions enhance student's achievement gains in chemistry (Meyer *et al.* 2007).

2.6 Students Attitudes towards Chemistry

Attitudes are acquired through learning and can be changed through using variety of techniques. Attitudes once established help to shape the experiences. People constantly form a new attitudes and modify old ones when they are exposed to new information and new experience (Adesina & Akimbola, 2005). Gagne (1979) defines attitude as internal state that influence the personal actions of individual. He recognized attitudes as a major factor in subject choice. He considers attitudes as a mental and neural state of readiness, organised through experience; exerting a directive or dynamic influence upon the individual's responses to all objects and situations, with which it is related. Teachers have the opportunity of structuring lessons cooperatively, competitively or individualistically and the decisions teachers make in structuring lessons can influence students interaction with others knowledge and attitudes (Carson, 1990). Schunk and Hanson (1985), suggested that the attitude of pupils is likely to play a significant role in any satisfactory explanation of variable level of performance shown by students in their school science subjects. Ogunleye (1993) in his finding reports that many students developed negative attitudes to science learning, probably due to other factors that teachers are unable to satisfy their aspiration or goals. According to Johnson and Johnson (1989), cooperative learning experiences promote more positive attitude towards the experience than competitive or individualistic methodologies.

According to Yara (2009), attitude of students can be influenced by the attitude of the teacher and his methods of teaching. He further showed in his work that teachers' method of mathematics teaching and his personality greatly accounted for students' positive attitude towards the subjects and that without interest and personal effort in learning by the students can hardly perform well in the subject. Keeves (1992) argued that attitude towards chemistry and other sciences are in general highly favoured, indicating strong support for science and the learning of science. There is also consistency across countries and age levels within a country in the average level of attitude towards Chemistry and general science. However, in countries where a high level of technological and industrial development had been achieved, the findings showed that attitude towards science were more neutral. Generally, boys had more favourable attitude towards science.

Olatoye (2001), found that students attitude towards Chemistry have significant direct effect on student achievement in the subject. Adesokan (2002) asserted that in spite of the recognition given to Chemistry among the science subject. It is evident that students still show negative attitudes towards the subject thereby teaching to prior performance and low enrolment. Bennet et al. (2001) argued that girls and boys start off an equal footing in Chemistry and other sciences subjects but once physical science and mathematics become optional at the secondary school level, there is a downward spiral of female enrolment accompanied by decrease in achievement and interest. This implies that there are underlining factors affecting the attitudes of young females' students towards Chemistry that needs to be addressed at the high school level (Santonino, 2005).

Developing positive attitude and interest towards science in general and learning of science in particular is one of the key goals for teaching and learning sciences. The three key factors that should be considered for enhancing attitudes and interest are the methods used to present the content (e.g. relevance and historical approach) instructional technique that are implanted and gender issues. The content of school science and its related pedagogical approaches are not aligned with the needs, motivational patterns and interest of most of the students (Sjoberg & Schreiner, 2006). Even in countries in which the results are above average students do not view science learning as either motivating or relevant (Osborne, 2003). This is specifically true for chemistry education and especially for those students who probably will never embark on science or science related careers, but will never the less need science personally and functionally for their future as literate citizens (Roth & Lee, 2004).

It is assumed that students who are interested in science and understand the scientific concepts will have more positive attitude towards science studies compared to those who have learning difficulties in the science disciplines. Fair- brother (2000), claimed that pupils learn only if they want to learn. There are many problems regarding the way science is being taught in schools especially if we considered non-science oriented students as an important target population. As a result pupils fail to make connections between the different facts and concepts presented and their practical applications, hence never developing confidence in its relevance.

If students are not interested in science, they tend not to make an effort to learn and understand the meaning of concepts that are being taught. It was shown that the most effective factor contributing to student's decisions to study science is their interest in the subject (Lindahl, 2003). When the students feel that they are familiar with the concepts or issues from the previous studies and they feel confident enough to explain them, it affects their attitude and achievement. Cheung (2009) suggested that one possible explanation for the inconclusive results could be that gender (and its interaction with grade) was not assessed or considered in their studies. In addition there are instructional technique that are more effective in chemistry; for example certain laboratory activities and approaches.

Gilbert (2006), listed several problems that he believes have the potential to affect attitude towards and interest in learning chemistry. His list consists of issues such as overload of the subject matter, failure to present a holistic approach to chemistry (i.e. presentation of isolated facts). Inadequate emphasis regarding selection and depth of the topics taught especially for those who are not going to embark on a career in chemistry or chemistry related sciences. Finally he suggested that many programs suffer from lack of relevance. Many of those that do elect to continue to study the subject (Chemistry) experience lack of relevance in it and seem to view it in an instrumental way rather than because it is worthwhile in itself.

2.7 Gender and Achievement in Chemistry

Gender refers to the fact that being male or female (Pearson Education, 2003). Kanno (2008) referred to gender as an analytic concept that describes sociological roles cultural/responsibilities and expectations of men and women in a given society or cultural setting. Therefore, gender is a psychological term and cultural construct developed by society to differentiate between the roles, behaviour, mental and emotional attributed of males and females. Most adolescents in secondary schools, cultural and societal expectations alongside career prospects and opportunities within socio-cultural are factors that play a major role in their individual choice of career and vocations. For those who elect to study the Chemistry related courses, they study Chemistry because it is required for their future career development to enable them play the role of their culture and society expect of them. Eze (2008) from his studies asserted that gender had significant effects on students' achievement in Chemistry and showed that male students achieved higher than their female counterparts. Owoyen (2007) asserted that students' achievement in Chemistry had nothing to do with whether the student is male or female.

Erinosho (1994) cited in Adesoji (2008) showed that the difference between achievement scores of female and male students was not statistically significant in Chemistry. Ssempala (2005) investigated gender difference in the performance of practical skills on quantitative analysis an aspect of Chemistry, showed that there was no statistically significant difference between girls and boys in their abilities to manipulate the apparatus/equipment, take observation, report/record results correctly, during chemistry practicals. Wachanga and Mwangi (2004) found out that gender had no effect on achievement of students when cooperative class experiment (CCE) was used. The influence of gender on learning and achievement has remained controversial and topical issue amongst educationist and psychologist. The pedagogical approach adopted by teachers in presenting the concept to student is to be blamed for students difficulty in understanding and under achievement in Chemistry concepts.

In this study the focus was on how gender affects achievement when CELA was used in teaching Chemistry. From the findings, gender had no effect on achievement in Chemistry.

With regard to gender researchers have proposed that male students due to certain attribute tend to benefit more than their female counterparts when ICT resources are scarce (Nawe, (2000). Hence advices that special consideration is given to female students during allocation of the instructional equipment. Sanga, Magesa and Kayunze (2011), proposed that failure of female students to access ICT resources just as their males counterparts may be due to gender factors. The researcher noted that boys tended to be more active in computer-related classroom discussion made more spontaneous comments and were also asked more questions by teachers. Girls tended to lack confidence in computing and most oftenly under estimated their computer-related competence. In this, the ICTs should be equally accessible to boys and girls. However, when conditions are provided where they can easily access the tools in more they can easily access the tools in more relaxed circumstances, they may benefit more thus facilitate their learning.

Gender has been identified as one of the factors influencing student's achievement in sciences at senior secondary school level. Olson (2002) reported that females performed better than male students when taught mathematics using Cooperative learning. Khairulnar et al. (2010) found gender differences in favour of male students. On the other hand, Yusuf and Afolabi (2010) reported that gender had no effect on academic performance of students when cooperative learning was used.

The findings is regarding performance of male and female students in STAD group agree with the earlier findings of Kost et al. (2009) which found no significant difference between male and female students performance when taught using cooperative learning strategy.

Furthermore it supports the findings of Panadian (2004) and Yusuf and Afolabi, 2010, which reported that gender, did not express any significant influence on Biology achievement using computer-assisted STAD Cooperative learning strategy. It also disagree with the findings of Olson (2002) which found that female students taught mathematics using Cooperative learning outperformed their male counterparts. Rugus et al. (2007) on gender difference in Cooperative learning with college students in a multiple choice test found no significant differences between boys and girls. Implications of these findings are that computer-assisted instruction is better in cooperative learning settings than individualised settings.

Gender differences in achievement have been attributed to a variety of biological and environmental factors in what usually comes down to nature and nurture debate (Dee, 2005). Dee continues to argue that teachers usually interact differently with boys and girls and some evidence suggests that students benefit academically from having teachers who are of the same gender as themselves (Dee, 2007). Achievement differences are also influenced by single sex versus mixed sex schools. Type of schools, teachers and the curriculum encourage girls to adopt passive and dependent behaviour, while boys adopt aggressive and independent behaviour.

Studies have found that females have more negative attitude towards maths and science (Wasanga, 1997). According to Wasanga, the majority of girls found science subjects difficult and perceived science subjects to be more useful to boys. The problem is more pronounced in co-educational schools and girls schools. Oludipe (2012) carried out a study to investigate the influence of gender achievement in basic science using cooperative teaching learning strategy. His findings reveal that there was no significant in achievement of male and female students.

Abungu (2014) from his studies indicated that boys and girls exposed to science process skills teaching approach showed no significant difference in Chemistry achievement. Keter (2014) from his studies on Cooperative Mastery Learning Approach showed no significant difference between boys and girls performance in Chemistry. Some observations don’t agree with these findings. Opara (2011) found out that boys performed better than the girls in Chemistry and Biology.

2.8 Gender and Attitude towards Chemistry

Attitude is defined as feelings that can be either unfavourable or favourable, positive or negative and are typically directed towards some specific object (Stingging, 1994). Attitude implies a psychological construct which is inferred from responses to a given stimuli. There are six dimensions regarding to attitudes, confidence, anxiety value, enjoyment motivation and expectations (Tapia and Marsh, 2004). Students attitude towards, science varies among the students. It depend on several factors. First factors that are associated with teacher, such as teaching methods, class management and teachers content, knowledge and personality. Second factors that are related to the environment such as educational background of parents and parental expectations. Third factor, come from students, including students achievement anxiety extrinsic motivation and experience (Debacker and Nelson, 2010).

One of the goals of science learning is to cultivate students' positive attitude towards science (Holfstein & Naaman, 2010). Investigating of the effect of gender on attitude towards science has attracted the attention of some researchers. Some studies conducted in UK confirmed that male students had more positive attitude towards science and choose science related career paths more often than the female. Ogawn and Shimale (2004) did their research in Japan and found that there was no difference between boys and girls with respect to attitude towards science.

Attitude towards Chemistry is essential. It denotes interest or feeling towards studying Chemistry. Attitude and academic achievement are important outcomes of science education in secondary school students. Attitude and interest plays substantial role in students decision to study science (Abulude, 2009). To enhance attitudes to learning Chemistry (Hofstein & Naaman) suggested three key factors that should be considered:-

(i) Methods use to present the content relevance and historical approaches.
(ii) Instructional techniques that are implanted
(iii) Gender issues.

Barnes *et al.* (2005) explored sex differences in interest in Chemistry and concluded that males found chemistry more interesting than females. Positive attitude of male students was associated to confidence, lack of anxiety, enjoyment and good performance in Chemistry than the female. Male students participate more in Chemistry than female students. These differences between male and female student suggest that there are social, cultural and educational or other factors which affect negatively female student's attitude towards Chemistry (El-Haj, 2003).

Adamuti and Trache (2007) argued that students' negative attitude where girls dislike science subject was due to teaching methods and the Chemistry teachers were mostly male. Parents influence was also felt with their attitude that boys are able to study hard and do difficult things like study science. This would demotivate the girls towards science subject (Hoffmann, 2002). This illiteracy idea, requires the parent to encourage their children (boys and girls) to study science subjects. This can solve the problems of girls disliking sciences. Also the negative attitude of students is the factors of anxiety, confidence and enjoyment. Students have no interest in physics and chemistry and they believe that science subjects are difficult and required more time to study. It is therefore suggested that students should be motivated and encouraged by providing them with conducive environment and different teaching and learning methods (Cheung, 2009). Also most boys' students developed positive attitude and interest towards chemistry due to the fact that they get support from their parents, who gives them privilege to private studies at home compared to girls. All this influences the male students to be confident, non-anxious and enjoyment towards science subject and hence increase their enrolment and choose science (Chemistry), (Barns *et al.* and Cleeves, 2005).

The significant different in the attitude between male and female towards chemistry causes minimal number of female profession in science compared to male. In this study the focus was how gender affects attitude towards chemistry when CELA was used in teaching chemistry. The findings were that gender had no effect on attitude towards Chemistry.

2.9 School Type and Students' Achievement in Chemistry

Effect of school characteristics on learning is important because public policy can influence characteristics of public schools as well as the cost to provide schools through voucher and scholarships. Chemistry which is a branch of science is introduced into curriculum content of secondary schools because of its educational value, relevant to the needs of the individual learner and society as a whole (Ogunleye, 1999). Therefore, to remain relevant in the society around us and also to be part of the development of new technologies, science students should be competent at mastering the necessary concepts and skills. Also to be able to translate them to everyday living. School type is one of the school factors considered to be militating against students' performance.

Shinho (2004) in his studies concluded that 10% of variance in the mathematics scores, was accounted for by the type of school after the location of school effect had been statistically controlled. From his research school type made no significant relative contribution to student's achievement in Chemistry. These findings contradict Olude (2005), who found that there was significant relationship between school type and achievement in Chemistry among learners. Yusuf and Adigun (2010) investigated the influence of sex and school type on students' academic performance and reported that school type had no significant influence on students' academic performance.

Riordan *et al.* (2008) argued that there is no significant difference in the test scores in mathematics when comparing students enrolled in single-gender classes and those taught in co-educational environment. Students did gain in both single-gender and co-educational classes. Harker (2000) in their study of relative achievement of girls in the single-sex and co-educational schools were explored in details with careful controls for the students population differences at the two types of schools. The apparent differences between the two types of schools showed non-significant in their achievement. In this study, there was no significant different between school type and achievement in Chemistry. If the government and other stakeholders in education industry could improve on the school factors, it is very likely that students' achievement in Chemistry will improve.

2.10 Conventional Teaching Methods used in Secondary Schools

Conventional teaching method or traditional teaching method involving instructors and students interacting in a face to face manner in the classroom. These instructors initiate discussions in the classroom and focus exclusively on knowing the content in textbooks and notes. Students receive the information passively and reiterate the information and memorised for the exam (McCarthy & Anderson, 2000). Technology in education is not something new in today's classrooms, but many education systems are still limited by conventional teaching and learning methods. Laurillard (2013) many teachers are still teaching their students in the same manner as how they were taught and how their own teachers were taught, not much of progress in terms of the teaching perspectives (Anglin & Anglink, 2008). Transformation to these conventional methods of teaching results in fear and reluctance from teachers who find the change hard and risky. Devinders and Zaitun (2006) cited that many teachers are still using conventional teaching classrooms while the teacher is explaining and writing on the board, students would be copying the same thing onto their notes, some day-dreaming and some sleeping. Conventional teaching is also limiting room for more creative thinking and also not considering individual differences.

The traditional teaching methods which comprises; exposition, discussion and demonstration approaches are teacher-centred. Expository instruction has been criticised for placing little emphasize on thinking. It has been described as a ‘cook book’ nature of learning. Conventional instruction which is heavily driven by the teacher-talk involves the transmission of knowledge by the teacher to passive listeners. In science classroom where conventional approaches dominate, little learning takes place (Vigh Narajah *et al.* 2008). The learner’s goal is to regurgitate the information or procedure as pre-arranged by the teacher (Caprio, 1994). The teacher determines the outcome of the learning process and the learner is not challenged to create or critically contest teachers’ results. The design in conventional approaches is such that the learners spend more time in finding the correct answer rather than critically thinking how to construct their own meaning of scientific concepts. Emphasis is on content coverage learners have or no time for resolution of cognitive conflict and for interaction in groups where they can explain their own position on the learning process asking explores elaborate and carryout hands on activities.

Chemistry is a practical subject and should be taught by way of discovery through investigation. Learner central approach is therefore most appropriate. However, learners require the teachers’ guidance. An integration of the two approaches may be necessary in certain topics. There are four major methods which are commonly used in teaching of Chemistry (KIE, 2006); class experiments, teacher demonstration, class discussion and projects. Besides these four, there are other instructional methods that may be incorporated such as question and answers, informal lecture and field trips.

2.10.1 Class Experiment Teaching Method

It involves learning by doing, here students engage in practical learning activities and also it provides an opportunity to the learners to put theory into practice. There are three ways in which class experiment can be carried out; individual or groups of students carry out identical experiments at the same time. This method is suitable when the apparatus and chemicals are simple and enough. Learners perform different experiments through rotation. This method is used when the apparatus are scarce. Different learners or groups carry out experiment without rotation. All results are collected, recorded and discussed by the whole class. This is good when the same type of reaction is to be investigated for many different substance (KIE, 2006).

Although this method is learner centred the teacher plays a vital role in ensuring that objectives of the experiment are achieved. The teacher encourages the mastery of the skills and instils in the learner a positive attitude towards practical work. Learners develop manipulative and managerial skills. In spite its importance, class experiments is expensive in terms of material and equipment, time consuming, less context will be covered and in-case of large class size, some students may not get the opportunity to carry out the practical (KIE, 2006; Mohanty, 2003).

2.10.2 Teacher Demonstration Method

This involves an experiment or a series of experiments performed by the teacher with the assistance of the learners. This method is used in situations where apparatus and supply of chemicals are limited. It is also useful in experiments with potential hazards, where delicate or complex apparatus are used. For example, burning of hydrogen in air/oxygen, preparation of poisonous gases and reactions involving very reactive substances such as sodium, potassium and phosphorous (KIE, 2006). This method requires much planning and preparation. It is teacher-centred hence learners have no opportunity to manipulate the learning materials. The teacher encourages the learner to ask questions to arouse curiosity and this helps the learners to develop positive attitude towards practical work. This method can be used as a means of introducing or approaching a new topic. It can be used to address ideas, principles and concepts for where words are inadequate. Students' participation may be limited to a few of the most vocal children. The phenomena demonstrated may not be seen equally well by all members of the class (Nayak & Singh, 2007).

2.10.3 Class Discussions

The most common type of collaborative methods of teaching in a class is classroom discussion. It is a democratic way of handling a class where each student is given equal opportunity to interact and put forth their views. A discussion taking place in a classroom can be facilitated by a teacher or by a student. A discussion could also follow presentation or a demonstration. Class discussion can enhance student understanding, add context to academic content, broaden student perspective, highlight opposing viewpoints, reinforce knowledge, build confidence and support community in learning. The opportunities for meaningful and engaging in class discussion may vary widely depending on the subject matter and format of the course (Petrina, 2007).

An effective classroom discussion can be achieved by probing more questions among the students, paraphrasing the information received, using questions to develop critical thinking with questions. This method helps the learners to gain respect on position of others they participate. It involves more talk than action and requires more careful planning (Nayak and Singh, 2007).

2.10.4 Project Method

Project work is extension or expansion of class experiment, demonstration and class discussion. It provides for laboratory activity that permits self-direction, exploration, the nurturing and satisfaction of scientific curiosity and creativity. Each learner has a chance to achieve certain objectives according to one's ability and interest. The project work can be done through, special classes, chemistry club and science club. Ideally, the learners should find problems and projects for themselves. However, most learners will need stimulating suggestions, possibly in form of a list of suitable project. The teacher should not force the learners into project activities but should encourage them to participate. Project work gives the learners opportunity to investigate some concepts mentioned in class to a deeper level. The learners are to put into practice the skills knowledge and ideas already acquired in class.

The project method is time consuming. Time for individual consultations, suggestions and guidance should be availed by the teacher. Learners by themselves are incapable of planning project activities and hence require teacher's assistance.

2.10.5 Question and Answer Method

This method is used to review a previous lesson, introduce a topic or review past examination questions. For effective use of this method, the teacher should think of the questions that will enable one carry out the session to the end of the lesson. The learners should be involved as much as possible by encouraging them to also suggest some questions on the review. In this learning process the teacher should guide and summarize the learner's questions and responses to focus on the objectives of the lesson. Summary should be related to the concept of the lesson (Nayak & Singh, 2007). This method stimulates analytical thought and diagnose students' difficulties. It motivates the learners and determines progress towards specific goals. Since the learners feel discourage when there are many incorrect answers, the teacher has to make sure there is a balance between correct and incorrect answers (KIE, 2006).

2.10.6 Field Trip

Field trips involve visits to places outside the classrooms such as industries, water purification and treatment plants, sewage disposal/treatment plants, laboratories. This trips help in correlating classroom work to real life experiences. The exposure has a special appeal and teaching/learning value. Trips also enrich coursework by stimulating learners and utilizing of local/community resources. Thorough preparation is essential when using trips as teaching/learning method. The teacher has to explore the place to be visited and make arrangements. Teacher has to prepare guidelines to be followed by the learners which are based on education value of the trip. Schedule of the visit must be properly integrated with the topics to be covered (KIE, 2006).

This method contributes to the course work by stimulating learners and utilizing local community resources. It correlates classroom work to real life experiences. Arranging a good field trip consumes a considerable amount of time. It is also expensive (Nayak & Singh, 2007).

There is no one best method of instruction. These methods overlap considerably to ensure that desirable outcomes are attained. A combination of these methods is necessary in achieving the stated objectives. Use of effective student-centred instructional approaches has a significant impact on the learning outcome especially in abstract topics (Sola and Ojo, 2007). Chemistry teachers should therefore play their part in solving this problem by embracing such instructional strategies. A good student centre approach to the teaching and learning at all abstract topics in Chemistry should therefore be emphasised because they are much difficult to internalise (Twoli, 2006). In practice, science as a process involves an integration of knowledge, skills and attitudes to develop scientific understanding. Practical work in science can include experiencing phenomena, developing practical skills or techniques and carrying out investigation.

A variety of needs that need to be encouraged; working in pairs to address a problem, using a wide range of contexts and allowing for creativity in projects so that the boys and girls can pursue tasks that are interesting (Kay, 2006). Activities that encourage students to be resourceful and construct their own knowledge should be promoted. In addition computers should be integrated into a variety of contexts and subject area. This being the 21st century, the present study will contribute positively to the realisation of the need to adopt instructional approaches that can enhance achievement and positive students' attitude towards Chemistry.

2.11 Co-operative Learning Approach

Cooperative learning refers to a method of instruction whereby students work together in groups to reach common goals. In contrast to the conventional method where students work individually or competitively, with cooperative learning students help one another and benefit from sharing ideas. It is the instructional use of small groups so that students work together to maximize classroom learning and accomplish shared learning goals (Liang & Gabel, 2005). Agashe (2004) noted that cooperative learning is a teaching approach involving students' participation in group learning that emphasize positive interaction. It is a strategy by which small teams each with students of different levels of ability are engaged in learning activities to improve their understanding of the subject. The participation of every student in the group and cooperation among group members is considered important. The students are rewarded for their individual and collective efforts (Muraya & Kimamo, 2011).

Zanaton (2007), noted that cooperative learning represents a shift in the educational paradigm from the teacher-centred approach to a more student-centred approach or to a more student-centred learning in small groups and it creates excellent opportunities for students to engage in problem solving with the help of their group members. There is a difference between simply having students work in a group and structuring groups of students to work cooperatively. Putting students into groups does not necessarily gain a cooperative relationship. It has to be structured and managed by a teacher.

