EFFECTS OF COOPERATIVE MASTERY LEARNING APPROACH ON SECONDARY SCHOOL STUDENTS' MOTIVATION AND ACHIEVEMENT IN CHEMISTRY IN BOMET COUNTY, KENYA

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A Thesis Submitted to the Board of Postgraduate Studies in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Education (Science Education) of Egerton University

EGERTON UNIVERSITY

December, 2013

DECLARATION AND RECOMMENDATION

DECLARATION BY THE CANDIDATE

I declare that this thesis is my original work and has not been submitted for the award of any Diploma or Degree in this or any other university.

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RECOMENDATION

This thesis has been submitted for examination with our approval as University Supervisors.

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DEDICATION

This work is dedicated to my dear wife, Milka, our son, Timothy, my late dad and mum, who are a great inspiration in my life.

ACKNOWLEDGEMENT

I would like to express my sincere appreciation and gratitude to my supervisors, Professor S. W. Wachanga and Professor M. O. Okere for their professional expertise, invaluable guidance, persistent encouragement, patience, incisive comments, enthusiasm and generous contribution of their valuable time, great assistance and inspiration in the development of my thesis. Special appreciation is also directed to my pastor and entire staff of Mulot High School who gave me invaluable love, encouragement, sacrifice, patience, moral support and for their reviews and comments on early drafts that were most useful. Above all, I wish to thank my wife, Milka. This thesis is a product of numerous late-night brainstorming sessions and hundreds of home-cooked meals. Without her selflessness, love, and encouragement, none of this would have been possible. Gratitude and sincere appreciation are also extended to NCST and Bomet County Education Office for granting me the permission to conduct my research in the chosen schools. I am grateful to Mr. Koech D., Mr. Cheres N., Mr. Korir R. and Mr. Yegon P.; the chemistry teachers that the researcher involved in the study, for the contextualization of the items in the instrument and the content validation of the coursework as well as administration of the pre-test and post-test. It is a pleasure for me to acknowledge the principals, teachers and students of the schools involved in the study for helping in the pilot study as well as the actual study. Their cooperation, endurance and involvement in data collection are very much appreciated. My sincere thanks are also extended to Dr. Barchok for proof reading the final draft of the thesis. Above all, I express sincere gratitude to my friends who faithfully gave me encouraging support throughout the duration of my writing. To God be the glory, great things he has done.

ABSTRACT

The teaching approach that teachers adopt is a crucial factor that may affect students' motivation and achievement in Chemistry. Innovative and research based teaching methods that enhance effective and efficient teaching of chemistry should be used. Such methods promote cognitive, psychomotor and affective characteristics of the learners. Recent developments in science education show that there is need to expose learners to basic concepts in a given topic. This prepares them psychologically for related but more challenging topics or units ahead and ensures that every learner masters the concepts taught before proceeding to the next unit of study. In line with these developments, this study investigated the effects of Cooperative Mastery Learning Approach (CMLA) on secondary school students' motivation and achievement in chemistry in Kenya's Bomet East and Bomet Central Sub-Counties. Chemistry performance at KCSE level has been low and has continued to decline over the years in these sub-counties. Solomon Four Non-equivalent control group design was used, in which samples of four co-educational district secondary schools were drawn from the schools in the County. A total of 205 Form Two students were involved. Students in all the four groups were taught the same chemistry content of the topic: Effect of Electric Current on Substances. In the experimental groups, CMLA teaching strategy was used while Conventional Teaching Methods were used in the control groups. Two groups were pre-tested prior to the implementation of CMLA treatment. At the end of the treatment, all the four groups were post-tested using Students' Motivation Questionnaire (SMQ) and Chemistry Achievement Test (CAT). The instruments were validated with the help of experts in the Department of Curriculum, Instruction and Educational Management of Egerton University. The SMQ and the CAT were pilot-tested to establish the reliability coefficients which were found to be 0.82 and 0.78 respectively hence acceptable for the study since each of the values was greater than 0.70. Data collected were analysed using mean, t-test, one-way ANOVA and ANCOVA. The SPSS computer package was used in data analysis. All statistical tests were subjected to a test of significance at 0.05 α-level. The findings indicate that the motivation level was significantly higher for students taught using CMLA compared to those taught using conventional teaching methods. Students taught using CMLA achieved significantly higher scores in CAT than those taught using conventional teaching methods. However, there was no significant gender difference in motivation and achievement when boys and girls were taught using CMLA. This implies that the CMLA is suitable for teaching both male and female students. In addition, education authorities in Kenya should encourage chemistry teachers to use the teaching approach. Moreover, teacher education institutions should make it part of their teacher training curriculum content.