Several models of cooperative learning have been developed including:-

(i) Jigsaw models.
(ii) Group investigation models
(iii) Learning together models
(iv) Students Teams Achievement Division (STAD)
(v) Teams Games Tournaments (TGT)

Slavin (1995), identified Students Teams Achievement Divisions (STAD), Team Games Tournament (TGT) and Jigsaw Cooperative Learning Models. Arends (1997), also identified STAD and Jigsaw group investigation and learning together models. STAD was adopted in this study because it is the simplest and straight forward model of cooperative learning. This model was developed by Slavin 1995.

The STAD model subdivides the learning/teaching process into different phases; Explanation by the teacher of the topic to be studied, subdivision of the class into small heterogeneous groups (group work), individual assessment, correction of the test and final grading. Groups should contain 4/5 students and must be heterogeneous so that in each group the different level (good, fair, poor) are represented, as well as both sexes and different socio-cultural backgrounds. In the group work the student task is to assimilate the concepts learned during the lesson and help their companion to do so. Students take weekly quizzes on the academic materials which are scored and each individual is given a score. A team average score is calculated and announcements are made of the teams with the highest average score, students with highest improvement scores and students who have perfect scores on the quizzes. This system of progress assessment allows each student to contribute to the group, if and only if he or she does his/her best and demonstrate a substantial improvement as the work develops (Moraya & Kimamo, 2011).

Cooperative learning has specific distinctive elements that distinguish it from other teaching and learning approaches. Johnson *et al.* (1994), cited in Muraya & Kimamo, 2011) proposed five essential elements that are necessary to construct positive effective cooperative group learning situations; positive interdependence, face-to-face promotive interaction, Individual and group accountability, interpersonal and small-group skills and group processing or evaluation.

2.11.1 Positive Inter-dependence

In traditional classrooms, where competitions is emphasised students experience negative interdependence, competing with one another for educational resources and academic recognition competition encourages better students to boast and to celebrate their successes at the expense of other students. In cooperative learning classrooms, students work together to ensure the success of each student. Positive interdependence teaches students that school life for each one of them is enhanced when everyone succeeds: students must see that their success of the other students in the group (resting positive interdependence requires a teacher to craft tasks that require insights and efforts of more than one person. Positive interdependence can also be promoted by linking the grades given in an assignment not just to an individual performance but of the other group members.

2.11.2 Face to Face Promotive Interaction

In cooperative learning situations, students interact, assist one another with learning tasks and promote one another success. The small group setting allows students to work directly with one another to share opinions and ideas: to come to common understanding and to work as a team to ensure each member's success and acceptance. Students must have time and opportunity to exchange ideas orally and discuss the concepts at hand. This occurs as structured time for discussion during class, often with the discussion scan folded by a series of questions or controversies posed by the teachers. To ensure student discussion, the groups may be required to report to the rest of the class and have individual students make summaries of the discussion. In addition, to promote interaction can be achieved through assigning each student in the group a specific role such as facilitator, recorder, time keepers etc. This provides every member of the group an entry point for participation and begins to generate individual responsibility within the group.

2.11.3 Individual and Group Accountability

In cooperative learning settings, each student is held accountable for his or her own academic progress and task completions, apart from the accomplishments of the group as a whole, individual may also be held accountable by means of grades based on their academic achievement. Students must be accountable both for contributing their share of the work as well as for the group reaching its common goal. The aspiration of Cooperative learning is to enable all students to benefit from the insights and skills of their colleagues and thus each improve their own learning. Individual and group accountability is achieved by grading students both on their individual work and on the work of the group for example both on an individual test and on group performance.

2.11.4 Interpersonal and Small Group Skills

Cooperative learning offers students a chance to develop the interpersonal skills needed to succeed at school work and within the community. Examples of Cooperative skills: Active listening to all members of the group, allowing all members of the group to verbally participate in discussion, being critical yet supportive of alternative views, maintaining opinions until convincing contrary evidence is provided, learning how to ask clarifying questions, effective communication understanding and appreciation of others, decision making, problem solving: conflict of resolution and compromise among others.

2.11.5 Group Processing or Evaluation

Groups of students need to evaluate and discuss how well they are meeting their goals, what actions help their group and what actions seem to hurt group interaction. They may articulate these evaluations during class discussion or provide the teacher with written progress reports. Students should also have a way of alerting the teacher to group problems. The teacher must develop plans for engaging students in problem solving and conflict resolution. Students must have opportunity to discuss how the work of the group is going, what has been successful, and what could be improved. Engaging in group processing enable students to improve their skills in working cooperatively, learn to address difficulties or tensions within the group and experience the process of conflict resolution that are essential in work place (Muraya & Kimamo, 2011).

2.11.6 Comparison Between Cooperative Learning Model with Competitive Learning and with Individualistic Learning Model

In co-operative learning situations, students provide more social support, both personally and academically than the students in competitive or individualistic students (Johnson & Johnson, 2010). Social support has been shown to promote more positive relationships, result in an increase in motivation and persistence in working towards the shared goals, as well as more satisfaction commitment to group goals, productivity and personal responsibility for achievement; (Salvin, 2011). Cooperative learning results in positive social relationships among participants (learners and teachers) and expands the circle of companionship among the students.

Cooperative learning has been shown to promote positive attitudes of students towards their own learning than do competitive or individualist learning environment, because students work together for shared goals (Johnson & Johnson, 2005). Vaughan (2002) from his studies argued that students in the Student Teams Achievement Division (STAD) group had positive attitudes towards mathematics after STAD was implemented. Similar research studies showed a strong relationship between cooperative learning methods and greater positive attitudes of students towards their own learning.

Mengeluo and Xiaoling (2010) investigated students attitude and showed that in cooperative situations, students believed that, their teacher paid more attention to their feeling students also noted that their peers liked to help one another and they were motivated to learn.

Le and Thanh (2010) investigates students attitudes toward cooperative learn and the attitudes towards their subject matter in victnamess setting of higher education. The results of these studies indicate that students working in cooperative learning groups enjoyed cooperative activities and obtained more knowledge because cooperatives learning improve their relationships with their peers decrease conflict in the group and enhanced self-esteem.

Cooperative context has been agreed enhanced the use of problem- solving, critical thinking and oral communication skills (Johnson, 2003; Adeyemi 2008); and interpersonal skills (Baker & Clark 2010). Cooperative learning facilitates greater improvement in self- esteem than, does competitive or individualistic learning environment (Johnson & Johnson; 2005). Thanh- Pham (2011), reported that cooperative learning promotes more use of higher level learning skills, more posture cohesion among participants, higher self- esteem in learning and more positive feelings towards learning task. These gains in cooperative learning groups may explain by two factors. Firstly students felt that they achieved more by learning trough this method and secondly, this was an improvement in social relations among students (Johnson and Johnson 2009).

2.12 Effects of Cooperative Learning on Students' Learning

Cooperative learning has many positive effects on a range of student's outcomes including academic achievement and social skill development (Ferrer, 2004). According to Agashe (2004), Cooperative learning was found effective in teaching science in such a school in India where it improved in individual achievement and development of social skills among learners. Lacarruba (1993), reported that during cooperative learning lessons, primary school children were actively involved in reading, listening, discussing or performing tasks and students expressed the desire to continue with task she further observed that, shy, quiet students began to express opinions and preferences within their cooperative group and began to participate more regularly in the whole class discussions. Research studies in diverse school settings and across a wide range of content areas have revealed that students engage in cooperative learning approach tend to have higher academic test scores, higher self-esteem, higher-level reasoning skills and collaborative skills, greater numbers of positive, social skills fewer stereotypes of individuals of other races of ethnic groups and a greater comprehension of the content and skills they learn (Johnson *&* Johnson 2003).

In a study where junior secondary students were taught social studies in Nigeria, those taught through cooperative learning approach performed better than their counterparts who were taught through the traditional teaching approach (Adeyemi, 2008). Aronson (2002) reported that elementary students taught through jigsaw cooperative learning approach learnt material faster and performed significantly better on examinations than a control group of students learning the same material through conventional teaching methods. Effandi and Zanaton (2007) further reported that an experimental group of students who were instructed through cooperative learning approach showed significantly higher scores in mathematics achievement test and problem solving skills than control group that was instructed through the traditional lecture method.

Ho and Boo (2007), reported that cooperative learning approach increased academic achievement and motivation to learn physics among secondary school students in Hon Kong as compared to those who were taught through traditional teaching approaches. Armstrong *et al.* (2007), in a study that compared cooperative learning approach and traditional lecture method in an undergraduate biology courses reported that the experimental group that has instructed through cooperative learning approach showed greater improvement in overall tests scores, than control group that was taught using a traditional lecture approach. He further noted that the experimental group performed significantly better on questions requiring both factual knowledge and comprehension than students in the control group who were instructed through the conventional method. Several studies have reported that cooperative learning approach promote higher academic achievement than the traditional teaching approaches. In addition, it promotes the development of social skills, among others that are important in school, work place and life in the community.

Cooperative learning is a structure of interaction designed to facilitate the accomplishment of a specific end product or goal through people working together in groups (Panitz, 1997). Each member of team is responsible not only to learn what is taught but also for helping teammates learn thus creating an atmosphere of collective achievement. Zaksaria and Iksan (2007) believed that cooperative learning is most effective when students are actively involved in sharing ideas and working cooperatively to complete academic tasks. Toumasis (2004) studied the effect of cooperative learning on 8^{th}-10^{th} grades ability to read and understand mathematical textbooks. He reported that, the working cooperatively helped students form new friendship and learn to appreciate differences in ability, differences in personal characteristics and differences in opinion. The cooperative learning approach to teaching increase not only the understanding of students but also the social and cooperative skills they exhibit. Baghcheghi *et al.* (2011) concluded that cooperative learning is an effective method of improved and increased communication skills of nursing students especially in interactive skills.

Wang (2009) in his research concluded that students got a lot of experience. Students were more motivated to work hard which created a positive atmosphere. Siegel (2005) concluded that because of its potential increase in students achievement and social skills development. Cooperative learning has been advocated for schools to reform. Students were more positive about each other when they learn alone cooperatively or individualistically, regardless of differences in ability ethnic background or being handicapped or not. Cooperative small groups learning is a pedagogical practice that helps learners to gain and create both academic and social relationships as well as accomplish shared goals. Gillies and Boyle (2010) reported that through such interaction, students learn to cross-examine issues, share ideas, elucidate difference and construct new understanding. Webb and master group (2003) from their research findings has showed that very few teachers who implemented cooperative learning milled could not even consider some aspects of the learners being organized on the basis of academic achievement interest and gender. These may inturn degrade and worsen the students, perception towards cooperative learning activities. Cooperative learning is better when students are organized based on their interest and academic achievement. Similar findings were reported by Fiszer (2004) who explained the significant learning gained when students are organised by their level of interest and learning performance.

Anto *et al.* (2003) revealed that classroom size lack of proper training on cooperative learning, lack of pedagogical knowledge and skill, lack of supportive materials are the substantial factors that are encountered on cooperative learning implementation. Cooperative learning has been linked to increase in the academic achievement of learners at all ability levels. Fajola (2000) and Balfakh (2003) reported significant differences between students of high, medium and low ability level in favour of high medium respectively. Igbal (2004) reported no significant differences between the mean scores of high achievers of the experimental and control groups. Yusuf (2004) reported that achievement levels had no influence on academic performance of learners. Other studies have found that high medium and low achievers were favoure in cooperative learning settings (Yager *et al.* 1995). Implications of these findings is that computer-assisted instruction to better in cooperative learning setting than individualised settings.

2.13 E-Learning

E-learning is the use of electronic media, information and communication technologies (ICT) in education. E-learning is broadly inclusive of all forms of educational technology in learning and teaching. It is broadly synonymous with multimedia learning, technology enhanced learning (TEL), Computer Based Instruction (CBI), Computer-based training (CBT), Computer-Assisted instruction or computer-aided instruction (CAI), Internet-based trained (IBT), Web-Based training (WBT), Online education, virtual education, M-learning and digital educational collaboration (Tavangarian *et al.* 2004). E-learning includes numerous types of media that deliver test, audio, images, animation and streaming videos. It includes technology applications and processes such as audio or video tape, Satellite TV, CD-ROM and Computer-based learning. Various technologies are used to facilitate e-learning. Most e-learning uses combination of these technologies including blogs, collaboration software and virtual classrooms. E-learning can occur in or out of the classroom. It can be self-paced, asynchronous learning or maybe instructor-led synchronous learning. E-learning comes in many media formats as shown in Figure 1.

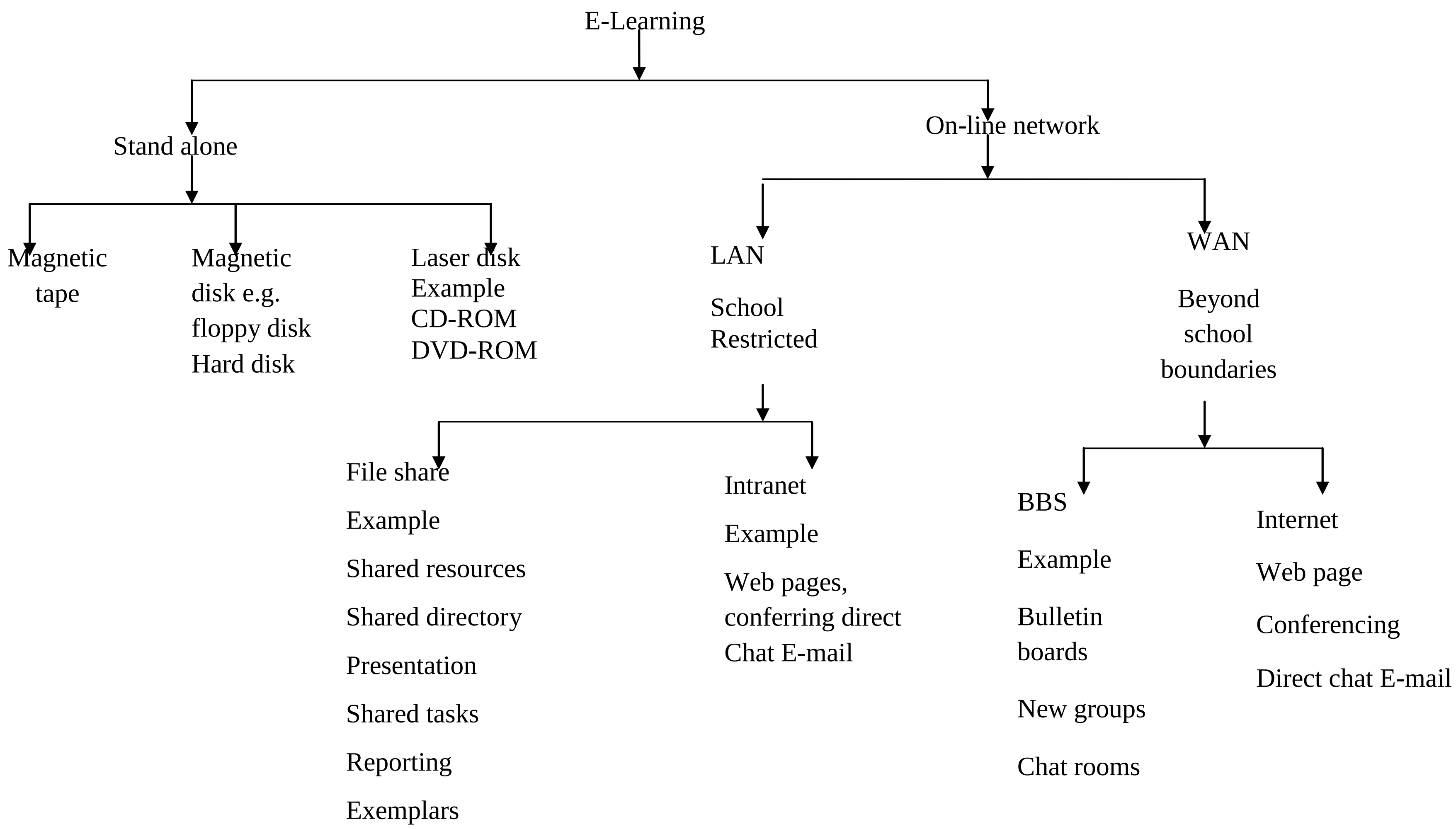

Figure 1. Media Formats of E-learning

If a computer is stand alone, then we have Computer Learning (CL) that can be used as either Computer Based Learning (CBL) or Computer Assisted Learning (CAL). CBL involves the computer taking the place for the most part of the teacher and is popular in distance education. CAL involves a teacher using e-learning to supplement face to face teaching (Hong *et al.* 2001 cited in Paris, 2004). This also applies to computer.

Hong *et al.* (2001) reveals that e-learning is becoming progressively an integral part of the secondary school to curriculum learning processes.

Computer usage in secondary schools has made many positive impacts and development into learning. However with reference to Computer Based Learning (CBL) Woodrow (1991) points out that monitoring teacher and student attitude is significant for communal usage, acceptance and success.

E-learning can also bring many advantages as it accommodates different learning styles and fosters learning through a variety of activities that apply to different learning styles; it enables "learning by doing" simulators. At the same time, it allows students to select learning materials or to be directed to content that meets their level of knowledge interest and what they need to know to perform more effectively in their particular activity (Gachange, 2007).

Gachange (2007) reported that e-learning incorporates speed, flexibility and control for the learner where a teacher may fall shy of words; the audio capability can step in. More so it has been claimed that e-learning can break down cultural and geographical boundaries and give more citizens access to learning than was previously possible. E-learning is not only cost-effective and convenient but, it can train a large number of users at onetime, especially with the use of a projectors, one computer per class might be sufficient (Omondi, 2009).

The computer has not only witnessed a wide range of application in virtually all human endeavors. It has also actually transformed the world on global village in such a manner that its contribution to human development over the years cannot be over emphasised. The computer plays a central role in information data collection, processing and dissemination. Thus use of computer is invading the educational system in away unparalleled in previous education history (Onasanya & Adegbija, 2007).

Inoorero University's E-learning uses different electronic forms to create effective communication that enables interaction similar to conventional classes. The learners for example get assignments from the learning portal and submit their work using internet. They can also hold classroom discussion and tutorials online. If required contact classes may be arranged at suitable times. In the near future electronic learning will replicate the classroom environment by providing online video lecture notes and hand-outs will also be made available on the learning management system (Nation Correspondent, 2012).

2.13.1 E-learning and Attitude towards Chemistry

Moll *et al.* (2007) define E-learning as flexible learning using ICT resource tools and applications focusing on accessing information interaction among teachers, learners and the online environment. E-learning is the use of technological intervening for teaching learning and assessment (Miltwa & Van Belle, 2011). It enables learners to improve problems solving skills, empower knowledge effectively. Milham *et al.* (2014) reported that E-learning is essential for the improvement of learner's performance, engagement, self-regulation, flexibility interest and motivation. It promotes active participation and self-regulated learning which enables construction learning-pace adjustment and gives desired learning outcomes. Sibanda and Donneky (2014) determined the impact of e-learning on performance, showing that learners performance increased after the introduction of online learning as years progressed and learners became academically engaged as they became more familiar with the online learning platform.

E-learning according to Markus (2005) is defined as a learning process created by interaction with digitally delivered content, network based services and tutoring support. E-learning may technically mediate learning using computers whether from a distance or in face to face classroom setting. Computer assisted instruction (also called computer-based learning or computer based training) uses computers to aid in delivery of stand-alone multimedia, packages for learning and teaching. E-learning is more efficient because learners gain knowledge, skills and attitudes faster than through traditional instructor lead methods. Means *et al.* (2009) in his studies concluded that students using e-learning performed better than students using who did not use it. Studies also indicate positive outcome of the use of CAL in teaching Chemistry. Ezeudu & Ezinwanne (2013), Kargben and Siraj (2009), maintain that the use of computers enhances learning and develops interactive learning environment resulting in students improved achievement. Cotton (1991) cited in Ogembo, (2017) found out that computer assisted learning enhanced mastery exponentially with users learning as much as 40% faster and retaining learnt content, which can lead to more positive attitude and achievement than conventional methods of instruction. According to researchers, CAL tools that enable visual representations enhance instruction of Chemistry concepts by providing easier and clear illustrations than those a teacher could make. Similarly Yushau, Mji and Wessels (2003) in their findings reported that visual representation of CAL tools supports student's mastery of Chemistry concepts more than diagrams in books. Other positive outcomes of CAL supported instructional resources reported include: use of computer assisted instructions to support students understanding of chemical formulas and mole concepts. Results obtained showed significant improvement in attitude of students in the experimental groups compared to those in the control groups.

Garanga *et al.* (2012) reported that computer assisted learning positively impact student's achievement in structure and bonding. This was also supported by Fraitich, Kesner and Hofstein (2007) who in an investigation of the influence of integrating a website into chemistry teaching of chemical bonding, found that the tool enhances learner's comprehension of Chemistry concepts and increased their awareness of the relevance of Chemistry to daily life.

Existing empirical data show contradictory research findings on the effect of use of ICT tool such as CAL on student's attitude and achievement in general and in Chemistry. Becta (2004) reported that negative attitude was a barrier towards integration of ICT in teaching and learning. Kubiatko and Italakova (2009) pinpointed that learners attitude toward use of ICT in teaching and learning was mainly based on its perceived impact. Slout and Barton (2007) added that ICT can motivate students in the learning by varying stimulus in lesson. Presentation and even sustaining the teachers interest in teaching. Ozman (2007) in an initial pre-test result reported no statistically significant differences between control and experimental groups, suggesting similarity of group composition irrespective to attitude. Comparative analysis of pre-test and post-test scores using an independent t-test scores using an independent t-test showed a statistically significant difference between groups in favour of the experimental group implying that positive impact on CAL on students attitude in Chemistry. Similar findings with the regard of effect of CAL on students' attitude in Chemistry had also been documented by among others (Akcay *et al.* 2003).

In a similar study of effect of computer simulations on students success and attitudes in Chemistry found out that though there was no significant difference between pre-test and post-test of control groups, a significant mean difference was found between pre-test and post-test of experimental groups indicating that computer-based education is more effective than conventional methods in moulding students attitude towards Chemistry (Ogembo, 2017).

2.13.2 Computer Based Instruction

The Computer Based Instruction makes teaching technique far more effective than those of the traditional teaching methods as it is used for presenting information, testing, evaluation and providing feedback. It makes contribution to the individualization of education. It helps to develop creativity and problem solving skills, identify and self-reliance in learners. CBI provides drawing graphics, and plenty materials for the students to proceed at their own pace and in line with their individual differences. It serves to control lots of variables having an impact on learning which cannot be controlled by means of traditional technique (Kash, 2000; Chang, 2002).