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LIST OF ACRONYMS

ANCOVA	Analysis of covariance
ANOVA	Analysis of Variance
CAT	Chemistry Achievement Test
CEO	County Education Office
CMLA	Cooperative Mastery Learning Approach
CTM	Conventional Teaching Methods
EM	Extrinsic Motivation
IM	Intrinsic Motivation
INSET	In-service Education and Training
JICA	Japan International Cooperation Agency
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
KIE	Kenya Institute of Education
KNEC	Kenya National Examination Council
LFM	Learning For Mastery
MASS	Motivation for Academic Study Scale
MOEST	Ministry of Education Science and Technology
MOPS	Motivation of occupational preference scale
MTC	Motivation Towards Chemistry
PSI	Personalised System Instruction
SDT	Self-Determination Theory
SMASSE	Strengthening of Mathematics and Science in Secondary Education
SMQ	Student Motivation Questionnaire
SPSS	Statistical Package for Social Sciences

SSBF	Students' Socio-Background Factor
STE	Science and Technology Education
TAT	Thematic Apperception Test

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

The ultimate goal of teaching science subjects in secondary school is to develop members of society that are sufficiently literate and that possess relevant skills needed for technological innovations as well as meet the manpower requirements for the development of a country. Theories in economics and sociology link the level of scientific and technological development in a country with its national development (Opare, 1996). Science and Technology Education (STE) is regarded as a vehicle for economic and social development in a country (Shumba, 2003).

Since independence, Kenya's Ministry of Education has been advocating for the need to improve the teaching and learning of science. Its main objective is to create a foundation of a technologically oriented workforce in line with the national development (Ministry of Education, 2003). Despite the increase in provision in terms of resources and facilities, schools generally have not been able to make significant improvements in science. This will have a serious repercussion on the country's effort towards becoming a scientifically and technologically advanced nation by the year 2030 (Kerich, 2004; Republic of Kenya, 2008). This is because, in order to achieve this vision it would require nothing short of good performance in science at all levels of schooling.

One of the challenges teachers are facing is how to improve students' performance nationally in chemistry as its pass rates at Kenya Certificate of Secondary Education level is the lowest compared to that of biology and physics (Njoku, 2007). Since chemistry is one of the important subjects in the fields of medicine and natural sciences, the country will not be able to produce sufficient number of doctors, dentists, pharmacists and natural scientists to meet the demand of the country's socio-economic development (Wachanga, 2005). This implies that scientific and technological development cannot be achieved unless the necessary scientific infrastructure is put in place, which in itself presupposes an adequate system of education. Thus without a strong base in STE, the development of a country is in shambles (Barchok, 2006).

Currently, science is perceived as something having universal value, and perhaps more importantly, an essential component of the core curriculum for all (Osborn & Wittrock, 2003). Advocates of formal education perceive science and mathematics as an essential component in developing the intellectual and critical abilities of an educated and rational individual, that is, somebody who is open-minded, holds a commitment to evidence, rather than dogma (Osborn & Wittrock, 2003). One of the prime aims of modern science education is to enhance creativity among learners (Okere, 1996). Science education should therefore develop the ability of the students to reason, understand and bring out their ability to use inventively and originally the theoretical knowledge and skills acquired. Kenya needs to develop through STE, a human resource capacity for rapid industrialization which will ensure economic growth and sustainable development (Changeiywo, 2000).

Science is an integrated subject encompassing three subjects in Kenyan secondary school curriculum, that is; Biology, Physics and Chemistry. The inclusion of these science subjects is to help Kenya as a country to achieve its national objective of self reliance and economic development (Barchok, 2006). The subjects are also supposed to equip her citizens with knowledge, skills and scientific attitudes necessary to help them solve problems in their day to day living.

Chemistry as a branch of science offered in Kenyan secondary school curriculum is introduced to the learners for the first time at secondary school level. The knowledge of chemistry is important in understanding the composition, properties and behaviour changes of matter that form the environment around us and the teaching of the subject aims at developing scientific concepts, principles and skills (KIE, 2002). Chemistry has contributed tremendously to mankind in a number of ways such as improvement of health, supply of foodstuff, increased comfort, convenience and pleasure, increasing efficiency of industrial processes and reduction of dependence on natural materials (Wachanga, 2005).

Although science is essential for mankind, there has been a general decline in its' academic performance of secondary school students at KCSE level. Students in Kenya perform poorly in mathematics and sciences (Changeiywo, 2000).This is particularly the case in chemistry examinations as shown by the results in Table 1. These results show that students' performance in chemistry compared to that of the other two science subjects is relatively low.

Table 1

Comparison of Students' Performance in Chemistry and other Science Subjects at K.C.S.E level from 2005-2009

	2005		**2006**		**2007**		**2008**		**2009**		
Subject	**Candidature**	**Mean %**	**Candidature**	**Mean %**	**Candidature**	**Mean %**	**Candidature**	**Mean %**	**Candidature**	**Mean %**	**Average %**
Chem.	253,508	26.99	236,831	24.91	267,719	25.38	296,937	22.74	328,922	19.13	22.43
Bio.	234,975	26.00	217,675	27.42	248,519	46.95	274,215	30.32	299,302	27.20	31.58
Phy.	69,424	25.88	72,299	40.32	83,162	41.32	93,692	36.71	104,188	31.33	35.11

(Source: Kenya National Examination Council Reports 2005, 2006, 2007, 2008 & 2009)

Table 1 indicates that students perform poorly in Chemistry as compared to other science subjects. From Table 1 it can be noted that the chemistry candidature has continually increased over the years. However, the results show that there has been a general decline in performance over the years in the subject. It is evident that the overall performance has been quite low. The highest mean score is 26.99% that was recorded in the year 2005 and the least score being 19.13% recorded in the year 2009. Perhaps, the poor performance in chemistry stems from students' lack of motivation to learn the subject or the teacher centred teaching methods used by most teachers. This calls for more research to find out exactly where the problem is and possibly find ways of improving it.

In Kenya, secondary school chemistry examinations usually test students' understanding of facts, concepts and general principles in chemistry (KNEC, 2008). The subject is tested using three papers; two of which are theory while the third is a practical paper. Table 2 indicates the national KCSE performance by gender in chemistry from the year 2005 to 2009. Analysis of the results over the same period of time also indicates that the performance of girls is poorer than that of boys. The achievement of both boys and girls over the five year period was generally poor as seen from the highest girls' mean score of 24.54% while that of boys was 29.44% in 2005. This was then followed by a general decline in both boys and girls to a mean score of 20.43% and 17.56% respectively in 2009. In addition, the number of girls enrolled for the chemistry course each year was lower than of boys. It has been noted that many students in Kenya have a negative attitude towards sciences as compared to art subjects; this is a common feature especially among girls (Aduda, 2003).This is a situation that requires drastic and deliberate action in order to achieve gender parity at secondary school level.

Table 2

Chemistry K.C.S.E Performance & Candidature by gender for the years 2005-2009

Year	**Candidature**					
	Male		**Female**		**Total**	
	NO.SAT	**MEAN%**	**NO.SAT**	**MEAN%**	**NO.SAT**	**MEAN SCORE %**
2005	136,684	29.44	116,826	24.54	253,510	26.99
2006	124,932	27.01	111,969	22.56	236,831	24.91
2007	144,229	27.69	122,532	22.65	268,001	25.38
2008	160,410	24.27	135,950	20.93	296,360	22.74
2009	179,167	20.43	149,755	17.56	328,922	19.13

(Source: Kenya National Examination Council Reports, 2007, 2008 & 2009)

The performance of students in chemistry at KCSE level in Bomet County is no exception since it has been relatively low compared to that of the other science subjects. Table 3 shows the examination report on performance at KCSE from 2006-2009 in the three science subjects obtained from the County Education Office (CEO). This report also shows that there has been a general decline in performance of students in chemistry between the year 2006 and 2009.

Table 3

Bomet County K.C.S.E Performance in Chemistry, Biology and Physics from 2006-2009

Subject	2006 Mean %	2007 Mean %	2008 Mean %	2009 Mean %
Chemistry	33.00	31.25	30.25	30.67
Biology	29.42	41.33	39.83	40.25
Physics	39.58	37.92	35.08	36.42

(Source: County Education Office, Bomet 2012)

Most countries at the moment are seeking to improve their education standards by promoting programmes that not only enhance effective acquisition of rapidly growing bodies of knowledge in a well organized framework, but also promote the learners' capability to learn meaningfully (Novak, 1998). The importance of good teaching cannot be overemphasized; however, it is worth noting that good teaching will encourage high quality students learning (Ramsden, 1992). According to Harlen (1993), use of appropriate teaching method by the science teachers should play a key role in helping children develop their ideas and science process skills such as observing, hypothesizing, predicting, investigating, drawing conclusions and communicating. This can be possible if teachers play their role well and select appropriate teaching methods which will facilitate the learning of school science.