Heinich *et al.* (2002), emphasise that the teacher must provide opportunity for learners to complete their work and learn effectively. If this strategy is to be effective, the teacher needs to plan in advance to integrate the computer into teaching and learning, prepare good learning environment for the students and work in collaboration with students during research period. He believes also that when the computer is integrated into the curriculum, students will be able to incorporate several different types of computer applications to explore a problem in a particular field. So the traditional method of teacher centre instruction used by most teachers will change. The students will learn too by doing, which is the cornerstone of all science learning. Students will also create meaningful learning experiences for themselves (Odera, 2011).

Liao (2007), found out that CBI had positive effect on individual by comparing 52 research studies carried out in Taiwan in his meta-analysis study. Senteni (2004) also found that CBI enabled students to increase their motivation and achievements and to develop positive attitudes. According to research studies in literature, the use of computer-based education increased students' attitudes and achievements significantly (Geban, 1995). It has been found out that CBI serves to develop meta-cognitive skills in students and help them to learn in meaningful way instead of rote-memory learning as well as it enables them to increase their achievement. (Renshaw & Taylor, 2000). Jimoyiannis and Komis (2001), examined the effect of the computer simulations on students to understand the orbital movements, by using basic concepts related with kinematics in a study made in physics teaching. As a result of this study it was seen that teaching basic concepts of kinematics through simulations brought about successful results and has contributed highly to learning processes. It is concluded that the teaching realized by the simulation program with an applied dynamic system is more successful than the teaching implemented by the traditional methods (Karamustafaoglu *et al.* 2005).

Abimbola (1983), reported that students exposed to a programmed instruction recorded higher and more favourable attitude towards mathematics. Similar results were obtained by Udousoro (2000), after using computer and text assisted programmed instruction.

A study was also carried out in Kenya among the NEPAD and non-NEPAD schools on the efficiency of computer technology in education (Ayere, 2009). The NEPAD schools on average had a wider variety and higher quantity of ICT equipment compared to the non-NEPAD schools. The NEPAD schools made use of the internet and online materials in research, electronic mail and ICT integration in teaching and learning as opposed to non-NEPAD schools. The study identified number of computers in schools, rules and regulations from the ICT department and the number of computer literate teachers as important factors that determine a students use of an ICT laboratory. The study concluded that the NEPAD schools that had a wide variety and high quality ICT equipment posted significantly better performance in national examinations compared to Non-NEPAD schools.

2.14 Cooperative E-learning and Students Achievements

Cooperative learning and technology are said to be natural partners because use of technology involves human dimensions of caring community and commitment. Using technology to promote sequenced learning within groups can lead to more in depth processing of course content and hence more retention of information (Millis & Cottell, 1998). The use of computers in classrooms to assist students achieve cooperative learning goals have increased since the 1980's (Slavin, 1980). Increased communication and social activity has occurred in many instructional settings that use computers. Using of group work strategy increase students access to the few computers available. Webb (1987), reviewed the literature concerning peer interaction and learning with computers in groups. She concluded that group work with computers was feasible and capable way to learn and it was possible to design group learning settings that can be beneficial to most students.

Howe *et al.* (1992), examined the role of group interaction in computer supported teaching. They concluded that, software that support computerized group work, requires students to explicitly state and agree on their join predictions. The approach offers a good medium for class room discussions that can facilitate participation and social interaction among students and between teachers and students (Shellens & Valckel, 2005). There will be interactions among members of the small groups during which the notion of individual responsibility is reinforced by the fact that it has a strong effect on the group assessment (Zhao *et al.* 2012).

Johnson and Johnson (2008) from his research findings indicated that the computer supported cooperative learning improves student learning and increase their academic achievement in problem solving skills and task related to student interaction. Students using computer assisted learning in cooperative learning settings performed well than students using the same individually (Yusuf & Afolabi, 2010).

Hopper (1992), extensively researched on behaviour surrounding the cooperative behaviour of giving and receiving help while using a computer between higher and lower ability students. He found that high ability students generated and received significantly more help in groups of similar ability levels than placed in groups of mixed ability levels. Hoppers' findings also suggested that when grouped heterogeneously, high ability students receive lower amounts of stimulations in conversation with lower ability students.

Research examining the interaction of cooperative learning and computing consistently uncover positive effects when that research incorporated gender into research. Dalton *et al.* (1989) found significant gender interactions when examine attitude towards computer use. In Daltons' study ratings for high-ability students on their attitudes regarding the computer based instruction were largely unaffected by instructional method. Low ability females had better attitudes regarding the cooperative computer-based treatment than did low-ability males. Yusuf and Afolabi (2010) reported that students exposed to computers assisted cooperative learning settings performed better than those exposed to the same program individually. The success could be attributed to implementation of five elements of cooperative learning which include; face to face interaction, positive interdependence, individual accountability, interpersonal, collaborative skills and group processing.

Currently, secondary school Chemistry teachers in Kenya predominantly use educational resources that incorporate only two dimensions (2D) such as chalkboard illustrations, charts. On addition they perform class experiments, teacher demonstration, class discussions. However, these are not able to help learners grasp certain abstract aspects in Chemistry (The mole). As such the predominant use of 2D materials in teaching the subject may not have a positive and long lasting impact on students, hence diminishing interest and performance in the subject. Often teachers are unaware of the range of innovative computer resources available to improve learning experience for their students. There are inconsistencies in the quality and use of ICT in Chemistry across schools as well as among staff within schools (Odera, 2011). Even though there is evidence of use of computers in Chemistry education in the developed economies, there is little or no corresponding evidence on the same in the developing countries. Inconsistences abound in the use of computer technology in Chemistry education in Kenya that consequently impact negatively on the performance of learners in the subject. There are also cognitively difficult topics or concepts (the mole), which may be illuminated by use of appropriate software that incorporate computers and effective teaching methods.

There is currently limited inclusion of real-world learning experiences in the traditional classroom setting. Fieldtrips, projects are rarely involved in Chemistry subject. The content presented in classroom is disconnected from its real-world content. This has shown negative impact on the learning process. Real world learning situated in real-world contents has been shown to have a positive impacts on learning and learner attitude (Papastergiou, 2009). There is need to provide pre-service and in-service training programs to enable teachers to successfully teach using computers in the classroom (Kinuthia, 2009). Lindahi (2003) argued that if students are not interested in sciences, they tend not to make an effort to learn and understand the meaning of concepts that are being taught. It was shown that the most effective factor contributing to students' decision to study science is their interest in the subject. Hence, the teachers should make an effort of changing the attitudes of learners positively by using effective teaching methods.

Even though research findings indicated that attitudes of students towards Chemistry was positive. There is need to find out whether or not the perceived favourable attitude would be corroborated in specific difficult Chemistry topics. It is necessary to find out if at all the students in Koibatek sub-county would have a positive attitude towards Chemistry, after the application of computer technology n teaching and learning.

2.15 Cooperative E-learning and Attitude towards Chemistry

Research has proven that Cooperative e-learning has been effective in encouraging students' interaction, developing positive attitudes towards better learning and producing positive effects on student achievement. Numerous studies have found that a computer supported STAD cooperative learning setting is effective in improving students' achievement. In this study, STAD Cooperative e-learning has also shown improvement in achievement and positive attitudes towards Chemistry. Yusuf, Ganbari, and Olumorin (2012) reported that students cooperative computer assisted instruction group outperformed their counterparts. Using individualized computer instruction. In such classrooms structure, students discuss subject matter, help each other learn and provide encouragement for members of the group. Yusuf and Afolabi (2010) reported that students in the cooperative computer assisted instruction group showed remarkable post-test mean differences over their respective counterparts who learned the same concepts through conventional methods. However Armstrong and Palmer (1998) found no significant differences in achievement of students taught with conventional methods.

In a study on computer-supported team assisted individualised cooperative learning, Xin (1999) found an improvement in student achievement and positive attitudes towards mathematics. Gupta and Pasrija (2011) revealed the encouraging effects of cooperative learning (STAD) on student's achievement, retention and attitudes towards mathematics. Cooperative (STAD) helps students to develop positive attitudes towards learning and to think independently inside and outside of the classroom (Ajaja & Erarwoke, 2010).

Khan and Inamullah (2011) investigated the effects of Student's Team Achievement Division (STAD) on academic achievement on student's studying Chemistry at higher secondary level in Pakistan. The post-test mean scores indicated that the experimental group taught using the STAD performed better in the test than the control group taught using the conventional methods. From these results exposing students to a computer-supported cooperative learning strategy improves student's performance in science as well as their attitudes towards the subject. A report by Bartish (2015) on disadvantage of using Cooperative learning indicates that the demands of organising cooperative learning makes it difficult to effectively relate performance to each individual learner.

2.16 Theoretical Framework

The theoretical framework of this study was based on constructivist theory. It is a theory which is based on observation and scientific study of how people learn. It says that humans, construct knowledge and meaning from their experience (Bereiter, 1994). The constructivist approach concentrate on the observable inner world of individuals. Constructivist learning theory gives prominence to individual's critical thinking, investigation, and problem solving (Brook & Brooke, 1993). All this depends on an environment where constructivist approach is applied successfully and places where real democracy is experienced. Tam (2000) listed four basic characteristics of constructivist learning environments which must be considered when implementing constructivist instructional strategies.

i) Knowledge will be shared between teachers and learners.
ii) Teachers and students will share authority.
iii) The teacher's role is one of a facilitator or guider.
iv) Learning group will consist of small numbers of heterogeneous students.

The role of the learner is not passive but active (Akar & Yildrim, 2004). This activeness takes form of students' contribution to learning environment by investigating, making mental efforts, searching questioning facts that are known or presented, interacting with others and developing innovative attitudes (Deryakulu, 2000). There are three different roles of the learner; active, social and creative (Yasar, 2010, Taber, 2006 and Ulgen, 1994). The behaviour learners are expected to demonstrate in constructive educational environments are as follows:-

i) To be active in the educational environment.
ii) To assume responsibility in the learning process.
iii) To benefit from very opportunities and possibility.
iv) To evaluate themselves and the group members they work with objectively.
v) To accept every criticism of themselves with tolerance.
vi) To apply what they learn to a new environment.
vii) To use knowledge sources and teaching materials.

In the constructivist classroom the teacher's role is to organise situations which will give way to the learners to manipulate objects or invent meaning on what they are learning. Constructivism requires a teacher to act as a facilitator whose main function is to help students become active participants in their learning and make meaningful connection between prior knowledge, new knowledge and the process involved in learning (Brook and Brooke, 1993).

A constructivist teacher will:-

i) Encourage and accept student's autonomy and initiative.
ii) Use a wide variety of materials including raw data, primary source and interactive materials and encourage students to use them.

iii) Inquire about students' understanding of concept before sharing his/he own understanding of those concepts.

iv) Encourage students' inquiry by asking thoughtful open-ended questions to each other and seek elaboration of student in initial responses.

v) Provide time for student to construct relationships and create metaphors.

vi) Assess students' understanding through application and performance of open-structured tasks.

Learner-centred places emphasis on student learning rather than the teacher teaching.

In this study computer assisted STAD was used, learners were grouped in to 4-5 members. Computer presented the lesson and the learners made sure that all team members had mastered the content. The learners were active not passive and interaction was a lot. Hence the study was in line with constructivist theory. In the constructivist learning approach, learning is carried out by active participation in processes such as discussion questioning and sharing of opinions (Yasar, 2010). It also emphasises that knowledge and meaning is constructed socially by interacting with other individuals, besides individual undertakes or active role in learning process. The creative role of the learner is about activities such as remembering, recording producing new products and maintaining learning in cooperation with group members, learning styles and strategies (Ulgen, 1994).

When we encounter something new, we have to reconcile it with our previous ideas and experiences. We are active creators of our own knowledge. In the classroom, the constructivist view of learning point towards a number of different teaching practices. In this, the learners are encouraged to use active techniques (experiments, real world problem solving) to create more knowledge and then to reflect on task about what they are doing and how their understanding is changing. The teacher makes sure she/he understands the learners. Pre-existing conceptions guides the activity to address them and build on them (Oliver, 2000).

In this study the use of different teaching approaches was recommended for example; demonstration, experimentation, discussion and inquiry based learning. The teacher as a facilitator helps the learners to link to previous experiences. Learners come to learning situations with knowledge gained from previous experiences and that prior knowledge influences the new or modified knowledge. In this they would construct from new learning experiences (Philip, 1995). According to Dricoll (2000) constructivism learning theory is a philosophy which enhances student's logical and conceptual growth. Two of the key concepts within constructivism learning theory which create the construction of an individual new knowledge are accommodation and assimilation.

Assimilation causes an individual to incorporate new experience into the old experiences. This causes the individual to develop new outlooks; rethink what were once misunderstanding and evaluate what is important. Accommodation is reframing the world and new experiences into mental capacity already present. Individual conceive a particular fashion in which the world operate when things do not operate within that context they must accommodate and reframe the expectations with the outcomes.

Constructivist learning is applicable where teaching of complex skills such as problem solving and critical thinking are concerned (Tam, 2000). In this study teaching of mole concept requires constructivist approach of learning. In this the learners will be able to solve problems dealing with moles, molarity, molar solutions and molar gas volumes. The use of cooperative E-learning Approach (CELA) has the characteristics of constructivist learning environment which must be considered when implementing constructivist instruction strategy. In CELA, knowledge is shared between teachers and learners though discussion, question and answer method and the teacher is a facilitator. The groups were heterogeneous of mix abilities.

In order to promote students learning, it is necessary to create learning environment that directly expose the learner to the material being students. For only by experiencing the world directly can the learners derive meaning from them. In this the learner's must be exposed to field trips, project work, visits to industries like, manufacture of sulphuric and nitric acid, Ammonia gas, hydrochloric acid and water purification and treatment plants.

Trips help to correlate classroom work to real life experiences. Project work is extension or expansion of class experiments. Project work gives the learners opportunity to investigate some concepts mentioned in class to deeper level.

2.17 Conceptual Framework

The conceptual framework used in this study is based on the constructivist theory of learning. In this theory Students learn best by trying to make sense of something on their own, with the teacher as a facilitator (Cooper & Robinson, 2002).The framework is also based on the systems theory which holds that the teaching and learning process has inputs and outputs. The input must have suitable materials for good outputs (Joyce & Weil, 1980).

Figure 2 diagrammatically represents the conceptual framework that guided the study.

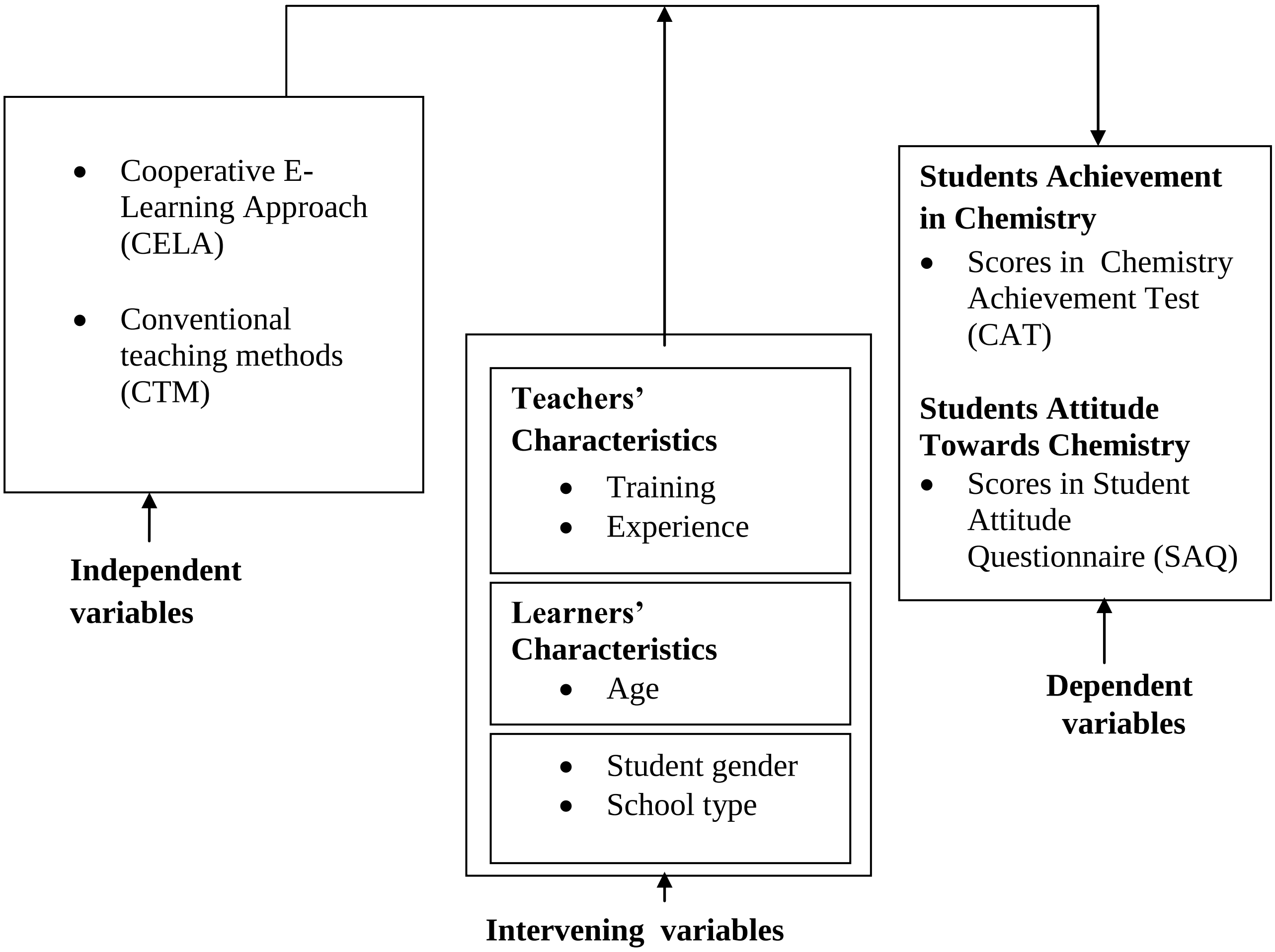

Figure 2. Conceptual Framework showing the Relationship of Independent, Intervening and Dependent Variables of the Study for Determining the Effects of Cooperative E-Learning Approach (CELA) on Students' Achievement and Attitude towards Chemistry.

The independent variables include CELA, Gender, school type and Conventional teaching methods. These variables are conceptualized as factors influencing the dependent variables of the study. The researcher manipulated the independent variables during the research in order to determine its effect in the dependent variable. These are scores in Chemistry Achievement Test (CAT) and scores in Student Attitude Questionnaire (SAQ). The intervening variable can influence the independent or dependent variable by either the researcher not being aware of their existence or of if aware he/she has no control over them. The intervening variables in this study are learner and teacher characteristics. To control teacher's characteristics, only trained teachers of at least two years of teaching experience will be used in the twelve schools. For the learners' characteristics, the learners' age is controlled by involving form three who are of the same age. Gender and school type variables will be address in the study. Gender variable will be used to answer the questions of whether there are gender differences in chemistry achievement scores and student attitude scores.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the methodology that was employed in this study. It consists of the research design, population of the study, sample and sampling procedures, instrumentation, data collection and analysis procedures.

3.2 Research Design

The study used Solomon Four Non-equivalent Control Group Design. The design helps to achieve four main purposes namely: To assess the effect of experimental treatment relative to control conditions, to assess interaction between pre-test and treatment conditions, to assess the effect of pre-test relative to non-pre-test and to assess the homogeneity of the groups before administration of the treatment (Mugenda & Mugenda (2003), Fraenkel & Wallen, 2009). According to Best and Khan (2003) it is difficult to ensure equivalence of the experimental and control groups in a school by random assignment of students because classrooms are formed as intact groups that cannot be dismantled for the purpose of the study. The design is strong enough to compare the effect of treatment, control and all major threats to internal validity except those associated with maturation, history and instrumentation. Table 4 shows Solomon Four Non-equivalent Control Group Design.

Table 4

Solomon Four Non-equivalent Control Group Design

Group	**Pre-test**	**Treatment**	**Post-test**	
E_1	O_1	X	O_2	Experimental
C_1	O_3	-	O_4	Control
E_2	-	X	O_5	Experimental
C_2	-	-	O_6	Control

Source: Fraenkel & Wallen (2009)

Key

(O) - Indicates observations or outcomes at pre-test and post-test phases

(O_1) Pre-test for group one (O_4) Post-test for group two

(O_2) Post-test for group one (O_5) Post-test for group three

(O_3) Pre-test for group two (O_6) Post-test for group four

(X) - Indicates treatment

(..............) - Indicates the use of non-equivalent groups

In the experimental groups (E_1 and E_2), CELA was used in teaching the topic 'The Mole' while the control groups (C_1 and C_2) were taught by using conventional method. To avoid interaction of students from different groups that may contaminate the results of the study, one class from a school constituted one group of subjects; hence twelve schools were required for the study. The four groups in each category were randomly assigned to treatment and control conditions. Each group had one boys, one girls and one co-educational school.

3.3 Location of the Study

The study was carried out in Koibatek sub-county. It is one of the sub-counties in Baringo county. Koibatek sub-county shares borders with other sub-counties. Rongai sub-county to the south, Uasin Gishu county to the West, Baringo Central to the North and Baringo South to the East. The sub-county has one national school, variety of county schools, extra-county and sub-county schools. The schools were located along Nakuru-Eldama Ravine road and Nakuru-Kabarnet road.

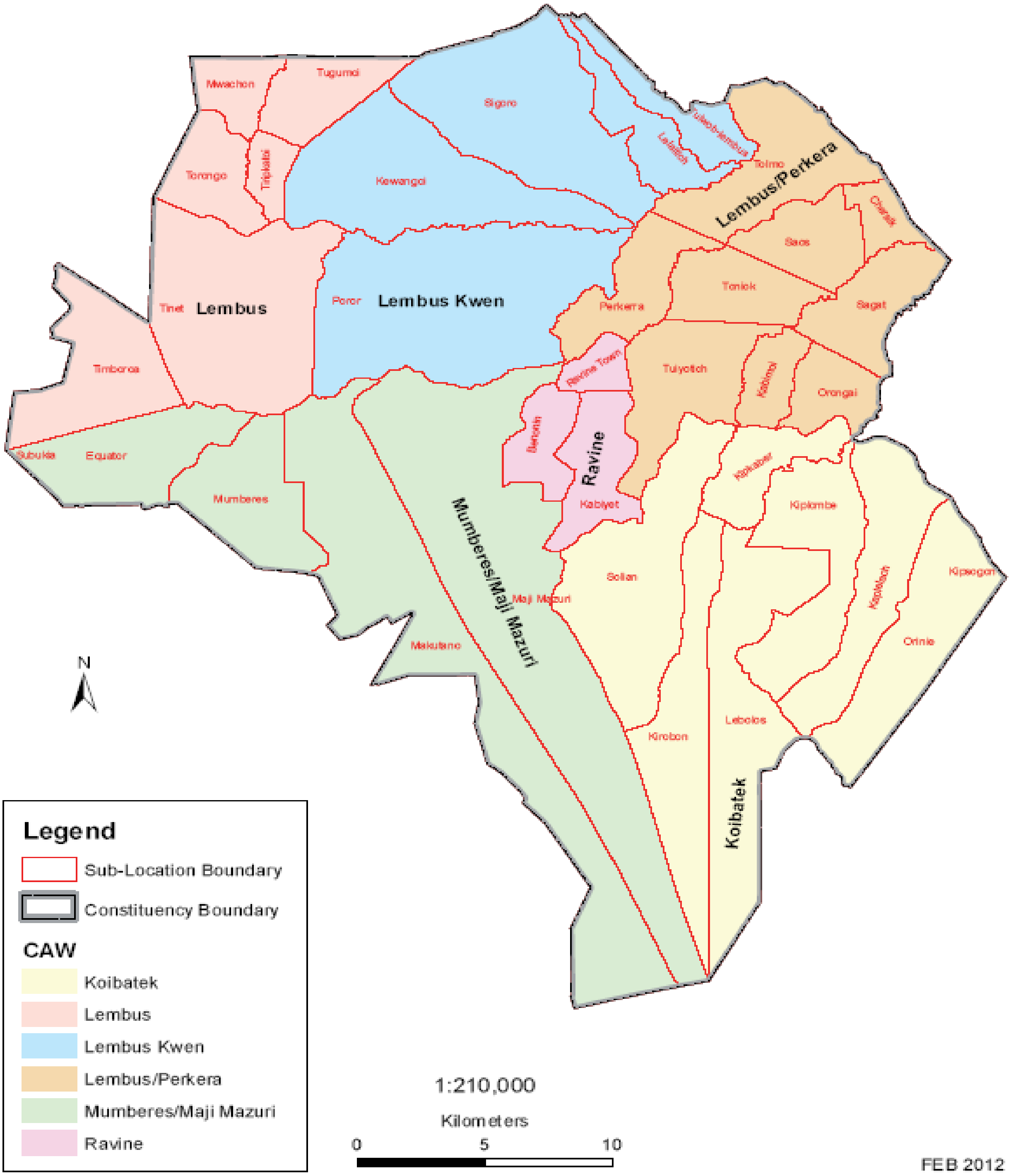

Figure 3. Map of the Study Area

Source: County of Kabarnet website.