It has been argued that one way of addressing the difficulties students experience in Kenyan science classrooms is through appropriate teaching interventions that can be realized through professional development of science teachers (Karega, 2008). It is hoped that professional development programs for science teachers will equip teachers with appropriate teaching skills and instruction strategies that are necessary for effective implementation of science curriculum in schools. By so doing, the Kenyan authorities with assistance from the Government of Japan hope to strengthen the teaching and learning of mathematics and science education in public schools through a pilot project called "Strengthening Mathematics and Science in Secondary Education (SMASSE)" (Kibe, Odhiambo & Ogwel, 2008). SMASSE has made mathematics and science subjects to become more relevant to learners, more practical and therefore more interesting, less expensive and more accessible (Kibe et. al, 2008). Although the Government has done its part, the role of the teacher in the classroom is important. The teaching approach that a teacher adopts is one factor that may affect students' achievement (Wambugu, 2006).

In an attempt to improve the teaching and learning process in science, research on teaching methods and approaches have been carried out in Kenya. Wachanga & Mwangi (2004) found out that Cooperative Class Experiment (CCE) Teaching Method facilitated students' chemistry learning. This method also increased students' motivation to learn. The Cooperative Concept Mapping (CCM) approach enhanced the teaching of secondary school biology in Gucha District (Orora, Wachanga & Keraro, 2005). Moreover, work done by Wambugu (2006) in the teaching of physics by using Mastery Learning Approach (MLA) revealed that students taught using this approach outshined their counterparts taught using CTM. This study addressed the effects of CMLA on students' motivation and achievement in chemistry. The CMLA brings together cooperative learning and mastery learning approaches to teaching. It is therefore a hybrid of the two approaches and therefore, likely to motivate the students by not only appealing to their cognitive domain but also their affective domain. This will consequently promote students' achievement.

The CMLA divides subject matter into units that have predetermined objectives. Students, in groups, work through each unit in an organized and systematic fashion. Students must demonstrate mastery on unit exams, typically a minimum score of 80%, before moving on to new material (Kulik, Kulik & Bangert-Drowns, 1990). Students who do not achieve mastery receive remediation through tutoring, peer monitoring, small group discussions, or additional assignments (Aggarwal, 2004). Additional time for learning is prescribed for those requiring remediation. Students continue with the cycle of studying and testing until mastery is met. Block (1981) states that students with minimal prior knowledge of material have higher achievement through mastery learning than with traditional methods of instruction.

In this study, the researcher adopted formal cooperative learning groups. Specifically, the study employed CMLA in the selected experimental groups. This CMLA is based on the fact that when students work independently they attribute their success or failure to personal effort while on the other hand cooperative goal structures require students to work together to accomplish shared goals (Ames & Ames, 1984; D'Amico & Schmid 1997) and therefore do not simply copy the science world; rather, they construct their own meaning of it through active involvement (Shuel, 1993). They must therefore be provided with opportunities to construct scientific knowledge through the interaction of their observations, prior knowledge, and mental processes as well as interaction with others. The present study intended to explore the effect of CMLA on students' motivation and achievement in chemistry.

1.2 Statement of the Problem

The poor performance of candidates in Chemistry as reflected by the KCSE Examinations results has continued to trigger a lot of concern among educationists and other stakeholders nationally and also in Bomet County over the years. Kenya's Vision 2030 aims at making Kenya a newly industrialized, "middle income country providing high quality life for all its citizens by the year 2030" (NESC, 2007). It also aims to capitalize on knowledge in Science, Technology and Innovation (STI) in order to function more efficiently, improve social welfare, and promote democratic governance. This poor performance in chemistry among other factors is likely to undermine the attainment of the projected goals as envisaged in the Vision 2030 development strategic plan. A critical look at students overall performance in chemistry at KCSE national examinations results between 2005 and 2009 reveals that it has persistently continued to decline, with average scores of 26.99% in 2005 and 19.13% in 2009. The teaching method is a crucial factor that may affect students' motivation and achievement. Gender disparity in chemistry achievement is compounded by use of traditional methods of teaching and the students' lack of motivation to learn chemistry. However, what is not known is how CMLA would affect students' motivation and achievement. In an attempt to address this issue, the present study explored the effects of CMLA on secondary school students' motivation and achievement in Chemistry in Bomet County, Kenya.