3.4 Population of the Study

The target population was all students in public secondary schools in Koibatek sub-county. Information from the statistics obtained from the sub-county Education office indicated that there were 11,073 students in all secondary schools in Koibatek sub-county. The accessible population were form three students. The statistics from the education office indicated that there were 2,718 students.

Form three were chosen because the topic 'The Mole' is taught in this level in all Kenyan Secondary Schools (KIE, 2000). Also the learners in this level have fully selected the subject that they will be examined on for the KCSE examinations.

3.5 Sampling Procedure and Sample Size

3.5.1 Sampling Procedure

The sampling techniques used in the study for selection of schools and students for the study was purposive sampling and simple random sampling. Purposive sampling was used to select twelve county schools in Koibatek sub-county. The schools were selected such that, there were four boys schools, four girls schools and four co-educational schools. The four schools in each category were randomly assigned to each of the four groups (E_1,E_2,C_1& C_2). Each group had one boy school, one girl's school and one co-educational school. Purposive sampling allowed for the use of cases that had the required information such as equipped laboratory, computers in their schools with respect to objectives of the study. The researcher visited the sampled schools to ascertain that they had the required facilities for research and also obtained the information on class composition, learners and teachers characteristics. Schools which offered computer studies as one of the examinable subject at KCSE level were selected. Equipped laboratories in these schools were also considered. It was assumed that, teachers trained with teaching experienced of at least two years, taught at the same level. In schools with more than one stream taking Chemistry, all the streams were taught the same content using similar approach for the control or experimental groups. After the treatment, one stream was randomly picked from each of the schools as advocated by Fraenkel and Wallen (2009).

3.5.2 Sample Size

Mugenda and Mugenda (2003) argue that the sample size depends upon the numbers of variables in the study, the type of research design and the method of data analysis. For experimental studies at least 30 students per group is recommended. In this study each school provided one form three class. The actual sample size that participated was 489 form three students, sampled as shown in Table 5.

Table 5

Sample Size of the Study

Group	Type of school	Number	Number of each group
E_1	Boys	48	
	Girls	46	141
	Co-educational	47	
E_2	Boys	40	
	Girls	50	123
	Co-educational	33	
C_1	Boys	41	
	Girls	40	120
	Co-educational	39	
C_2	Boys	34	
	Girls	40	105
	Co-educational	31	
Total			489

Table 5 shows the total number of respondents selected from the twelve county schools in Koibatek sub county. The total number was 489 students. According to Solomon Four Non-equivalent Control Design, the twelve schools selected for use in the study represented the sub-county as a whole.

3.6 Instrumentation

Two instruments were used;

(i) Chemistry Achievement Test (CAT)

(ii) Student Attitude Questionnaire (SAQ)

3.6.1 Chemistry Achievement Test (CAT)

The Chemistry Achievement Test (CAT) (see Appendix B) was developed by the researcher to assess the learners mastery of content on the topic 'The Mole' in secondary Chemistry. Nineteen items of short answer and structured questions on mole, based on KICD Chemistry syllabus was used in scoring of short answer items and structured items (KIE, 2002). These items tested knowledge, comprehension and application of learned materials. The total score was 50. The items were scored using a standardized marking scheme and the scores attained was recorded and used during data analysis.

3.6.2 Student Attitude Questionnaire (SAQ)

The Student Attitude Questionnaire (SAQ) (See Appendix C) was adapted from (Rockwood, 1997: Abulude, 2009) and modified to suite the study. The instrument comprised thirty (30) items. The items aimed at assessing students' level of attitude towards Chemistry, using CELA and conventional teaching methods. The instrument contained closed-ended and based on the five point Likert scale ranging from Strongly Agreed SA to Strongly Disagreed SD. Scoring of each positive item in the SAQ was done using the key SD=1, D=2, U=3, A=4 and SA = 5 while negative items were scored using the key SD = 5, D=4, U=3, A=2 and SA =1.

3.6.3 Validation of the instruments

Validity of research instruments is defined as the accuracy with which it measures what it is intended to measure. It is the degree to which the instruments measure the variables it claims to measure (Mugenda & Mugenda, 2003). The instruments CAT and SAQ were checked by two supervisors in the Department of Curriculum Instruction and Educational Management (CIEM) of Egerton University and experienced secondary school Chemistry teachers. It was moderated by education specialists from the Department of CIEM of Egerton University. They examined the instruments and suggested modification that could be made on them in order to make it appropriate for use. Comments from them were used to improve the instruments.

3.6.4 Reliability of the Instruments

Reliability of an instrument is the degree of consistency with which it measures what is expected to measure. It refers to consistency of the information supplied by the instrument (Wallen & Fraenkel, 2000). The instruments were pilot-tested in two schools in Koibatek sub-county which was not part of the study but having similar characteristics as the sampled schools. Reliabilities of the instruments were estimated by the use of Cronbach's alpha because the items yielded a range of scores (Thorndike & Thorndike, 1994). CAT had a reliability coefficient of 0.87 and SAQ had 0.78. The reliabilities are above 0.7 hence acceptable (Fraenkel & Wallen, 2009).

3.7 Development and Use of Teaching Materials

The content used in the class instruction was developed and based on the revised KICD, 2002 chemistry syllabus, teachers guide, students' text book and other relevant materials. Teachers module include the content to be covered, lesson plan to be used in teaching the topic 'Mole' in form three chemistry and the use of computers. Student manual was the CELA modules which introduce the learners to the use of computers in learning topic 'Mole' in chemistry.

The teachers in the experimental groups were trained by the researcher on the use of the module and cooperative learning for one week to the commencement of the treatment (Appendix D). They were given the modules by the researcher. In the control groups, the conventional teaching/learning methods were used. Classes in all the four groups used the same curriculum materials and spent five weeks on the topic mole as recommended in the syllabus.

3.8 Data Collection Procedure

The researcher sought permit to conduct research in the sampled schools in Koibatek sub-county from the National Commission for Science Technology and Innovation (NACOSTI), through the Board of Post graduate Studies of Egerton University. NACOSTI is a government agency in the Ministry of Higher Education Science and Technology (MOHEST) in Kenya and is responsible for issuance of research permit. Before the commencement of the studies, the researcher reported to the office of the county Director of Education and the office of County Commissioner as indicated in the NACOSTI research authorization letter. The twelve sample schools were visited to seek permission from the headteacher, who introduced the researcher to the HOD of Science and Chemistry teachers, in the respective schools. The Chemistry teachers in the experimental groups were teachers trained for a week on the use of Chemistry module to be used in the teaching in their classes. A pre-test (CAT and SAQ) was conducted in experiment (E1) and Control Group (C1) in order to determine the students entry behaviour before treatment. In the experimental groups CELA was used while in the control groups, conventional teaching/learning methods were used. At the end of the treatment period, post-test (CAT and SAQ) were administered to all groups. CAT and SAQ were used to measure the student's achievement in Chemistry and attitudes towards Chemistry respectively. Both pre-test and post-test were administered under similar conditions to both experimental and control groups. These tests were supervised by regular teachers and the researcher. The researcher scored the pre-tests and post-tests using a marking scheme prepared and validated by the team of experts in the Faculty of Education and Community Studies of Egerton University.

3.9 Data Analysis

The scoring of the two instruments CAT and SAQ gave rise to pre-tests and post-tests data. The results were used to determine learner's level of achievement and attitudes towards Chemistry before and after the treatment. Both descriptive and inferential statistics were used to analyse the data. Descriptive statistics such as means and standard deviations needed for further analysis were used. Inferential statistics were used to analyse the data and test the research hypotheses. A t-test was used to compare means of the two groups subjected to the pre-test. This was to enable the researcher to find out whether there was any statistically significant difference between the Experimental (E_1) and Control (C_1) before treatment. This was to check the entry behaviour of the two groups, whether they were similar. After treatment ANOVA was used to check whether there was any statistically significant difference in the means of post-test scores in CAT and SAQ.

Experimental (E_1) and Control (C_1) were pre-tested and found to be homogeneous, but Experimental (E_2) and Control (C_2) were not pre-tested hence ANCOVA was used to reduce the effects of initial differences statistically by making compensating adjustments to the post-test means of the groups. A post-hoc analysis was also done to determine where statistically significant difference occurred between the groups. Hypotheses were tested at significance level at $\alpha = 0.05$ so as to make reliable inferences from the data. Analysis was done with the aid of Statistical Package for Social Sciences (SPSS).

3.10 Ethical Consideration for the Study

The researcher addressed several ethical considerations before and after the research. Upon receiving the authorization report to the county commissioners' office and county Director of Education's office as directed by the commission. The county officers issued authorisation letters allowing research to be done within the area of jurisdiction (Appendix F and G).

According to Kathuri and Pal (1993), researchers should remain impartial and keep respondents and their responses confidential. Integrity of the researcher was foremost for the results to be accurate and unbiased. The identities of all the participants in the information collected neither embarrass nor harm them. Since the researcher had sought permission from school administrators to do research in these schools, with the help of the Chemistry teacher. Hence researcher had informed consent from the participants involved in the study. The respondents were with regard to their personal opinions about learning of Chemistry.

There was cooperation of all the subjects and the researcher ensured that no physical or psychological harm came to anyone who participated in the study.

Table 6
Summary of Data Analysis

Hypotheses	**Independent Variable**	**Dependent Variable**	**Method of Data Analysis**
H_O1: There is no statistically significant difference in achievement in Chemistry between those exposed to CELA and those taught through Conventional Teaching Methods.	• Cooperative E-learning Approach (CELA) • Conventional teaching method	• Post-test Scores in Chemistry Achievement Test (CAT)	t-test ANOVA ANCOVA
H_O2: There is no statistically significant difference in students' attitude towards Chemistry between those exposed to CELA and those taught through Conventional Teaching Methods.	• Co-operative E-Learning Approach (CELA) • Conventional teaching Method	• Post-test Scores in student Attitude Questionnaire (SAQ)	t-test ANOVA ANCOVA
H_O3: There is no statistically significant gender difference in Achievement in Chemistry among students exposed to CELA.	• Co-operative E-Learning Approach (CELA) • Gender	• Post-test Scores in Chemistry Achievement Test (CAT)	t-test
H_O4: There is no statistically significant gender difference in Students' Attitude towards Chemistry among students exposed to CELA.	• Co-operative E-Learning Approach (CELA) • Gender	• Post-test Scores in student Attitude Questionnaire (SAQ)	t-test

H_O5: There is no statistically significant difference in Chemistry achievement between boys exposed to CELA from boys' schools and those from co-educational schools.	• Co-operative E-Learning Approach (CELA) • School Type	• Post-test Scores in Chemistry Achievement Test (CAT)	t-test
H_O6: There is no statistically significant difference in Chemistry achievement between girls exposed to CELA from girls' schools and those from co-educational schools.	• Co-operative E-Learning Approach (CELA) • School Type	• Post-test Scores in Chemistry Achievement Test (CAT)	t-test

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The chapter covers presentations on the data analysis as well as on the effect of CELA on the secondary school students' achievement and attitude towards Chemistry. Descriptive and inferential statistics were used in data analysis. The statistics used include t-test, ANOVA and ANCOVA. Inferential statistics were used to test the six hypothesis of the study. Results of the analysis were presented in tabular form and graphs. Conclusion was made indicating whether the hypotheses were rejected or accepted at a stated significance level of 0.05 alpha level.

4.2 Presentation of Results and Discussion

To establish whether the experimental groups (E_1) and control group (C_1) were similar at the beginning of the study. Pre-test scores of CAT and SAQ were analysed using independent sample t-test. The post-test results were analysed to determine the effects of CELA on students' achievement and attitude towards Chemistry, the effects of gender on students' achievement and attitude towards Chemistry when CELA was used, the effect of school type on a students' achievement when CELA was used.

ANOVA was used to determine whether the differences in post-test mean scores between experimental and control groups were statistically significant. ANCOVA was used to reduce the effects of initial group differences statistically by making compensating adjustments to the post-test means of the groups. Post-hoc analysis was done to find out where the differences existed between the groups. T-test was used to find out the effects of gender and school type on achievement and attitude towards Chemistry when CELA was used in teaching. The sections that follow contain information in the following areas.

(i) Effects of CELA on students' achievement in Chemistry.
(ii) Effects of CELA on student attitude toward Chemistry
(iii) Effects of gender on students' achievement when CELA was used.
(iv) Effects of gender on students' attitude towards Chemistry when CELA was used.
(v) Effects of school type on students' achievement when CELA was used.

4.3 Effects of CELA on Students' Achievement in Chemistry in Secondary Schools

The first objective of the study was to find out whether there was any statistically significant difference in achievement in Chemistry between students who were exposed to CELA and those who were not exposed to it. The corresponding hypothesis states that there is no statistically significant difference in achievement in Chemistry between those exposed to CELA and those taught through Conventional Teaching Methods.

4.3.1 Pre-test Scores on CAT

The instrument Chemistry Achievement Test (CAT) was pre-tested. This was done to enable the researcher check the entry behaviour of the students and determine whether the groups were similar before the intervention. Experimental group (E_1) and control group (C_1) were pretested. This study used Solomon Four Non-equivalent Group design such that: E_1 was experimental group which was pre-tested, E_2 was experimental group not pre-tested, C_1 was control group pre-tested, C_2 was the control group not pre-tested. The arrangement was to enable the researcher:-

(i) Determine the similarity of groups before applying treatment and to generate to the group's which did not receive pre-test.
(ii) Determine presence of any interaction between pre-test and treatment.

Table7 shows students pre-test scores on CAT.

Table 7

Pre-test Score on CAT

Group	**N**	**Mean**	**SD**
E_1	141	10.28	7.34
C_1	122	11.61	6.92

The results in Table 7 shows that mean scores for groups (E_1) was (M=10.28, SD=7.34) while that of groups (C_1) was (M=11.6, SD=6.92) out of maximum score of 50. These results shows that the mean scores in the experimental and control groups were similar.

To assess the homogeneity of the groups before treatment, a t-test was conducted on the CAT pre-test mean scores. Table 8 shows the independent sample, t-test analysis on pre-test results for CAT

Table 8

The independent sample t-test of the pre-test mean scores on CAT

Test	Group	N	Mean	SD	df	t-value	p-value
CAT	E_1	141	10.28	7.34	262	1.50	.14
	C_1	122	11.61	6.92			

The t-test analysis results in Table 8 shows that the pre-test CAT mean scores of both groups E_1 and C_1 were not statistically significant different at 0.05 significant level t-(262) = 1.50 , $p>0.05$.

Therefore the two groups used in the study exhibited comparable characteristics and therefore suitable for the study.

Tale 9 shows CAT post-test mean scores for the groups E_1, C_1, E_2 and C_2.

Table 9

Students' Chemistry Achievement Post-test Mean Scores and Standard Deviation

Group	N	Mean	Standard Deviation
E_1	141	44.88	15.30
C_1	120	23.48	11.17
E_2	123	48.45	15.22
C_2	105	24.64	11.35

Maximum score = 50

Figure 3 shows CAT post-test mean scores for the groups E_1, C_1, E_2 and C_2.

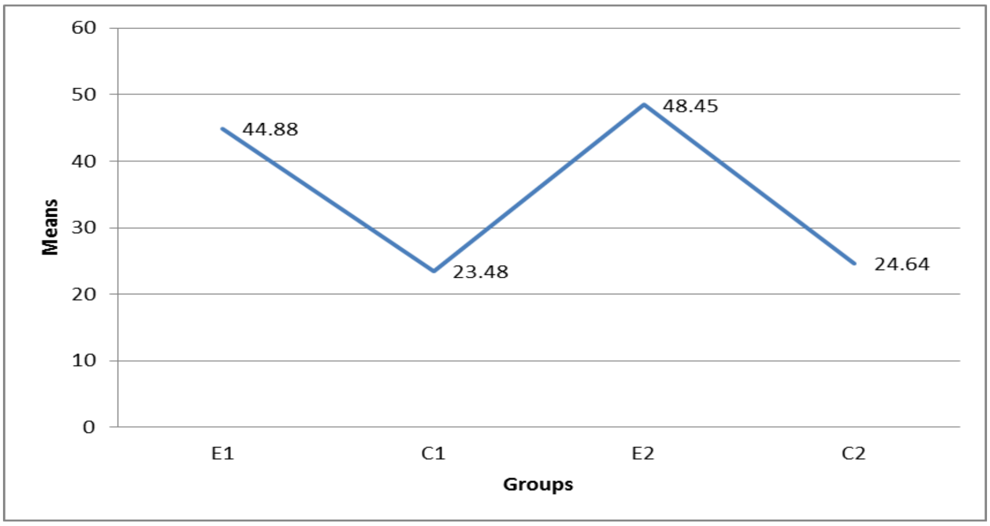

Figure 3. Students' Chemistry Achievement Post-test Mean Scores

Figure 3 indicates that from the heights of the bar graphs the experimental groups achieved higher mean marks than the control groups.

Results shown in Table 9 and Figure 3 indicate that the experimental groups E_1 and E_2 achieved higher mean scores than the control groups C_1 and C_2. This shows that CELA had an effect in improving performance as compared to the conventional teaching method. ANOVA was carried out to establish whether the groups mean scores on the CAT were statistically significantly different. Table 10 shows analysis of variance of the mean scores on the CAT.

Table 10

ANOVA of the Post-test Mean Score on the CAT

Test	**Group**	**Sum of squares**	**df**	**Mean square**	**F**	**p-value**
CAT	Between groups	62381.72	3	20793.91	113.09	.00*
	Within group	88811.5	483	183.88		
Total		151193.2	486			

Mean difference Significant at 0.05 level

Results in Table 10 indicate that a statistically significantly difference exists between the groups, mean scores because the F (3,483) = 113.09, $p<0.05$.

While the null hypothesis could be rejected, the results do not indicate which groups are similar and which are different. To establish this mean difference, it was necessary to carry out the least significant difference (L.S.D) post hoc test. Table 11 shows the post hoc comparisons of the CAT mean scores for group E_1, C_1, E_2 and C_2.

Table 11

Post Hoc Comparisons of the CAT, Post-test Mean Scores for Four Groups.

Paired Group	Mean Difference	P-Value
E_1-C_1	21.40	.00*
E_1-E_2	-3.57	0.21
E_1-C_2	20.24	.00*
C_1-E_2	-24.97	.00*
C_1-C_2	-1.16	.94
E_2-C_2	23.81	.00*

*Significant at 0.05 level

Table 11 shows results of post hoc comparisons test of significance for difference between any two means. The CAT means of groups E_1 and C_1, groups E_1 and C_2, groups E_2 and C_1 and groups E_2 and C_2 were statistically significant different at 0.05 level. However, there were no statistically significant difference in the means between E_1 and E_2, groups C_1 and C_2.

From these results the subjects in the experimental conditions out-performed the subjects that were in control groups. It can therefore be concluded that CELA approach used in the experimental group led a relatively higher achievement in the learning of the mole than the conventional method used in the control groups.

The study involved non-equivalent control group design. Hence, there was need to confirm these results by carrying out analysis of covariance (ANCOVA) using students Kenya Certificate of Primary Education (KCPE) scores as covariance. Analysis of Covariance reduces the effects of initial group differences statistically by making compensating adjustments to the post-test means of the groups involved (Wachanga, 2002). Table 12 shows adjusted CAT post-test mean scores with KCPE as the covariate.

Table 12

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

Group	**N**	**Mean**	**Standard Deviation**
E_1	141	46.42	1.17
C_1	120	22.35	1.23
E_2	123	48.52	1.21
C_2	105	24.40	1.29

Table 13 shows that ANCOVA results based on the adjusted means of the four groups displayed in Table 12.

Table 13

Analysis of Covariance (ANCOVA) of the post-test scores of CAT with KCPE as covariant

Source	**Type sum of squares**	**df**	**Mean squares**	**F-ratio**	**p-value**
KCPE score	3703.10	1	3703.10	21.09	.00
Group	66936.90	3	22312.30	127.09	.00*
Error	83919.99	478	175.57		
Total	782932.00	483.			

* Significant at 0.05 level

The results confirm that difference between the means are significant at 0.05 level $F(3,478) = 127.09$, $p<0.05$. Post hoc pairwise comparison was carried out as shown in Table 14.

Table 14

Post hoc Pairwise Comparison Post-test Score of CAT

Paired Group	**Mean Difference**	**p-Value**
E_1-C_1	24.07	.00*
E_1-E_2	-2.10	.22
E_1-C_2	22.02	.00*
C_1-E_2	-26.18	.00*
C_1-C_2	-2.06	.25
E_2-C_2	24.12	.00*

* Significant at 0.05 level

The post hoc pairwise comparisons based on the ANCOVA. Table 14, shows that there was statistically significant difference in the following groups:-

i) Groups E_1 and C_1
ii) Groups E_2 and C_1
iii) Groups E_1 and C_1
iv) Groups E_2 and C_2

Differences in mean scores between groups E_1 and E_2 and groups C_1 and C_2 were not statistically significant. It is evident that CELA approach had similar effects to both experimental groups. But the control groups C_1 and C_2 that were not exposed to this treatment had a lower mean scores and hence were out performed by the experimental groups. The results of ANOVA, ANCOVA confirm that there is a statistically significant difference in the mean score of experimental and control groups. Therefore Ho1 is rejected.

Table 15 shows the comparison of mean CAT scores and mean gains obtained by the students who participated in both pre-test and post-test.

Table 15

Comparison of Mean Score and Mean gain obtained by the Students in the CAT

		Group	
		E_1. N=141	**C_1 N=122**
Pre-test	Mean	10.28	11.61
	Standard deviations	7.34	6.92
Post-test	Mean	44.88	23.48
	Standard deviation	15.30	11.17
Mean gain		34.60	11.87

As indicated in Table 15 group E_1 had a higher mean gain in the CAT than C_1. The experimental group gained more than the control group. CELA method resulted in higher achievement than the control conditions. It gives an indication of the relative effectiveness of treatment on the study groups.

Further analysis was done to establish whether the mean gains were statistically significant, in Table 16.

Table 16

Comparison of Students Chemistry Achievement Mean Gain Between E_1 and C_1

Group	**N**	**Mean Gain**	**SD**	**df**	**t-value**	**p-value**
E_1	141	34.60	19.16	261	8.58	.00*
C_1	122	11.87	13.93			

* Significant at 0.05

Table 16 shows that the mean gains are statistically significant $t(261) = 8.58$ $p < 0.05$. Table 19 reveals that both groups gained significantly from teaching. The experimental group had a higher mean gain than the control group. This strengthens the position that the CELA method resulted in higher achievement than the control conditions.

The researcher found that students who were taught through CELA achieved significantly higher scores in CAT compared to those taught through conventional method. These observations are in agreement with the finding of similar studies carried out earlier. Gambari

(2010), Yusuf and Afolabi (2010), reported that the students exposed to computer assisted cooperative learning settings performed better than those exposed to the same programme individually. In Co-operative settings the learners were divided into groups consisting of (5-6) students. Aluko (2004) argued that, an adopted version of cooperative learning strategy required students to solve Chemistry problems together in small groups (usually 5-6 members per group), and the teacher acting as a facilitator. The topics taught to the two groups were gas laws and the mole. The results showed that there was a significant main effect of treatment for those using cooperative instruction. In this study the topic taught was the "mole" and the results in Table 13, shows that there was statistically significant difference in the mean scores.

Other research findings indicated that computer-supported cooperative learning improved students learning and increased their academic achievement, problem solving skills, student-student interaction (Johnson & Johnson, 2008).

In this study CELA method enhanced their achievement and also there was student-student interaction. Khan and Inamullah (2011) investigated the effect of Students' Teams Achievement Divisions (STAD) on academic achievement. Students studying Chemistry at higher secondary level in Khyber (Pakistan) participated. The post-test mean score indicated that the experimental group taught using the STAD performed better in the test than the control group taught using conventional method. In this study Table 15 shows the mean scores of the experimental and control groups. E_1 had 46.42, E_2 = 48.52; C_1=22.35 and C_2 = 24.40. The experimental groups performed better. Orora (2014) conducted a similar study on the effect of cooperative e-learning on Biology in Nakuru County, Kenya. The method enhanced achievement and creativity in Biology among the learners. These observations are in agreement with the studies done earlier. Linn (2010) reported that the teaching of Chemistry concepts through cooperative learning method was more effective in increasing academic achievement compared to the traditional teaching method. Tekos and Solomonidou (2009) from their research findings indicated that computer supported cooperative learning improved students' learning and increase their academic achievement problem solving skills, and task related student interaction. Taiwo (2008) reported that student taught mathematics using computer-assisted cooperative learning strategy performed better than those taught with conventional method.

Yusuf *et al.* (2012) reported that students in cooperative computer assisted instruction group showed remarkable post-test mean differences over their counterparts who were taught the same concept through conventional methods. These observations are not in agreement with the findings of Armstrong, Palmer (1998) and Glassman (1989), who found no significant difference in the achievement of students, taught using STAD and those taught using conventional method.

4.4 Effects of CELA on Students' Attitude towards Chemistry in Secondary Schools

The second objective of the study was to find out whether there was any statistically significant difference in students' attitude towards Chemistry between those taught through CELA and those taught through conventional teaching methods. The corresponding hypothesis states that there is no statistically significant difference in student's attitude towards Chemistry between those exposed to CELA and those taught through conventional teaching methods. Table 17 shows the sum, means and standard deviation on students' attitude towards Chemistry (SAQ).

Table 17

Students Pre-test Scores on SAQ

Group	**N**	**Mean**	**SD**
E_1	141	3.55	0.50
C1	116	3.58	0.54

The results in Table 17 shows that the mean score for group (E1) was (M=3.55, SD=0.50) while that of group C1 was (M=3.58, SD=0.54). Out of maximum score of 5. These results shows that the mean scores in the experimental and control groups were similar.

A t-test was conducted on the SAQ pre-test means scores. Table 18 shows independent sample t-test analysis on the pre-test results for SAQ.

Table 18

The Independent Sample t-test of the Pre-test Mean Scores on SAQ

Test	**Group**	**N**	**Mean**	**SD**	**df**	**t-value**	**p-value**
SAQ	E1	141	3.55	0.50	2.55	.55	.58
	C1	116	3.58	0.54			

The t-test analysis results in Table 18 shows that the pre-test (SAQ) mean scores of both groups E1 and C1 were not significantly different at 0.05 significant level.

$t\ (255) = 0.55 \qquad p > 0.05$

Therefore the two groups used in the study exhibited comparative characteristics and therefore suitable for the study.

Table 19 shows the SAQ post-test mean scores for the groups E_1, C_1, E_2 and C_2.

Table 19

Students Attitude towards Chemistry Post-test mean Scores and Standard Deviation.

Maximum score = 5

Group	**N**	**Mean**	**Standard Deviation**
E_1	141	3.87	0.41
E_2	120	3.83	0.63
C_1	116	3.64	0.57
C_2	101	3.76	0.63

Results in Table 19 indicate that the experimental groups E_1 and E_2 achieved higher mean scores than the control groups C_1 and C_2. CELA had an effect of improving the performance as compared to conventional teaching method. ANOVA was also carried out to establish whether the groups mean scores on the SAQ were statistically significantly different as shown in Table 20.

Figure 4 shows the SAQ post-test mean score for the groups E_1, C_1, E_2 and C_2

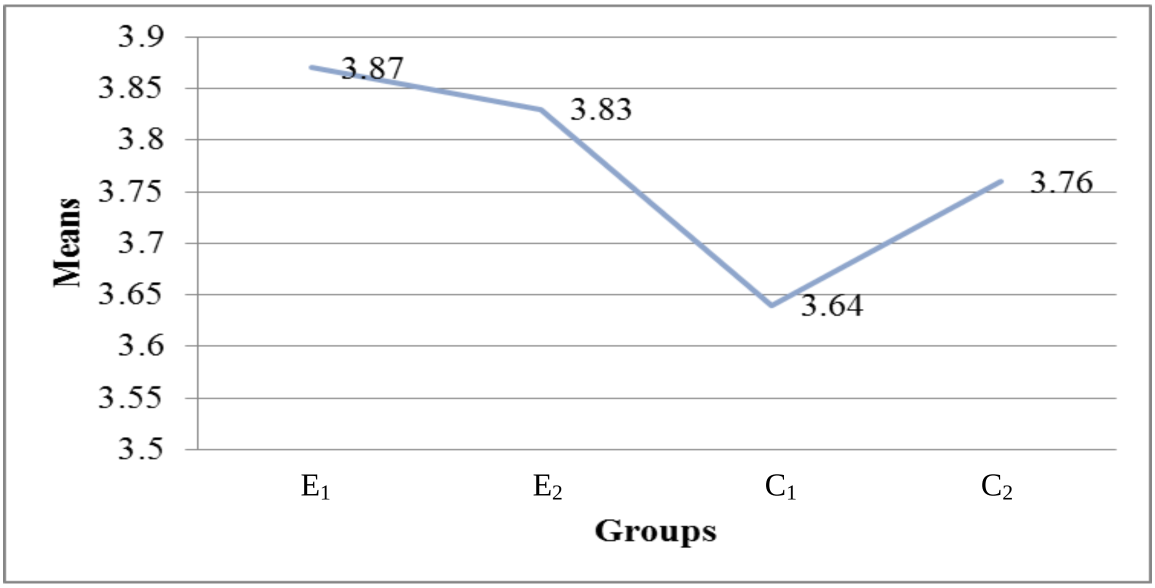

Figure 4. Students' Attitude towards Chemistry Post-test mean Scores

Table 20

ANOVA of the Post-test Scores on the SAQ of Students exposed to CELA

Test	**Group**	**Sum of squares**	**df**	**Mean square**	**F**	**p-value**
	Between groups	3.68	3	1.23	3.89	.01**
	Within group	149.48	474	.320		
Total		153.16	477			

Results in Table 20 indicate that a statistically significant difference exist between the subjects mean scores because the $F(3,474) = 3.89$, $p<0.05$. While the null hypothesis could be rejected, results do not indicate which groups are similar and which are different. To establish this, least significant differences (LSD) post hoc test was carried out.

Table 21 shows the post hoc comparison of the SAQ post-test means for four groups.

Table 21

Post Hoc Comparison of the SAQ Post-test Means for Four Groups

Paired Group	Mean Difference	P-Value
E_1-E_2	0.04	.94
E_1-C_1	023	.01*
E_1-C_2	0.11	.50
E_2-C_1	0.18	.02*
E_2-C_2	0.07	.84
C_1-C_2	-0.12	.51

* Significant at 0.05

Table 21 indicates the results of post hoc comparisons. The SAQ mean scores of groups E_1 and C_1, groups E_2 and C_1, groups were statistically significant different at 0.05 level. However, there was no statistically significant difference in the means between groups E_1 and E_2, C_1 and C_2, E_2 and C_2, E_1 and C_2. The study involved non-equivalent control group design, there was need to confirm these results by performing analysis of covariance (ANCOVA) using students (Certificate of primary Education) KCPE scores as covariant.

Table 22 shows the adjusted post-test mean scores of SAQ with KCPE as the covariant.

Table 22

Adjusted Students Attitudes towards Chemistry Post-Test Mean Scores with KCPE as the Covariant

Group	Mean	Std. Error.
E_1	3.87	0.05
E_2	3.83	0.05
C_1	3.64	0.05
C_2	3.76	0.05

Table 23 shows ANCOVA of the post-test scores of SAQ.

Table 23

Analysis of Covariance (ANCOVA) of the Post-test Scores of SAQ with KCPE as Covariant

	Type III sum of squares	**df**	**Mean square**	**F-ratio**	**p-value**
Group	3.28	3	1.09	3.46	.02*
Error	149.48	473	.32		
Total	6983.85	478			

Mean difference is significant at 0.05 levels.

Table 23 shows ANCOVA results based on the adjusted means of the four groups displayed in Table 22. There was statistically significant difference in the (SAQ) mean scores of the four groups $F(3, 473) = 3.46$, $p<0.05$. Pairwise comparisons were carried out to find out where the difference existed, Table 24.

Table 24

Post hoc Pairwise Comparisons; Post-test Scores of SAQ

Paired Group	**Mean Difference**	**P-Value**
E_1-E_2	0.04	.55
E_1-C_1	0.23	.00*
E_1-C_2	0.11	.14
E_2-C_1	0.19	.01*
E_2-C_2	0.07	.37
C_1-C_2	-0.12	.13

* Significant at 0.005

Results in Table 24 were not very conclusive. Researcher could not get the expected SAQ values. Further analysis was conducted to examine the effect of the treatment. This could have been due to learners/teachers characteristics. Some learners hate the subject, poor attitude. For this to change, their attitude, it requires a longer period. Poor implementation of tools (CELA) by the teachers could be the cause. Also some schools had limited facilities and resources. Attitude is something which is abstract and subjective. Hence it is difficult to measure changes over a short time. A more prolonged and extensive treatment may be required.

The post hoc pair wise comparisons based on the ANCOVA. Table 24 shows that there was statistically significant difference in the following groups, E_1 andC_1 groups E_2 and C_1. But the difference between groups E_1 and E_2, groups C_1 and C_2, groups E_1 and C_2, groups E_2 and C_2 were not statistically significant. The results of ANOVA and ANCOVA confirm that there was statistically significant difference in the mean scores of the experimental and control groups. Therefore H_O2 was rejected.

Further analysis on comparison of students' attitudes towards Chemistry mean gain by use of CELA as shown in Table 25.

Table 25
Students Attitudes towards Chemistry Post-test Mean Scores, Standard Deviations and Mean Gains (SAQ)

		Group	
		E_1. N=141	**C_1 N=122**
Pre-test	Mean	3.55	3.58
	Standard deviations	0.50	0.54
Post-test	Mean	3.87	3.64
	Standard deviation	0.41	0.57
Mean gain		0.32	0.06

As indicated in Table 25 Group E_1 had a higher mean gain in the SAQ than C_1. The experimental group gained more than the control group. Hence CELA method resulted in higher achievement than the control conditions. It gives an indication of the relative effects of treatment on the study groups.

Further analysis was done to establish whether the mean gains were statistically significant as shown in Table 26.

Table 26

Comparison of Students Attitude towards Chemistry Mean Gain Between E_1 and C_1.

Group	**N**	**Mean Gain**	**SD**	**df**	**t-value**	**p-value**
E_1	141	0.32	0.41	255	5.61	.00*
C_1	116	0.06	0.34			

* Significant at 0.05

Table 26 indicates that the mean gains were statistically significant. $t(255) = 5.61$ $p<0.05$.

From the results, the students who used CELA method achieved significantly higher mean scores in SAQ than those who did not use it. In this study the experimental groups outperformed the control groups. Table 18 shows this results. $F(3,474) = 3.89$; $p<0.05$. These observations are in agreement with the findings of similar studies carried out earlier. Zakaria, Chin and Daud (2010), reported that Cooperative learning showed an improvement on students achievement in mathematics and positive attitude towards Maths. Pandian (2004) investigated the effects of Cooperative computer-assisted learning and traditional method. Results of the analysis showed that, students in the treatment group achieved better in Biology than those in traditional groups when cooperative learning was used to investigate students attitude toward the subject matter. The results indicated that students working in cooperative learning groups obtained more knowledge and improved attitude towards the subject (Le & Thanh-Pharn, 2010).

Vaughan (2002), from his studies suggested that students in (STAD) students, Teams Achievement Division had positive attitude towards mathematics than those who were not. Slavin (2011), in his research showed that cooperative learning was effective in helping students obtain practical learning skills and promoted positive student attitudes towards their learning. Johnson and Johnson (2005) confirmed that cooperative learning results in more positive attitudes towards learning. From other researches it was noted that when cooperative learning was used there was higher academic achievement knowledge retention and attitudes towards learning. (Tran, Lewis, 2012). In this study STAD was used and it also showed positive attitude towards Chemistry.

Gupta and Pasrija (2011) in their studies reported encouraging effects of cooperative learning (STAD) on students' achievement and retention and attitudes towards mathematics. Cooperative learning helps students develop positive attitudes towards learning and to think independently, inside and outside of classroom (Ajaja & Eravwoke, 2010).

Khan and Inamullah (2011) investigated the effects of Student's Team Achievement Division (STAD) on academic achievement of students studying Chemistry at higher secondary level in Pakistan. The post-test mean scores indicated that the experimental groups taught using (STAD) performed better in their test than the control group taught using the conventional lecture method. From these results exposing students to a computer supported cooperating learning strategy improves student's performance in science as well as their attitude towards the subject. Studies have proven that cooperative learning settings have been very effective in encouraging student interaction and developing positive attitudes towards learning. Zakaria *et al.* (2013) found that students exposed to cooperative learning had more positive attitudes than those taught with conventional methods.

4.5 Effects of Gender on Students' Achievement in Chemistry when they are Exposed to CELA.

Objective three of the study sought to find out whether students achievement in Chemistry was gender dependent when CELA was used. The corresponding hypothesis stated that there was no statistically significant gender difference in achievement in Chemistry among students exposed to CELA. Table 27 shows pre-test scores on CAT according to gender.

Table 27

Pre-test Scores on CAT Based on Students' Gender

Group	N	Mean	SD
Male	133	13.35	9.42
Female	130	12.93	8.46

The results in Table 27 shows that the mean scores for male was (M=13.35, SD=9.42) while for the female was (M=12.93, SD = 8.46) out of maximum 50. The results shows that the mean scores of both male and female were similar.

Table 28 shows the independent sample t-test analysis on pre-test results for CAT.

Table 28

Independent Sample t-test of the Pre-test Scores on CAT's on Student Gender

Test	Group	N	Mean	SD	df	t-value	p-value
CAT	Male	133	13.35	9.42	261	.38	.71
	Female	130	12.93	8.46			

The t-test analysis results in Table 28 shows that the pre-test CAT mean scores based on gender were not statistically significantly different at 0.05 significant level t (261) = .38 $p>0.05$

Therefore the two groups used in the study were similar, and hence suitable for the study. T-test was used to determine the homogeneity of the two groups, the male students and the female students before treatment. T-test was also administered on post-test to check whether there were any significant gender differences in achievement in Chemistry when both groups were exposed to CELA.

Table 29 shows post-test mean scores on CAT based on Gender

Table 29

Students Post-test CAT mean scores based on Gender when Exposed to CELA.

Gender	**Mean**	**N**	**Standard Deviation**
Male	48.39	132	15.11
Female	44.69	131	15.34

The results in Table 29, shows that CAT mean scores for both male and female students are almost equal. Male students with a mean of 48.39 while female with a mean of 44.69. The use of CELA improved the achievement equally for both male and female students.

Table 30 shows the results of t-test on CAT means scores for both male and female students exposed to CELA.

Table 30

Difference in Achievement in Chemistry by Gender of Students Exposed to CELA

Group	**Gender**	**N**	**Mean**	**SD**	**df**	**t-value**	**p-value**
	Male	132	48.39	15.11	261	1.96	.06
Experimental	Female	131	44.69	15.34			

Table 30 reveal that there was no statistically significant difference in the mean scores in the CAT between boys and girls exposed to CELA. $t(261)=1.96$ $p>0.05$.

Hypothesis H_O3 is therefore retained, implying that boys and girls who were exposed to CELA perform equally well. Gender has no effect on the achievement of students in Chemistry.

The researcher found that boys and girls who were taught through CELA showed no statistically significant difference in their mean scores in the CAT (Table 28). $p>0.05$. This implies that that boys and girls who were exposed to CELA, performed equally well. Gender had no effect. The use of CELA bridges the gender gap in achievement. From KNEC results, Table 2, there is evidence that boy's performance in Chemistry subject is better than the girls (KNEC, 2013). This method helps to overcome the gender disparity in achievement. These observations are in agreement with finding of similar studies carried out earlier. Ajaja and Oludipe (2010) examined the influence of computer assisted STAD cooperative learning on junior secondary student's achievement in basic science. Their analysis showed no significant differences between male and female students. Gender had no effect on academic performance. In another study, it was found that student learning with computer based instruction in cooperative groups, performed better than those taught using traditional teaching and individual computer instruction settings (Yusuf & Olumorin, 2012).

Yukselturk and Bulut (2009) when analyzing gender differences in achievement in an online learning environment, found no statistically significant mean differences between genders in language subjects. Abubakar and Oyuguo (2011), used cooperative learning to compare the performance of boys and girls. In their comparison they found no significant difference between the performance of boys and girls. Hence it can be concluded that gender has no effect on achievement.

Garduno (2001) investigated gender differences in cooperative learning and found not statistically significant differences in student's achievement. Studies by Linn (2010) reported that gender difference among girls and boys was close. They performed similarly. These findings are in agreement with that of Mbacho and Githua (2013) who reported that there was no significant difference in achievement when students were exposed to cooperative learning.

Mineo *et al.* (2013) asserted that there was no statistically significant difference between the performance of male and female students in mathematics. This observation is not in agreement with the findings of similar studies. In Uganda the trend in academic excellence has shown that boys perform better than the girls in Chemistry. A study was carried to determine if there were any gender differences in the performance in Chemistry skills among senior girls and boys in selected secondary schools in Kampala. Although there were no differences in the student ability to manipulate apparatus and report results. Girls had poor self confidence in their ability as most of them believed that boys were better (Ssempala, 2005).

The findings as regarding performance of male and female with earlier findings of (Kost *et al.* 2009) which found no significant difference between male and female students performance was taught using Cooperative Learning Strategies. Furthermore, it supports findings of Pandian (2004) and Yusuf & Afolab, (2010) who reported that gender did not show any significant influence on biology achievement using computer assisted STAD, Cooperative Learning Strategy. These observations disagree with the findings of Olson (2002) who found that female students taught mathematics using cooperative learning outperformed their male counterparts. Also, Khairulanuar *et al.* (2010) reported that male students perform better than female students in their cognitive, affective and psychomotor skill in achievements. Rugus *et al.* (2007) on gender difference in Cooperative Learning with college students in a multiple choice test found no significant difference between boys and girls.

4.6 Effects of Gender on Attitudes towards Chemistry of Boys and Girls who were exposed to CELA

Objective four of the study sought to find out whether students' attitude towards Chemistry was gender dependent when CELA was used. The corresponding hypothesis stated that there is no statistically significant gender difference in students' attitude towards Chemistry among students exposed to CELA.

An analysis of the SAQ pre-test and post-test data was carried out for the boys and girls who were exposed to CELA. T-test was used to determine the homogeneity of the two groups, that of male students and that of female students before treatment. T-test was also done on post-test to determine whether there was any significant gender difference in attitudes towards Chemistry.

Table 31 shows the SAQ pre-test results based on gender.

Table 31

Pre-test Scores of SAQ based on Gender

Group	Gender	N	Mean	SD
	Male	114	3.64	0.49
	Female	142	3.50	0.54

The results in Table 31 shows that the mean score for male was (M=3.64, SD=0.49) while that of female was (M=3.50, SD=0.54) out of maximum score of 5. This shows that the mean scores of the male and female students were similar.

To establish whether there was any significant gender differences in the SAQ mean scores of the two genders before treatment, an independent t-test of pre-test scores based on gender was done. Table 32 shows the results of t-test.

Table 32

Independent Sample t-test of the pre-test Scores on SAQ based on Students' Gender.

Test	**Group**	**N**	**Mean**	**SD**	**df**	**t-value**	**p-value**
SAQ	Male	114	3.64	0.49	254	2.27	0.24
	Female	142	3.50	0.54			

Table 32 shows that the mean scores of the pre-test when SAQ is used are not statistically significantly different, t (254)=2.27, p>0.05. Hence, there was no gender difference in attitude towards Chemistry at the beginning of the treatment. They were suitable for the study. To establish the effect of gender on attitude towards Chemistry, the post-test means of SAQ were analysed.

Table 33 shows the sum, mean and standard deviation

Table 33

Students Post-test SAQ Mean Scores Based on Gender

Gender	**Mean**	**N**	**Standard Deviation**
Female	3.79	114	0.55
Male	3.92	140	0.49

The results in Table 33 shows that SAQ mean scores for both male and female students are almost equal with that of female students being a mean of 3.79 while that of male being 3.92 out of total mark of 5.

Table 34 shows the results of t-test on SAQ mean scores for both male and female students exposed to CELA.

Table 34

Difference in Attitude towards Chemistry by Gender of Students exposed to CELA

Group	**Gender**	**N**	**Mean**	**SD**	**df**	**t-value**	**p-value**
Experimental	Male	114	3.79	0.55	252	1.89	.06
	Female	140	3.92	0.49			

Table 34 shows that there were no statistically significant differences in the mean scores in the (SAQ) between boys and girls exposed to CELA. $t(252) = 1.89 \quad p>0.05$

Hypothesis H_O4 was accepted, implying that the boys and girls who were exposed to CELA performed equally well. Gender had no effect on attitude towards chemistry of students.

In this study, the researcher found that there was no statistically significant difference in the mean scores of (SAQ) when t-test and analysis of variance was done. Table 34 p values was greater than 0.05 $p>0.05$. The boys and girls exposed to CELA performed equally well. Gender had no effect. These observations are in agreement with the finding of similar studies carried out earlier. Garduno (2001) investigated gender differences in Cooperative problem-solving in students. She found no statistically significant difference in attitudes towards the subject matter. Katz *et al.* (1995). In his research reported that, there was no significant difference in the attitudes of males and female students when cooperative learning was used. Abubakar and Oyuguo (2011) in their studies on comparison of boys and girls performance, found no statistically significant difference. They perform equally well. Kirk and Cuban (1998) from their studies concluded that, when females and males students at all levels of education had the same amount, type of experience on computer; male and female achievement scores and attitudes were similar (no statistically significant difference). The findings are in agreement with those of Salta and Tzouglaki, (2004). In this study, they found no statistically significant difference between boys and girls attitude towards Chemistry. Can (2012) did a similar study and found that both boys and girls attitudes towards Chemistry were slightly average ‘no significant differences’. These observations are not in agreement with the findings of similar studies carried out earlier. Hofstein *et al.* (19970 from their research showed that there was a significant difference between boys’ and girls’ attitude towards learning chemistry. Girls tended to have more positive attitudes towards chemistry than males. Barnes *et al.* (2005) from their study reported that male students were more interested in learning chemistry than female students. In conclusion gender has no effect on attitudes towards Chemistry.

Table 35, shows the mean gain for boys and girls on attitude towards Chemistry.

Table 35

Student's Mean Gain in SAQ based on Gender

Gender	**N**	**Pre-test**	**Post-test**	**Mean Gain**
Male	114	3.64	3.79	0.15
Female	140	3.50	3.92	0.42

Results in Table 35, shows that the mean gain for male and female students was 0.15 and 0.42 respectively. Both boys and girls benefitted from the CELA approach in-terms of attitude towards Chemistry.

4.7 Effect of School Type on the Achievement of Boys in Boys schools with that of Boys in Co-educational when CELA is used

Objective five of the study sought to compare the achievement of boys in boys' school with that of boys in co-educational school when CELA was used. The null hypothesis stated that there was no statistically significant difference in Chemistry achievement between boys exposed to CELA from boys schools and those from co-educational schools.

An analysis of the CAT pre-test and post-test was carried out for boys in boys school and boys in co-educational schools who were exposed to CELA.

Table 36 shows the CAT pre-test results based on School type.

Table 36

Student's CAT Pre-test Based on School Type

School category	**N**	**Mean**	**SD**
Boys	85	16.27	9.53
Co-educational	84	10.71	8.75

The results in Table 36, shows that the CAT mean scores for boys only was (M=16.27 SD=9.53) while for boys in co-educational schools was (M=10.71 SD = 8.75) out of maximum score of 50. This shows that the CAT mean scores of the boys in boys school and boys in co-educational were similar.

To establish the effect of school type on achievement in Chemistry, the post-test mean scores of CAT were analysed. Table 37 shows the sum, mean and standard deviation.

Table 37

Students' Post-test CAT Mean Scores Based on School Category

School type	Mean	N	SD
Boys only	47.42	91	15.86
Co-educational	47.97	69	14.71

The results in Table 37, shows that CAT mean scores for both boys only schools and co-educational schools are almost equal. Boys only had a mean of 47.42 and boys in co-educational schools had a mean of 47.97.

Table 38 shows the results of t-test on CAT mean scores according to school type.

Table 38

T-test Results of Boys exposed to CELA, in Boys Schools and in Co-educational Schools.

School type	N	Mean	SD	df	t-value	p-value
Boys only	91	47.42	15.86	130	1.10	.27
Co-educational	41	47.97	13.21			

Results shown in Table 38, indicates that the difference between the means (M=47.42 SD=15.86) scores of boys only school was not statistically significant different from that (M=47.97 SD=13.21) of boys in co-educational schools at 0.05 level. t (130) = 1.10 $p>0.05$

The results of t-test shows that there was no statistically significant difference in mean scores accordingly to the school type. Therefore H_O5 is retained. This implies that boys exposed to

CELA in boys schools and boys in co-education schools perform equally well. School type does not affect the achievement of students in Chemistry.

From the results, school type does not affect the achievement of students in chemistry. Boys from boy schools and those from co-educational schools perform equally well. These observations are in agreement with findings of similar studies carried out earlier. Riordan *et al.* (2008) argued that there was no significant differences' in the test scores in mathematics, when comparing students enrolled in single gender schools and those taught in co-educational. Students did gain in both settings. Seymour (1995) found that there was no statistically significant difference in Physics achievement of single sex and co-educational school students. School type had no effect on Physics achievement.

These results are not in agreement with the following observation. Gibb *et al.* (2008) found out that student in single–sex class had higher levels of achievement than did students in co-educational schools. The advantage for single sex schooling tended to be greater for girls than for boys. Vroomas (2009) from his studies found out that the students within single gender classroom demonstrate significant difference in mathematics test scores in comparison to co-education settings. Wachanga and Mwangi (2004) reported that when they used cooperative class experiment in teaching method in different schools, school type significantly affected boy's achievement. Boys in boy's schools attained higher scores than boys in co-educational schools.

4.8 Effect of School Type on the Achievement in Chemistry of Girls in Girls Schools with that of Girls in Co-educational Schools when CELA was used

Objective six of the study sought to compare the achievement of girls in girls' school with that of girls in coeducational schools when CELA was used. The corresponding Null hypothesis stated that there was no statistically significant difference in Chemistry Achievement between girls exposed to CELA from girls' schools and those from co-educational schools.

An analysis of CAT pre-test and post-test was carried out for girls in girls' schools and girls in co-educational schools who were exposed to CELA.

Table 39 shows the CAT pre-test results based on school type.

Table 39

Student's CAT Pre-test Based on School Type

School type	N	Mean	SD
Girls	94	12.47	7.77
Co-educational	84	10.71	8.75

The results in Table 39, shows that the CAT pre-test mean scores for girls only schools (M=12.47 SD = 7.77) while for girls in coeducational schools was (M=10.71 SD=8.75) out of maximum score of 50. This shows that the mean scores of girls in girls' schools and girls in co-educational schools were almost similar.

To establish the effect of school type on achievement in Chemistry, the post-test means score of CAT was analysed. Table 40 shows the sum, mean and standard deviations.

Table 40

Students Post-test CAT mean scores based on School Category

School type	Mean	N	SD
Girls only	44.83	103	15.18
Co-educational	47.97	69	14.71

The results in Table 40, shows that the CAT mean scores for both girls' only schools and coeducational schools were 44.83 and 47.97 respectively.

Table 41 shows the results of t-test on CAT mean scores according to school type.

Table 41

T-test Results of Girls Exposed to CELA in Girls School and Girls in Co-educational Schools

School type	N	Mean	SD	df	t-value	p-value
Girls only	103	44.83	15.18	129	.19	.85
Co-educational	41	44.21	16.19			

Results in Table 41, indicates that the difference between the means (M=44.83 SD = 15.18) scores of girls only schools was not statistically significant different from that (M=47.97 SD=14.71) of girls in co-educational schools at 0.05 level.t (129) = 0.19 , p>0.05

The results of the t-test indicated that there were no statistically significant differences in mean scores according to school type. Therefore H_O6 was retained, implying that girls exposed to CELA from girls schools and girls from co-educational schools performed equally well. School type has no effect on the achievement of students in Chemistry.

In the study it is indicated that there was no statistically significant differences between the achievements mean scores of girls from girl schools and girls from co-educational schools, they perform equally well. These observations are in agreement with findings of similar studies carried out earlier. Harker (2000) in the study of relative achievement of girls in single-sex school and co-educational schools were explained in details with careful control for student population differences. The two types of school showed non significance in achievement. Also a study conducted by carpenter (1987) in Austrilia found no significant differences for girls in single-sex and in co-educational schools and in their studies. This observation is not in agreement with the following findings. Spielhofer *et al.* (2002) from their studies indicated that girls and boys perform significantly better in single sex schools than in co-education. Streitmalter (1999) conducted a study in Queensland and Austrilia and found no statistically significant difference between girls from girls' school and girls from co-educational school in their achievement.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

5.1 Introduction

The chapter presents a summary of the major findings of the study based on the results of the analysis guided by the six hypotheses of the study. Conclusions are highlighted based on the findings and generalized to Form three Chemistry students in Koibatek sub-county in Kenya. Implications of the study are made to Chemistry teachers and all education stakeholders on how Chemistry teaching can be improved by incorporating, new innovative approaches like CELA. Suggestions for further research have also been made.

5.2 Summary of Major Findings of the Study

From the analysis of the data presented in chapter four, the following conclusions have been reached.

(i) The results of the study show that there was a statistically significant difference in achievement in Chemistry between students exposed to CELA and those taught through conventional methods. Experimental groups had higher achievement than the control groups.

(ii) The results of the study show that CELA resulted in higher positive attitudes towards Chemistry than conventional teaching method.

(iii) Results of the study show that the achievement of boys in Chemistry is equivalent to that of girls when CELA is used.

(iv) Results of the study show that there was no significant gender difference in attitude towards Chemistry between boys and girls taught through CELA. Boys and girls exposed to CELA perform equally well.

(v) The results of the study show that there was no significant difference in achievement in boys in co-educational schools when exposed to CELA. School type does not affect the achievement of students in Chemistry.

(vi) From the results of the study, it was found that there was no statistically significant difference in achievement in Chemistry between girls from girls' schools and girls from co-educational schools when exposed to CELA.

5.3 Conclusions

Based on this study the following conclusions have been made.

i) The use of CELA in teaching Chemistry enhances students' achievement than the Conventional Teaching Methods.
ii) Teaching Chemistry through CELA approach enhances students' attitudes towards Chemistry than CTM.
iii) Gender does not affect students' achievement in Chemistry when they are exposed to CELA.
iv) Gender does not affect students' attitude towards Chemistry when they are taught through CELA.
v) School type does not affect the achievement in Chemistry between boys in boys' school and that of boys in co-educational schools when CELA is used.
vi) School type does not affect the achievement in Chemistry between girls in girls' schools and that of girls in co-educational schools when CELA is used.

5.4 Implication of the Study

(i) Use of CELA resulted in higher students' achievement and thus should be used in Chemistry teaching at secondary school level. When the approach is implemented in secondary school, achievement and attitude towards Chemistry is likely to improve and performance at KCSE exams would be better. But more investigations covering a larger area would be necessary to reach a meaningful conclusion about the approach.

(ii) The use of conventional methods, for example, lecture method or writing notes, cannot adequately achieve meaningful learning. The classroom learning used, benefits mainly the bright students, weaker students are disadvantaged since they are not able to master the concepts taught, they need more time and remedial. Use of CELA (Cooperative E-learning Approach) where learners are subdivided into small heterogeneous groups of (4-5) students would cater for all levels of learners, the higher and lower achievers. Hence teachers should be sensitized on the importance of the new teaching methods.

5.5 Recommendations

Based on the findings of this study, CELA lead to high students' achievement in CAT and positive attitudes towards Chemistry in secondary school. It is therefore recommended that:

i. Chemistry teachers should incorporate this method in teaching Chemistry in secondary school level especially in the topic “mole”.
ii. Teachers should expose Chemistry students to cooperative E-learning approach (CELA) strategy so as to improve students performed in Chemistry and also change the student attitudes towards Chemistry positively.
iii. Government, educational agencies and other education stakeholders should organize. Teachers’ workshops on the use of cooperative E-learning strategy to enhance better performance.
iv. Teacher education programmes in Kenya in tertiary institutions should be improved upon to prepare teachers who can apply innovative approaches such as CELA which promotes effective teaching and learning. This could be achieved by practical demonstration of CELA in the classroom during micro teaching and teaching practice exercises.

5.6 Suggestions for Further Research

From the study CELA approach led to higher achievement and positive attitude towards Chemistry. The following areas need further investigations.

i. A study should be carried out on the use of CELA on different subjects and at different levels to provide sound basis for the integration of CELA in Kenyan schools.
ii. A study should be carried out on the effect of cooperative E-learning on students’ problems solving abilities in secondary Chemistry.
iii. The study on the teachers’ attitude towards the use of CELA in teaching Chemistry could be carried out.

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APPENDIX A

INTRODUCTORY LETTER TO THE RESPONDENTS

EGERTON UNIVERSITY

DEPARTMENT OF C.I. & EM

BOX 536,

EGERTON

DEAR TEACHER,

RE: QUESTIONNAIRE ADMINISTRATION

I am a post-graduate student in Egerton University Department of Curriculum, Instruction and Educational management in partial fulfilment of the requirements for the Degree of Doctor of Philosophy in Science Education (Curriculum and Instruction). I am carrying out a research on effect of cooperative E-learning approach on students' achievement and attitude towards chemistry.

Please read the instructions carefully and provide answers to the items in the questionnaire attached to this letter. All information you give will be treated with confident.

Thanks in advance

Yours sincerely

CHEBII ROSELYN

APPENDIX B

CHEMISTRY ACHIEVEMENT TEST (CAT)

Time: 2 hours

Class____________ Sex__________ School ____________

INSTRUCTIONS

1. Write your class, sex and school in the spaces provided.
2. Please answer all questions
3. Read the questions carefully before writing your answer
4. Write your answer in the spaces provided in the question paper

QUESTIONS

1. What is the mass of 0.25moles of calcium carbonate (Ca=40, O=16, C=12) (2marks)

 ____
 ____
 ____

2. How many moles are there in 13.6g of magnesium sulphate? (Mg=40, S=32, O=16)

 (2mks)

 ____
 ____
 ____

3. Define the term mole (1mark)

 ____
 ____

4. Calculate the molar mass of an element if a mass of 5.6g contain 0.1moles of the element (2mks)

 ____
 ____
 ____

5. Define the following terms

    a. Relative atomic mass (1mark)

    ____

    ____

    b. Empirical formula (1mark)

    ____

    ____

6. Work out the relative formula mass of

    a. $NaHCO_3$ (1mark)

    ____

    ____

    b. $Al_2(SO_4)_3$ (1mark) (Na=23, C=12.0, O=16, S=32, Al=27)

    ____

    ____

7. A compound Q contains 73.5% carbon, 10.2% of hydrogen by mass and the rest is Oxygen. Its relative molecular mass is 98. Calculate the molecular formular (4marks)

    ____

    ____

    ____

    ____

8. 24.6g of a hydrated salt of $MSO_4.XH_2O$. On heating produced 12.0g of anhydrous MSO_4. Find the value of X (M=24, S=32, O=16) (3marks)

    ____

    ____

    ____

    ____

9. Define the term molarity (1mark)

    ____

    ____

10. Determine the molarity of a solution containing 10.6g of sodium carbonate dissolved in $250cm^3$ of distilled water (RAM, Na=23, Ca=12, O=16) (2marks)

11. A student reacted 10.8g of aqueous silver nitrate and an excess aqueous sodium chloride

    a. Write chemical and ionic –equation the reactions (2marks)

    b. Write the formulas of the spectator ions (2marks)

    c. Calculate the mass of silver chloride precipitated (2marks)

12. Explain the observation made when lead(II)nitrate is:

    a. Reacted with potassium iodide (2marks)

    b. What is the purpose of adding ethanol in the reaction in (a) above (1marks)

13. 10.0g calcium carbonate were heated strongly to a constant mass. Calculate the mass of the solved residue produced (Ca=40, C=12, O=16) (3marks)

14. Write down the formula of the following compounds

a. Ammonium phosphate (1mark)

____

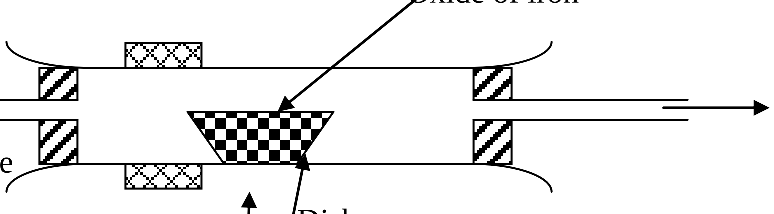
____

b. Magnesium hydrogen carbonate (1mark)

____

____

15. Excess Carbon (II) Oxide gas was passed over a heated sample of oxide of iron as shown in the diagram. Study the information and answer the question



Mass of empty dish= 10.8g

Mass of empty dish + oxide of iron = 13.30g

Mass of empty dish + residue = 12.66g

a. Determine the formula of the oxide of iron (RFM of oxide of iron = 232, Fe= 56, O=16) (3marks)

____

____

____

b. Write the equation of the reaction which took place in the dish (2marks)

____

____

____

16. What volume of hydrogen gas is obtained when 2.4 of magnesium reacts with excess dilute hydrochloric acid (Molar gas volume=22.4^3dm) (3marks)

____

____

____

17. Define the term atomicity of an element (1mark)

____

____

18. Given Avogadro's constant L= 6 x 10^{23} mol^{-1}. Calculate the number of atoms in (Fe= 56, Al == 27)

    a. 4.2g of iron (1marks)

    ____

    ____

    b. 0.1 mol of aluminum (1mark)

    ____

    ____

19. Calculate the percentage of each element in hydrated copper (II) Sulphate ($CuSO_4.5H_2O$) (Cu= 63.5, S=32, O=16, H=1) (3marks)

____

____

____

APPENDIX C

STUDENTS ATTITUDE QUESTIONNAIRE (SAQ)

Class____________ Sex__________ School ____________

INSTRUCTIONS

1. Read the items carefully before you tick the answer or give your opinion
2. Circle the letter that corresponds with how you feel towards chemistry
3. This is not a test and there are no right or wrong answers
4. Please give your honest feelings
5. The letter choices are SA= Strongly Agree, A = Agree, U=Undecided, D= Disagree, SD=Strongly Disagree
6. All the information you give will be treated as confidential

STATEMENTS

1.	I enjoy reading Chemistry books daily	SA	A	U	D	SD
2.	When I grow up I would like to be a doctor	SA	A	U	D	SD
3.	Chemistry is my favorite subject	SA	A	U	D	SD
4.	Chemistry as a subject is very interesting	SA	A	U	D	SD
5.	Chemistry is needed at all your work or course of study	SA	A	U	D	SD
6.	Chemistry teachers are hardworking people	SA	A	U	D	SD
7.	Chemistry is not a difficult subject to learn	SA	A	U	D	SD
8.	Chemistry is very useful for our survival in life	SA	A	U	D	SD
9.	Chemistry teacher is highly motivated while teaching	SA	A	U	D	SD
10.	Chemistry teacher is approachable	SA	A	U	D	SD
11.	Chemistry theories are very useful and can be applied in solving problems	SA	A	U	D	SD

12.	Our chemistry teacher gives assignments regularly	SA	A	U	D	SD
13.	I enjoy doing private practice in solving problems in chemistry	SA	A	U	D	SD
14.	Solving problems in chemistry is my hobby and that enhances my good performance in subject	SA	A	U	D	SD
15.	My teachers uses instructional materials to arouse my intrest while teaching some concepts in chemistry.	SA	A	U	D	SD
16.	Chemistry experiments are very boring	SA	A	U	D	SD
17.	Only brilliant students should study chemistry	SA	A	U	D	SD
18.	Our chemistry teacher is too harsh and incompetent	SA	A	U	D	SD
19.	Our chemistry teacher is too lazy to look at our notes for the purpose of making necessary correction.	SA	A	U	D	SD
20.	Personally I doubt if I can ever make any pass in chemistry	SA	A	U	D	SD
21.	Concepts, theories and formulas of chemistry are too much to be understood	SA	A	U	D	SD
22.	Teaching methods used by my teacher of chemistry are obsolete	SA	A	U	D	SD
23.	The recommended chemistry textbooks are too difficult for a beginner as it does not carry enough worked examples and exercise which could guide private learners	SA	A	U	D	SD
24.	Some chemistry textbooks are expensive to produce	SA	A	U	D	SD
25.	At home I find my chemistry textbooks too easy for private studies	SA	A	U	D	SD

26.	I prefer non-chemistry subject than study chemistry	SA	A	U	D	SD
27.	If chemistry is not a compulsory subject for science studies, I would not have registered nor sit for it.	SA	A	U	D	SD
28.	I study chemistry to enable me secure admission in chemistry careers.	SA	A	U	D	SD
29.	My parents told me ever before I got into secondary that chemistry is difficult and volatile subject and so I dare not like it	SA	A	U	D	SD
30.	Chemistry as a subject should be removed totally from secondary school curriculum	SA	A	U	D	SD

APPENDIX D

CHEMISTRY TEACHING MODULE

1.0 INTRODUCTION

The cooperative e-learning module on chemistry topic mole is developed for form three. It is developed in order to help students understand about the topic the mole i.e. on how to calculate moles, e.g. given masses molecular mass. The module will follow the secondary school curriculum and syllabus (2002). The appropriate chemistry text books for form three will be used. The data consists of non-verbal information and visual display on the computer for cooperative learning. Dynamic visual display (DVD) will be used to relay information via the computer. The students will be expected to use the key board and the mouse to interact.

The Chemistry teacher will take major role during the lesson. The teacher will teach the learners during the lesson and then guide them on how to use the computers when they move to their groups learners will work as groups and not individuals and will be expected to interact freely with each other

GENERAL OBJECTIVES

By the end of the topic the learners should be able to;

1) Define the term mole
2) Relate the mole to relative atomic mass
3) Convert mass to mole vice versa
4) Determine the empirical and molecular formula
5) Explain the terms; concentration, molarity and dilution of solution.
6) Prepare molar solutions
7) Explain the term stoichiometry of chemical reactions
8) Write stoichiometry equations
9) Write an ionic equation

LESSONS 1 AND 2

Sub-Topic: Mole

Lesson objectives: At the end of the lesson the learner should be able to:

a) Define the term mole

Apparatus: Beam balance, banana about 12, orange at least 12, 12 mangoes, computer system units (courseware CBI, software and manuals), pens, exercise books.

Method: teacher demonstration, group discussion

Lesson development

Step 1: The teacher shall remind the students

a) The basic skills on how to start and operate the CBI
b) The direction keys used and the general specific objectives of the course via electronic chalkboard

Step II: The teacher can start by asking the learners to state some of the counting units such as dozen (12) a pair (2) gross (144), century (100), platon (39) etc.

The teacher asks the learner to count smaller units such as maize grains, beans and vice in 100g.

Teacher activities

a) Organises the students in the proper sitting arrangements
b) Explain what the students are required to do
c) Helps the students turn the system on and checks if all the students can see clearly.
d) Supervise the tasks and gives the apparatus
e) Supervises students work

CBI: Lesson Input

a) Presents/ relays the information on the objectives of the lesson and the definition of the term mole
b) Presents/ poses questions to students

Students activities

a) Work in groups on the computer
b) Participate in group discussions
c) Press a function key or type at the keyboard to continue the lesson process.

COMPUTER BASED INSTRUCTION

WELCOME TO FORM 3 CHEMISTRY

ON THE MOLE

INTRODUCTION TO MOLE

Questions

(i) State some of the counting units

(ii) Give the masses of the following:-

- 12 bananas
- 12 oranges
- 12 mangoes

(iii) Find how many fruits of each type weight 2 kg

- Bananas =
- Oranges =
- Mangoes =

BACK NEXT

SOLUTION

(i) Counting units can be a:

- Dozen (12)
- Pairs (2)
- Gross (144)
- Century (100)

(ii) Fruits have different masses

(iii) The number of fruits vary because of the unit masses

Count small units of example maize, sugar in 100g?

If the units mass of one particle is known, then it is possible to estimate the number of particles there are in one kilogram of sugar without counting.

BACK QUIT NEXT

DEFINITION OF MOLE

It is the counting unit for very small particles such as atoms and molecules. It is a counting unit like a dozen but has 6.023×10^{23} particles.

Just like a dozen has 12 units, a mole has 6.023×10^{23} specific particles

Example

A mole of bananas = 6.023×10^{23} bananas

A mole of copper atoms = 6.023×10^{23} atoms

A mole of oxygen molecules = 6.023×10^{23} molecules

It has been established that 1 mole of any substance contains the same number of particles as there are atoms in 12.00g of pure carbon-12

BACK NEXT

EXPERIMENT 2.2: How many nails of each size have a mass equal to the corresponding relative mass as expressed in grams

Counting units

QUESTIONS

i. Which nail size was taken as the standard reference in this experiment.
ii. Explain what is meant by the term relative mass.
iii. What are the units for the relative mass in this experiment
iv. What are the main sources of error in this experiment

BACK NEXT

LESSONS 3 AND 4

Subtopic: relative atomic mass

Lesson objectives: at the end of the lesson: the learner should be able to

i) Relate the mole to relative atomic mass

Experiment: how many times is a large nail heavier than 2.5cm

Apparatus: beam balance, nails' 5.0cm, 7.5cm, 10cm, 12.5cm and 15cm. computer, books and pens

Method: class experiment, group discussion

Lesson development

Step I: The learners briefly review the previous lesson on the definition of the term mole

Step II: Teacher asks them questions on what they had covered the previous lesson.

Step III: The teacher should demonstrate first on how to carry out balancing in finding out the number of nails

Teacher activity

Teacher should observe whether learners are handling the beam balance correctly

i) Organise the learners in proper sitting arrangements
ii) Explain what is required for learners to do
iii) Issue apparatus to learners
iv) Supervise student's book

Student activities

i) Attends to the information presented on the electronic chalkboard
ii) Work in groups on the computer
iii) Follow instructions and directions required to continue CBI lesson
iv) Participate in group discussion

CBI Lesson Input

i) Presents/ posses some questions to the students
ii) Relay the feedback to the students via the screen
iii) Relays non-verbal information

SOLUTION

(i) The smallest nail is taken as the reference because ratios obtained would be whole numbers.

(ii) Relative mass in this experiment is the mass of the big nail compared to the smallest

(iii) Relative mass has no units. It is a ratio

DEFINITION OF RELATIVE MASS

Relative mass of atoms is the mass of substance compared with the mass of a given standard substance.

In Chemistry carbon-12 used as the reference when the mass of an atom is compared to that of carbon. It is reffered as Relative Atomic Mass (R.A.M).

The International Union of Pure and Applied Chemistry (IUPAC), recommended a new scale based on Carbon-12 isotope. Carbon twelve was chosen as the reference because it is solid, stable and a very common element

$$\text{RAM} = \frac{\text{Average mass of one atom of the element}}{\text{One twelfth } (^1/_{12}) \text{ of mass of one atoms of carbon 12}}$$

BACK NEXT

RELATIVE ATOMIC MASSES OF SOME SELECTED ELEMENTS

ELEMENTS	RAM
Hydrogen	1
Carbon	12
Oxygen	16
Sodium	23
Magnesium	24
Sulphur	32
Calcium	40

The relative atomic mass of an element in grams contains one mole of atoms of that element.

It has been established that one mole of any element contains the same number of atoms. This meant that one gram of hydrogen contains the same number of atoms as twelve grams of carbon.

The number of particles in 1 mole of any substance has been established to be 6.023×10^{23}. This number is referred as Avogadro's number or constant. Amount of any substance that contains Avogadro's number of particle is called a MOLE.

Mole is used to measure the amount of particles (atoms, molecules, ions, electrons of any substance)

Mass in grams of one mole of a substance is referred to as MOLAR MASS.

BACK NEXT

LESSON 5

Sub-topic: Avogadro's constant, molar mass

Lesson objectives: At the end of the lesson the learner should be able to develop the concept that, number of particles of any element with mass equal to its R.A.M is a constant: One mole

Apparatus: The computer, books, pens

Method: CBI Group Discussion

Lesson Development

Step I: The learner's briefly reviews the previous lessons

i) The relative atomic mass of an element contains a mole of atoms of that element
ii) There is a constant number also to a mole of atoms (One relative atomic mass).
   $= 6.023 \times 10^{23}$

Teachers activities

a) State the objectives of the lesson
b) Organise the students in the proper sitting arrangements
c) Help the students turn the system and check if all the students can see clearly
d) Supervise the students work

Students activities

a) Attends to the information presented on the electronic chalkboard
b) Working in groups on the computer
c) Follow instructions and directions required to continue CBI lessons
d) Participate in group discussion.

CBI Lesson input

i) Relay feedback to students via the screen
ii) Relays non-verbal information
iii) Presents/ poses some questions to the students

MOLAR MASSES AND AVOGADRO'S CONSTANT

Element	Formula	RAM	Molar mass g/mol	No. of particles
Hydrogen	H	1	1	6.023×10^{23}
Carbon	C	12	12	6.023×10^{23}
Sulphur	S	-	32	-
Iron	Fe	56	-	-
Calcium	Ca	40	-	6.023×10^{23}
Nitrogen	N	-	-	6.023×10^{23}
Magnesium	Mg	24	-	-

Questions

(i) Complete the table above
(ii) How many atoms are there in mole of oxygen atoms
(iii) What mass of oxygen atoms would you expect to contain the same number of atoms as six grams of carbon
(iv) How many atoms are there in 20g of calcium

BACK NEXT

SOLUTION

(i) 6.023×10^{23} atoms
(ii) 8 grams
(iii) 3.01×10^{23} atoms

BACK NEXT

LESSON 6

Sub-topic: Molecule and the mole

Lesson Objectives: at the end of the lesson the learner should be able to:

i) Explain the relationship between molecules and the mole

Apparatus: The computer, books, pens

Method: CBI group discussion

Lesson development

Step I: The learner's briefly reviews the previous lessons

Step II: The teacher gives the learners various substances which exists as molecules to enable them workout the number of molecules in a given mass.

Step III: Learners to relate relative atomic mass to relative molecule mass. Example oxygen O has relative atomic mass of 16 ,oxygen gas O_2 has relative molecular mass of 16x2= 32.

Teachers activities

a) State the objectives of the lesson
b) Organise students in proper sitting arrangements
c) Help the students turn the system on and check if all the student can see clearly.
d) Supervise the learners during class and group discussions

Students activities

a) Attend to these information presented on the electronic chalkboard
b) Working in groups on the computer
c) Follow instructions and directions required to continue CBI levels
d) Participate in group discussions

CBI lesson input

a) Relays non-verbal information
b) Relays feedback to students via the screen
c) Presents/poses some questions to the students

MOLECULE AND THE MOLE

Some elements in the periodic table do not exist as atoms but molecules. For example a sample of oxygen gas is made up of oxygen molecules. O_2. Oxygen atom cannot exist freely on their own. Oxygen has a relative atomic mass of 16. Oxygen O_2 has relative molecular mass of 16 x 2 = 32.
One mole of oxygen molecule have a mass of 32g. This mass contains 6.023×10^{23} molecules of oxygen.
Since each molecule of oxygen has two atoms, then, 1 mole of oxygen molecules would contain
$2 \times 6.023 \times 10^{23} = 1.2046 \times 10^{24}$ atoms of oxygen
0.5 mole of oxygen molecules would contain $6.023 \times 10^{23} \times 0.5 = 3.0115 \times 10^{23}$ molecules of
oxygen.

BACK NEXT

QUESTIONS

i. Name other element which exists as molecules.

ii. How many chlorine atoms are there in 1 mole of chlorine molecules.

iii. How many atoms of Bromine are there in two moles of bromine gas.

iv. Calculate the number of molecules of nitrogen that are in 0.5 moles of nitrogen atoms.

BACK NEXT

SOLUTION
(i) Nitrogen, Iodine, Chlorine etc.
(ii) Chlorine has two atoms Cl_2
1 mole of chlorine molecules = $2 \times 6.023 \times 10^{23} = 1.2046 \times 10^{23}$ atoms
(iii) Bromine = Br_2 has to atoms
1 mole of bromine molecule has = $(2 \times 6.023 \times 10^{23})$ atoms
2 moles of bromine molecule = $(2 \times 2 \times 6.023 \times 10^{23})$ atoms
(iv) 1 mole of nitrogen molecule contains 6.023×10^{23} molecule
0.5 = $(0.5 \times 6.023 \times 10^{23})$ molecules of nitrogen

BACK QUIT NEXT

LESSONS 7 AND 8

Sub-topic: Calculation involving moles

Lesson objectives: At the end of the lesson the learners should be able to

i) Convert mass into moles and vice versa.

ii) Obtain mass of the element given the number of moles

iii) Obtain molar mass or RAM given mass and number of moles

iv) Recall the relationship; number of moles = mass/molar mass

v) Determining molecular mass given the formula of the compound

Lesson Development

Step I: The learners briefly reviews the previous lessons

Step II: Teachers gives them the relationship between elements and the mole; 1mole of an element has a mass equal to relative atomic mass in grams.

Example

1 mole of magnesium has a mass of 24g

0.5moles of magnesium has a mass of;

1 mole of Mg = 24g

0.5mole – x

X = 0.5 x 24 = 12g

Mass of an element (in grams) = molar mass x number of moles

Step III: The learners should form groups and discuss the problem on the

- Element and the mole
- Compound and the mole

Teachers activities

a) Organises the learners for group learning

b) Supervises the CBI lessons

c) Supervises the learners during class/ group discussion

Student activities

a) Attend to instructions given by the teachers and the information presented on the electronic chalkboard.
b) Follow instructions and directions required to continue with CBI lessons
c) Participate in group discussions
d) Answer questions posed by the teacher/ CBI

CBI Lesson Input

a) Relays non-verbal information
b) Relays feedback to students via the screen
c) Presents/ poses some questions to the student.

ELEMENTS OF THE MOLE

1 mole of an element has a mass equal to its relative atomic mass in grams.

1 mole of magnesium has a mass of 24g.

The mass of 0.5mol of magnesium

1 mole of Mg → 24g

0.5mol of Mg = x

$$x = \frac{24 \times 0.5}{1 \text{ mol}} = 12g$$

24g/mol → molar mass of magnesium

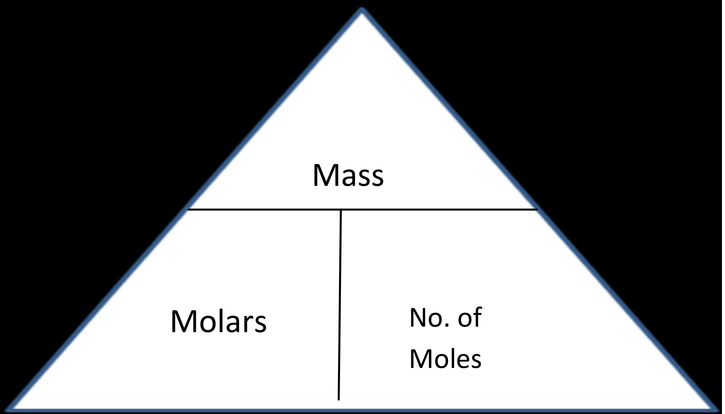
Mass of an element (in grams) = molar mass x number of moles

BACK NEXT

$$\text{No. of moles} = \frac{\text{Mass}}{\text{Molar mass}}$$

$$\text{Molar mass} = \frac{\text{Mass}}{\text{No. of moles}}$$

Mass = No. of moles x molar mass



BACK NEXT

QUESTIONS

(i) How many moles are there in 3g of carbon

(ii) How many moles are there in 4.6g of sodium

(iii) Calculate the mass of 0.25 moles of Beryllium

(iv) Calculate the number of moles of molecules in

13.2 g of propane C_3H_8

4.4g of carbon (iv) oxide CO_2

BACK NEXT

COMPOUND AND THE MOLE

The mass of a molecule is the sum of the relative atomic mass of the atoms in it.

Example: Molecular mass of chlorine molecule

Cl_2 is 35.5 x 2 = 71g

Relative molecular mass (mr) of a compound is the sum of all the relative atomic masses of the atom in a molecule of the compound.

Example relative molecular mass of water

H_2O is (1x2) + (16x1) = 18

NB: If the compound consists of ions then the value is referred to as relative formula mass.

QUESTION

How many moles are there in 10.6g of sodium carbonate

BACK NEXT

SOLUTION

Relative formula mass of Na_2CO_3 = (23x2) + 12 + (16x3)

46 + 12 + 48

= 106

1 mole of $Na_2CO_3 \rightarrow$ 106g

x moles $\rightarrow$ 10.6

$$x = \frac{10.6g}{106} \times 1mol = 0.1 \text{ moles}$$

Determine the formula mass of the following:-

NH_4Cl

$NaHCO_3$

$Al_2(SO_4)_3$

BACK NEXT

LESSON 9

Sub-topic: Empirical Formula

Lesson Objectives: By the end of the lesson the learner should be able to

i) Determine the empirical formulae of compounds from experiment results when magnesium reacts with oxygen.

Apparatus:

Weigh balance, crucible and lid , pair of tongs, source of heat, tripod stand and wire gauge.

Chemicals: Magnesium ribbon.

Method: Teacher demonstration, group discussion

Lesson development

Step I: The teacher asks oral questions on the previous lesson and the learner answer questions orally. Teacher gives the objectives by the lesson and leads a discussion on the topic.

Step II: The CBI lesson should guide the learner through the procedure of the experiments and the definition of the term Empirical Formula.

Step III: The CBI lesson should guide the learner through the procedure of the experiments and the definition of the term empirical formula.

Teacher activities

a) Demonstrates the experiments
b) Guide all learners on how to calculate the empirical formula

Learner activities

i) Follow procedure and make observation during the experiments
ii) Participate in group discussions
iii) Answer questions

CBI lesson input

i) Relays non-verbal information
ii) Relays feedback to students via the screen

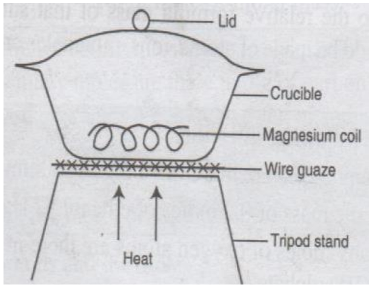
EMPIRICAL FORMULA

Empirical formula of a compound shows the simplest whole number ratio in which atoms a combine to form the compound. The formula is determined from experimental data.

Exp. 2.3 KLB BK3

Magnesium + Oxygen → Magnesium oxide

$Mg_{(s)} + O_{2(g)} \rightarrow MgO_{(s)}$



BACK NEXT

Mass of empty crucible + lid = A
Mass of crucible + lid + Magnesium = B
Mass of crucible + Magnesium oxide + lid
Mass of magnesium (D) = B – A
Mass of magnesium oxide (E) = C-A
Mass of oxygen = (C-A) – (B-A)
E-D

BACK NEXT

QUESTIONS

i. Why is it necessary to clean the magnesium ribbon?
ii. Why was the lid kept on the crucible at first?
iii. What was the purpose of the occasional lifting of the lid?
iv. Explain why it is necessary to heat the crucible and its contents until there was no further change in mass.
v. What masses of magnesium and oxygen combine to form magnesium oxide?
vi. How many moles of atoms of each element reacted in this experiment?
vii. Calculate the mole ratio of magnesium to oxygen in magnesium oxide
viii. What is the simplest formula of magnesium oxide?
ix. Find the percentage by mass of magnesium in the magnesium oxide
x. Name the possible sources of error in this experiment.

BACK NEXT

SOLUTION

i) It is necessary to clean the magnesium ribbon to remove any oxide film on it.

ii) The lid was kept in place to prevent any solid from escaping.

iii) The purpose of lifting the lid from time to time is to allow in air.

iv) It is necessary to heat the crucible and its contents until there was no further change in mass to ensure that all the magnesium had reacted.

Mass of Mg = 0.84g		Mass of oxygen = 0.56
Molar mass = 24		16
No. of moles = Mass = $\frac{0.84}{24}$ (Molar)		$\frac{0.56}{16}$
Moles	0.35	0.35
Mole ratio	1	1
	Mg	0

Simplest formula of magnesium oxide is a mole of magnesium atoms combines with a mole of oxygen atoms.

Simplest formula of magnesium oxide is MgO

vi) % by mass $\frac{Mg}{MgO} \times 100 = \frac{0.84}{1.4} \times 100 = \frac{84}{14} = 60\%$

vii) Possible errors i) Weighing the contents
ii) Performing the experiment or while heating the contents

BACK QUIT NEXT

QUESTIONS

i) Work out the formulae of compound which has the following percentage composition Sodium 43.40%, carbon 11.30% and oxygen 45.30%.

ii) Magnesium 9.8%, sulphur 13.0%, oxygen 26.0% and water of crystallization 51.2% (H=1, C=12, 0=16, Na=23, Mg=24).

iii) Determine the percentage composition by mass of each of the elements in the following compounds.

i. Ammonium sulphate $(NH_4)_2SO_4$
ii. $NaHCO_3$
iii. C_2H_5OH

BACK NEXT

LESSON 10

Sub topic: molecular formula

Lesson objectives: By the end of the lesson the learner should be able to;

a) Determine the molecular formulae of the compounds from experimental results

Method: Class discussion

Lesson development

Step I: The teacher asks oral questions on the previous lesson a teacher gives the objective of the lesson and leads a discussion on the topic to be covered.

Step II: The teacher gives the relationship between the empirical formula and the molecular formula.

Teacher activities

a) Reviews previous lessons
b) Gives the objectives of the lesson
c) Supervises group discussions

Student activities

a) Participate in group discussions
b) Attend to information presented on the electronic chalkboard
c) Answer questions posed by the computer
d) Write answers for questions given

CBI Lesson Input

i) Poses questions to the learners
ii) Relay non-verbal information

MOLECULAR FORMULAR

Molecular formula shows the actual number of each kind of atoms present in a molecule of the compound. If the empirical formula is known, then the molecular formula can be determined

(mass of empirical formula) n = molecular mass

n is a whole number

molecular mass is always a multiple of the empirical formula mass

Worked Examples

A hydrocarbon was found to contain 92.3% of carbon and the remaining is hydrogen. If its molecular mass is 78. Determine its molecular formula (C=12, H=1)

BACK NEXT

SOLUTION

Element	Carbon	Hydrogen
	92.3	7.7
RAM	12	1
No. of Moles	92.3 12 7	7.7 1 7.7
Mole ratio	1	1

Therefore empirical formula is CH

Molecular formula

$(CH)n = 78$

$(12 + 1)n = 78$

$13n = 78$

$n = 6$

$(CH)_6 = C_6H_6$

Molecular formula

$= C_6H_6$

BACK Revision Exercises p.g. 88-90 Nos 13, 1, 2b, 4(a,b0 5(c, e) 9(11),12 NEXT

LESSON 11

Sub-topic: concentration and molarity of a solution

Lesson objectives: By the end of the lesson the learner should be able to

i) Explain the terms concentration and molarity of a solution.

Method: Class discussion

Lesson development

Step 1: The teacher asks questions on the previous lesson.

Step 2: The teacher gives the objectives of the lesson and leads a discussion on the topic to be covered.

The teacher emphasise to the learners that concentration of solution is expressed in both mass (grams) and the number of moles of solute per any given volume.

Teachers activities

a) Review the previous lessons
b) Give the objectives of the lesson
c) Teachers leads the discussion

Student activities

1. Participate in group discussion
    a) Attend to the teacher's explanation on molar solution
    b) Write the answers for the questions given

CBI Lesson input

a) Present non-verbal information
b) Posses questions items to the learners

CONCENTRATION OF A SOLUTION

Concentration of the solution is a known amount of solute contained in a given volume. Consider 4.0g of sodium hydroxide pellets dissolve in $200cm^3$ of distilled water and then made up to $250cm^3$ of solution by adding enough distilled water. The concentration of this solution is expressed as 4.0g per $250cm^3$ solution in this solution in this concentration is expressed in <u>Mass of solute in grammes per given volume.</u>

$$\underline{4.0g/250cm^3}$$

Concentration can also be expressed as moles of solute per given volume

Number of moles in 4.0g = $\frac{4.0}{40}$ = 0.1moles

$250cm^3$ of solution in which 4.0g of sodium hydroxide is dissolved contained 0.1moles of sodium hydroxide.

Concentration can be expressed as 0.1 moles per $250cm^3$ solution

0.1 mole/$250cm^3$

Concentration of a solution may be expressed in terms of mass of solute in grams per given volume or

number of moles of the solute per given volume.

BACK NEXT

MOLARITY

Molarity of a solution is given only in moles of the solute per litre of solution. Moles/$1000cm^3$. This is normally expressed as mol/l or M

Worked Example

Determine the morality of solution containing 10.6g of sodium carbonate dissolved in:-

250cm3 of distilled water

500cm3 of distilled water (Na=23, C=12, O=16)

BACK NEXT

SOLUTION

Moles of Na_2CO_3

Molar mass = (46 x 2) + (12 x 1) + (16x3) = 106

$$\text{Moles} = \frac{\text{Mass}}{\text{Molar mass}} = \frac{10.6}{106} = \frac{106}{1060} = 0.1 \text{ moles}$$

0.1 moles → $250cm^3$

x moles → $1000cm^3$

$$= \frac{1000 \text{ x } 0.1}{250} = 0.4 \text{ mols/l}$$

= 0.4 moles/l

= 0.4M

0.1 moles → $500cm^3$

t moles → $1000cm^3$

$$t = \frac{0.1 \text{ x } 1{,}000}{5000} = 0.2 \text{ moles/l}$$

= 0.2M

Revision exercises No. 2, 3 and 4

BACK

NEXT

LESSONS 12 AND 13

Sub-topic: Preparation of molar solution and dilution of solution

Lesson objective: by the end of the lesson the learner should be able to

a) Define molar solution/ dilution of solution
b) Prepare molar solutions

Method: Class discussion and experiment

Lesson Development

Step I: The learner is introduced to the apparatus used to prepare molar solution by the teacher

Step II: The teacher involves the learner in the preparation of the molar solution

Step III: The teacher states the objectives of the lesson and emphasise to the learner the importance of taking accurate measurements of both masses of solutes and the volume of solvents.

Teacher activities

i) Organises them in groups
ii) Give the objectives of the lesson
iii) Introduce the apparatus to the learners
iv) Guide the learners through the procedure on how to perform these experiment

Learners activities

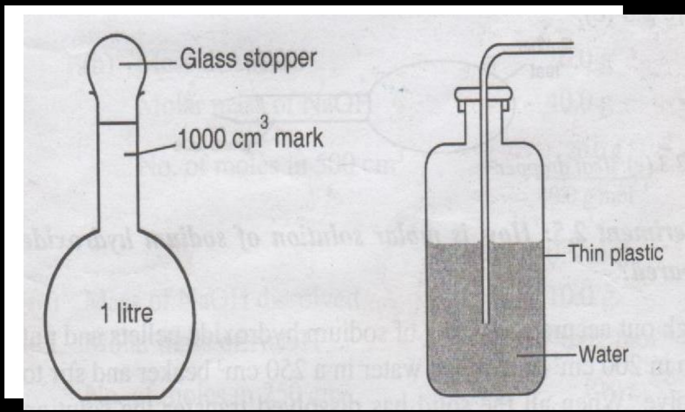
i) Perform the experiment
ii) Participate in group discussion
iii) Do the calculations

CBI lesson input

a) Present non-verbal information
b) Displays the apparatus to be used in the experiment (beaker, volumetric flask, wash bottle)

MOLAR SOLUTION

Molar solution is a solution containing one mole of a solute per liter of solution.



BACK NEXT

40.0g of sodium hydroxide pellets are weighed accurately and put in $200cm^3$ of distilled water in a $250cm^3$ beaker and stirred to dissolve.

When all the solid has dissolved, transfer the solution into one liter volumetric flask. Rinse the beaker with some distilled water and transfer the solution into the volumetric flask.

Using the distilled water in a wash bottle, make the solution to the mark.

Mass dissolved = 40.0g

Molar mass of NaOH = $40.0g\ Mol^{-1}$

No. of moles in 1 liters solution = $\frac{40.0g}{40.0g/mol}$

= 1.0mole

This is one mole per liter. Hence molar solution

BACK NEXT

DILUTION OF SOLUTION

Diluting a solution means making a solution less concentrated by adding more solvent to it.

Amount of solute remains the same as the volume of the solution increases.

Example

Measure accurately $25cm^3$ of 2M Hcl.

Transfer the solution into $250cm^3$ volumetric flask. Add distilled water to the acid and make up to $250cm^3$ of solution.

Repeat the process using $500cm^3$ volumetric flask instead of $250cm^3$

QUESTION

Determine the number of moles in $25cm^3$ of the 2.0m Hcl.

Determine the molarity of the solution formed in the:-

$250cm^3$ flask

$500cm^3$ flask

BACK NEXT

SOLUTION

Moles of HCl in $1000cm^3$ = 2.0 mole

Moles of HCl in $25cm^3 = \frac{2.0}{1000} \times 25cm^3$

= 0.05moles

0.05moles → $500cm^3$

t moles → $1000cm^3$

$t = \frac{1000 \times 0.05}{500}$ = 0.1 moles

NB/= Although equal volume of solutions containing equal moles were diluted. The molarities of the resulting solutions are different. The solution to which less water was added is more concentrated than the one which more water was added.

BACK NEXT

LESSONS 14 AND 15

Sub topic: Stoichiometry

Lesson objectives: by the end of the lesson the learner should be able to

i) Write correct formula and ionic equations of reactions with state symbols

Experiments: reaction between iron metal and Copper (II) Sulphate

Method: Class experiment

Lesson development

Step I: Teacher gives the objectives of the lesson

Step II: The teacher involves the learners in the actual measurement of the quantities of chemical needs for experiment.

Step III: Teacher emphasis to the learner the importance of taking accurate measurements for accurate experiment results

Step IV: Teacher emphasis to learner that knowledge of the products of a chemical reaction and the chemical formula is important in order to determine a balanced ionic equation in a chemical reaction.

Teacher activities

a) Review the previous lessons
b) Give the objectives of the lesson
c) Discuss the procedure with the learners
d) Supervises the group work

Student activities

a) perform the experiments
b) Participate in group discussion
c) Follow the instructions required
d) Take accurate measurements

CBI Lesson Input

i) Present non-verbal information
ii) Poses questions items to the learner

STOICHIOMETRY

Chemical reaction is represented either by word equation or a chemical equation.

A chemical equation is represented by means of chemical symbols and formula for both the reactants and products.

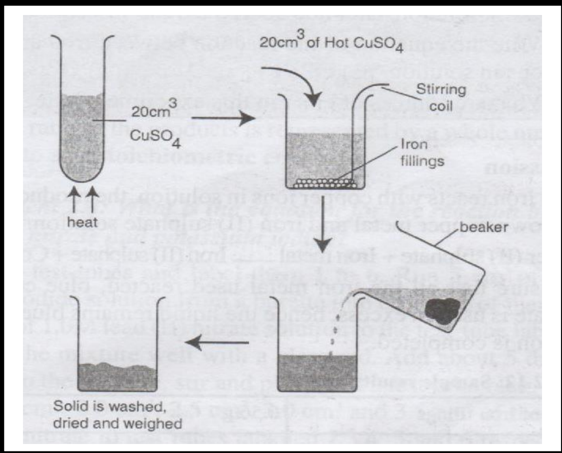
When particles combine in a chemical reactions, they do so in a specific proportion

$$A + B \rightarrow AB$$

Reacting amount of A and B can be expressed in terms of moles and the proportions in which they combine is referred to mole ratio

BACK NEXT

Exp. 27: WHAT IS THE EQUATION OF REACTION BETWEEN IRON METAL AND COPPER (II) SULPHATE



Mass of Iron fillings = 0.56g
Mass of Copper displaced = 0.64g

BACK NEXT

QUESTION

i. What observations were made when iron fillings and Copper (II) Sulphate reacted.

ii. Why was it necessary to use excess Copper (II) Sulphate?

iii. Calculate the

a) Number of moles of Iron metal reacted

b) Number of moles of Copper metal displaced from the solution (Fe=56; Cu=63.5)

iv. Write the equation of the reaction between iron and copper ions in solution

v. What are sources of error in this experiment?

BACK NEXT

SOLUTION

(i) Moles of iron used = $\frac{0.56}{56g/mol}$ = 0.01 moles

Moles of copper metal displaced = $\frac{0.64}{63.5}$ = 0.01 moles

Fe^{2+} ; Cu^{2+}

0.01 ; 0.01

1 ; 1

Hence one mole of iron atoms reacts with one mole of copper ions to produce one mole of atoms of copper metal

Equation

$Fe(s) + CuSO_4(aq) \rightarrow Cu(s) + FeSO_4(aq)$

When iron reacts with copper ions in solutions the products formed are brown copper metal and Iron (II) sulphate solution

Copper (II) Sulphate + Iron metal → Iron (II) sulphate + Copper Metal

BACK NEXT

LESSONS 16 AND 17

Sub-Topic: Stoichiometry

Experiment: reaction between Lead (II) nitrate and potassium iodide.

Lesson objective is at the end of the lesson the learner should be able to:-

i) Write correct full formula and ionic equations reactions with state symbols
ii) Distinguish a stoichiometric equation from an ionic equations
iii) Carry out experiment and make accurate observations

Lesson development

Step 1: The teacher states the objectives of the lesson

Step 2:The teacher reads through the procedure and emphasise the importance of taking accurate measurement for accurate experimental results.

Step 3: Teacher advices teams on how to take precautions when performing experiments to get accurate observations.

Teachers activities

i) Organise the students in the proper sitting arrangement
ii) Explain what the students are required to do .
iii) Specifying the tasks and gives the apparatus
iv) Supervises students work

Learners' activities

i) Attend to the teacher explanation on the experiment
ii) Follow instructions as required
iii) Participate in group work
iv) Attend to the information related via to the screen

CBI lesson input

i) Presents/ relays the information on the table in the graph
ii) Presents non-verbal information
iii) Poses test items to the learners

EXP. 28: REACTION BETWEEN LEAD (II) NITRATE AND POTASSIUM IODIDE
QUESTIONS

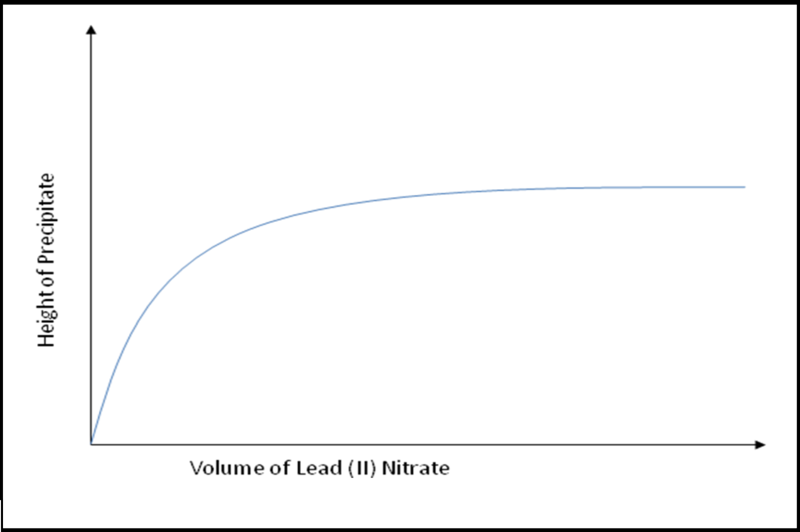
i) What was observed on mixing the two substances?
ii) What was the purpose of adding ethanol to the mixture?
iii) Calculate the:
   a) Number of moles of KI in 5cm^3 of 1.0m. KI solution
   b) Number of moles of $Pb(NO_3)_2$ which reacted completely with 5.0cm^3 of 1.0m KI.
iv) The heights of the precipitate remained constant in the test-tubes labeled 4, 5 and 6 explain.
v) How many moles of KI would react with one mole of lead (II) nitrate?
vi) Write a balanced chemical equation for the reaction between lead (II) nitrate and potassium iodide
vii) Comment on the shape of the graph of the height of precipitate against volume of the lead (II) nitrate.
viii) To ensure that all the Iron metal used reacted have liquid remains blue when the reaction is completed.
ix) Sources of errors are: (i) Weighing the residue
(ii) Measurement done

Stoichiometric equation is a chemical equation in which the mole ration of the reactants and the mole ratio of the products is represented by a whole number

BACK NEXT

EXP. 28: REACTION BETWEEN LEAD (II) NITRATE AND POTASSIUM IODIDE

Test tube number	1	2	3	4	5	6
Volume of 1m Lead (II) nitrate	1.0	1.5	2.0	2.5	3.0	3.0
Height of ppt						



BACK NEXT

SOLUTION

i) **When Lead (II) Nitrate solution reacted with potassium iodide solution, a bright yellow precipitate of Lead (II) Iodide was formed.**

ii) **Ethanol was added to the mixture to make settling of these precipitate faster.**

iii) **The heights of precipitate in test tubes labeled 4 to 6 remained constant because lead (II) ions were in excess and all the iodide ions had reacted.**

iv) **Moles of KI in $5.0cm^3$ = 1 mole → $1000cm^3$**

x → $5cm^3$

$$= \frac{5 \times 1}{1000} = 0.005 \text{ moles}$$

Moles of $Pb(NO_3)_2$ that reacted completely

$$= \frac{1.0 \times 2.5cm^3}{1000} = 0.0025 \text{ moles}$$

Lead ions and iodide ions reacted in the ratio

0.0025 = 0.005

Pb^{2+} = 1

1 = 2

(v) Equation of (Stoichomitry equation)

$Pb(NO_3)^2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$

Lead ions (Pb^{2+}) and Iodide ions (I^-) have undergone a chemical change.

But Nitrate (NO^-_3) and potassium (K^+) remain unchanged after the reaction.

Ionic equation

$Pb^{2+} \quad + \quad 2I^-(aq) \quad \rightarrow \quad PbI_2(s)$

Colourless Colourless Yellow

Ionic equation is a chemical equation which shows only the species which have undergone chemical change during a reaction

The species which remain is solution and are unchanged are referred to as SPECTATOR IONS

BACK

NEXT

LESSONS 18 AND 19

Sub-topic: Stoichiometry

Experiment: Reaction between barium ions and carbonate ions

Lesson objectives: At the end of the lesson the learner should be able to: -

i) Write correct full formula and ionic equations of reactions with state symbols
ii) Distinguish stoichiometry equation from on ionic equation

Lesson development

Step 1: The teacher states the objectives of the lesson

Step 2: The teacher discusses the procedure of the lesson and emphasise the importance of taking accurate experimental results.

Step 3: The CBI lesson shall guide the learner through the stages of the reaction. Learner shall observe, read, taking notes of the events.

Teachers activities

i) Organise the learners in the proper sitting arrangements
ii) Explain what the students are required to do
iii) Specifies the tasks and gives the apparatus
iv) Supervises the students work

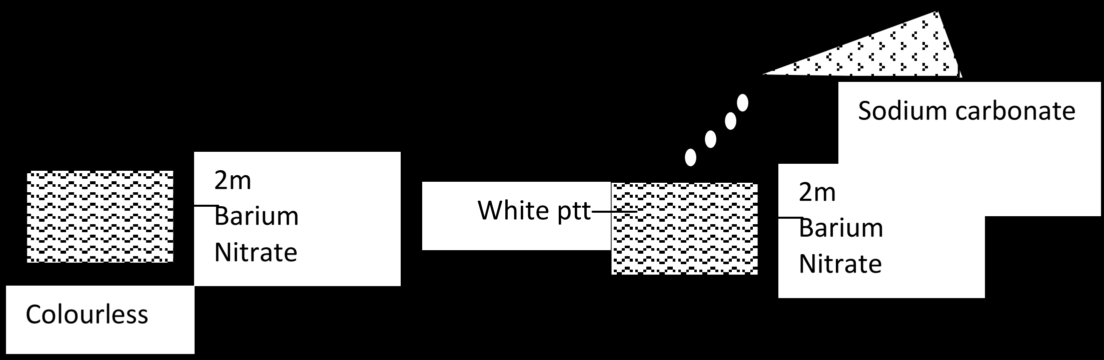
Learners activities

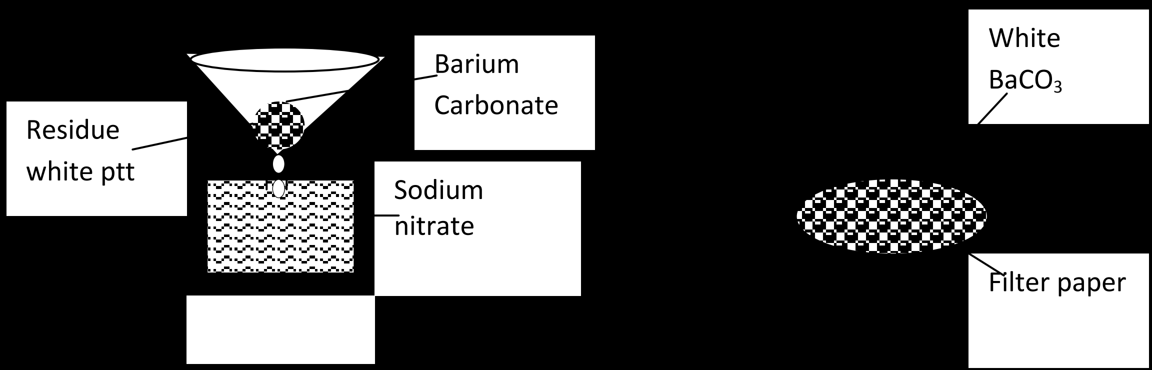
i) Attend to the teachers explanation on the experiment
ii) Follow instructions as required
iii) Participate in group work
iv) Attend to the information related via the screen

CBI lesson Input

i) Present/ relays the information on the screen
ii) Presents non-verbal information
iii) Poses tests item to the learner

REACTION BETWEEN BARIUM IONS AND CARBONATE IONS





The ions present in Barium Nitrate are Ba^{2+} ion and NO_3^- ions

Sodium carbonate = Na^+, and CO_3^{2-} ions. When the two solutions are mixed a white precipitate is formed. Barium ions combines with carbonate ion to form insoluble Barium carbonate.

The solid residue is not dried by heating because the compound $BaCO_3$ decomposes on heating.

BACK

$$BaCO_3 \xrightarrow{\text{heat}} BaO(s) + CO_2(g)$$

NEXT

QUESTIONS

(i) Calculate the number of moles of Barium ions and carbonate ions used in the reaction? What assumption have you made.

(ii) Calculate the number of moles of Barium carbonate formed.

NEXT

BACK

(iii) What is the whole number ratio of Barium Carbonate formed to that of Barium ions and Carbonate ions used?

(iv) Write the (i) Stoichrometric equation

(ii) Ionic equation for the reaction

SOLUTION

In this experiment it is assumed that 25.0cm^3 of 2M sodium carbonate reacted completely with 25.0cm^3 of 2M Barium chloride.

(i) Moles of Barium chloride used

2 moles → 1000 cm^3

x moles → 25cm^3

$x = \frac{2 \times 25}{1000} = 0.05$ moles

(ii) Moles of sodium carbonate used

$= \frac{25 \times 2}{1000} = 0.05$moles

(iii) Mass of Barium Carbonate formed = 9.85g

Moles of $BaCO_3$ formed = $\frac{9.85}{197}$

Ba = 137 0=16

C = 12 Na = 23 = 0.05 moles

Cl = 35.5

(iv) One mole of Barium Chloride reacts with one mole of sodium carbonate to produce one mole of Barium Carbonate hence equation

$BaCl_2(aq) + Na_2CO_3(aq) \rightarrow BaCO_3(s) \rightarrow 2NaCl\ (aq)$

Stoichiometric equation

$BaCl_2(aq) + Na_2CO_3(aq) \rightarrow BaCO_3(s) + 2NaCl(aq)$

(v) Ionic equation

BACK

$Ba^{2+}(aq) + CO_3^{2-}(aq) \rightarrow BaCO_3(g)$

NEXT

APPENDIX E

LETTER OF 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/16/67787/11039**

Date: **5th May, 2016**

Roselyn Jepkosgei Chebii
Egerton University
P.O Box 536-20115
EGERTON.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on **"*Effects of cooperative e learning approach on student' achievement and attitude towards chemistry in secondary schools in Koibatek Sub County Kenya,*"** I am pleased to inform you that you have been authorized to undertake research in **Baringo County** for the period ending **5th May, 2017.**

You are advised to report to **the County Commissioner and the County Director of Education, Baringo 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.

DR. STEPHEN K. KIBIRU, PhD.
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Baringo County.

The County Director of Education
Baringo County.

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified

APPENDIX G

RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MS. ROSELYN JEPKOSGEI CHEBII
of EGERTON UNIVERSITY, 0-20115 EGERTON,has been permitted to conduct research in *Baringo County*

on the topic: *EFFECTS OF COOPERATIVE E LEARNING APPROACH ON STUDENTS ACHIEVEMENT AND ATTITUDE TOWARDS CHEMISTRY IN SECONDARY SCHOOLS IN KOIBATEK SUB COUNTY KENYA*

for the period ending:
5th May,2017

Permit No : NACOSTI/P/16/67787/11039
Date Of Issue : 5th May,2016
Fee Recieved :Ksh 2000

....
Applicant's Signature

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

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 Officers 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

RESEARCH CLEARANCE PERMIT

Serial No. A 9040

CONDITIONS: see back page

APPENDIX H

PUBLICATION JOURNALS

Scientific Research Publishing

Creative Education, 2018, 9, 1872-1880
http://www.scirp.org/journal/ce
ISSN Online: 2151-4771
ISSN Print: 2151-4755

Effects of Cooperative E-Learning Approach on Students' Chemistry Achievement in Koibatek Sub-County, Kenya

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How to cite this paper: Chebii, R., Wachanga, S. W., & Anditi, Z. O. (2018). Effects of Cooperative E-Learning Approach on Students' Chemistry Achievement in Koibatek Sub-County, Kenya. *Creative Education, 9,* 1872-1880.
https://doi.org/10.4236/ce.2018.912137

Received: July 9, 2018
Accepted: September 26, 2018
Published: September 29, 2018

Abstract

The study investigated the effectiveness of Co-operative E-learning approach (CELA) on secondary school students' achievement in Chemistry. It was carried out in Koibatek sub county in Kenya, where there has been persistent low achievement in the subject. The Solomon Four Group, Non-equivalent Control Group Design was employed in the study. Three students from twelve county schools, purposively selected from 40 secondary schools were taught the same course content on the topic "mole" for a period of five weeks. The experimental groups (E_1 and E_2) received their instruction through the use of CELA approach and control groups (C_1 and C_2) using the conventional teaching method. The researcher trained the teachers in the experimental groups on the technique of CELA before treatment. The Chemistry Achievement Test (CAT) was used for data collection. Pre-test was administered to students in the experimental group (E_1) and control group (C_1) before teaching commences and after the teaching a post-test was administered to the four groups. The instrument was pilot tested to ascertain its reliability. The data collected was analyzed using t-test, ANOVA and ANCOVA. Hypothesis of the study was tested at $\alpha = 0.05$ level of significance. Results indicated that, the students in the experimental groups outperformed the control groups in the Chemistry Achievement Test. It was concluded that CELA enhanced better performance in Chemistry than conventional teaching method. Science teachers, educationist and policy makers are expected to benefit from the findings of the study. It should be included in regular pre-services and in-service training of Chemistry teachers in Kenya.

Keywords

Cooperative E-Learning Approach (CELA), Achievement in Chemistry, Conventional Teaching Method

Effects of cooperative e-learning approach on students attitude towards chemistry in Koibatek sub-county, Kenya

Roselyn J. Chebii[1], Zepheniah O. Anditi[1] and Samuel W. Wachanga[1]

[1]Department of Curriculum Instruction and Educational Management,
Egerton University, Kenya

ABSTRACT

The study investigated the effectiveness of Co-operative E-learning approach (CELA) on students' attitude towards Chemistry. The Solomon Four Group, Non-equivalent Control Group Design was employed in the study. The study was carried out in Koibatek sub-county, Kenya where there has been persistent low achievement in the subject. Form three students from twelve county schools, purposively selected from the sub-county were taught the same course content on mole for a period of five weeks. The experimental groups received their instructions through the use of CELA approach and control groups using the conventional teaching method. The researcher trained the teachers in the experimental groups on the technique of CELA before treatment. Student Attitude Questionnaire (SAQ) was used for data collection. One way ANOVA, ANCOVA and t-test were used in data analysis. Hypothesis of the study was tested at level of significance. The results indicated that students in experimental groups outperformed the control groups in attitude towards Chemistry. It was concluded that CELA enhanced better performance in Chemistry than the conventional method. Chemistry teachers should be encouraged to incorporate this method in their teaching and should be included in regular in-service of teachers in Kenya.

Key words: *Cooperative E-learning Approach (CELA), Attitude towards Chemistry, Conventional Teaching Method.*