1.3 Purpose of the Study

This study was designed to determine the effect of using CMLA on students' motivation and achievement in chemistry in Bomet County, Kenya.

1.4 Objectives of the Study

This study was designed to determine the effect of CMLA on students' motivation and achievement in chemistry. Its specific objectives were:

(i) To determine whether there is a difference in motivation of students who are taught through CMLA and those who are not.

(ii) To determine whether there are differences in achievement in chemistry between students taught using CMLA and those taught using CTM.

(iii) To determine whether there is a difference in motivation to learn chemistry between boys and girls exposed to CMLA.

(iv) To determine whether there is a difference in achievement in chemistry between boys and girls exposed to CMLA.

1.5 Hypotheses of the Study

The study was guided by the following null hypotheses:

$H_0 1$ There is no statistically significant difference in motivation to learn chemistry between students exposed to CMLA and those taught using CTM.

$H_0 2$ There is no statistically significant difference in students' achievement in chemistry between those exposed to CMLA and those taught using CTM.

$H_0 3$ There is no statistically significant difference in motivation to learn Chemistry between boys and girls exposed to CMLA

$H_0 4$ There is no statistically significant difference in achievement in chemistry between boys and girls exposed to CMLA

1.6 Significance of the Study

This study provides data on the effectiveness of using CMLA on motivating students thus improving their achievement in chemistry. It also examined how gender affects their motivation and achievement in chemistry. This information is vital in determining the best way to organise students for learning.

The findings of this study are expected to supplement Government's efforts directed towards improving the chemistry learning and achievement in Kenya's secondary schools. The information will be helpful to the following organisations, individuals and groups of people.

The information will help in sensitizing the teachers to pay attention to both the affective and cognitive domain of the learners. The assistance that the students will get from the teachers will enable them develop self-confidence and a positive attitude towards the learning of chemistry. Such desirable attitudes will consequently boost achievement in the subject. Also, the knowledge on how a teaching approach affects both cognitive and affective dimensions of students will help policy makers and curriculum developers such as the Kenya Institute of Education (KIE) to formulate relevant policies and strategies, geared towards enhancing meaningful learning through; group heterogeneity, promotive interaction, individual accountability, interpersonal skills, team competition, equal opportunities for success and positive interdependence (D'Amico & Schmid, 1997). Teacher training colleges and universities in Kenya will also benefit from the information in their task of producing effective and qualified chemistry teachers while heads of science departments and chemistry teachers are likely to teach in a motivating manner that will make chemistry lessons interesting for the learners and consequently produce better results in chemistry. Moreover, the information will be useful in production of Chemistry teaching materials that embrace CMLA. The research will also serve as a frame of reference for further research on more innovative teaching approaches in science education.

1.7 Scope of the Study

The accessible population used in the study was that of form two chemistry students from four randomly selected co-educational district secondary schools from Bomet County, since the topic selected is usually covered in form two as scheduled in the syllabus. Categorisation of schools for the purpose of sampling in the study was based on the school type categorized as: boys' school, girls' school or co-educational. District Co-educational schools formed the sampling frame for this study since most schools in the county fall in this category. Generalization of findings was therefore narrowed to form two chemistry students in district co-educational schools from the county.

The topic covered was that of Effect of an Electric Current on Substances as presented in the approved K.I.E syllabus (KIE, 2010). The topic was chosen for the study since it prepares the learners for a related topic in form four; Electrochemistry. Moreover, most teachers teach the topic theoretically and yet there are a number of activities that can involve the learners, hence active learning which will consequently motivate them. Generalisation of findings therefore was limited to the chemistry lessons contained in the teaching manual (see Appendix C) developed on the study rather than chemistry as a subject.

1.8 Limitations of the Study

The involvement of the four chemistry teachers could introduce teacher's effect variable. This challenge however, was addressed by selecting male trained teachers whose teaching experience is a period of three years and above. The information obtained from the CEO indicated that most teachers teaching chemistry in the county were male. Therefore, the researcher chose to use male teachers only for convenience. In addition, the teachers for the experimental groups were trained by the researcher and their teaching supervised through out the intervention period to minimise the effect of teacher variable. The training involved going through the theory of CMLA contained in the Chemistry teachers' manual, dividing the topic into small progressive units, grouping of students, preparation of worksheets and lesson plans in CMLA. This training assisted in reducing variations in teacher performance. Teachers in the control groups were expected to teach the same content using the Conventional Teaching Methods

1.9 Assumptions of the Study

In this study it was assumed that:

i) the information collected from the respondents is true and frank response of their perceptions, feelings, and judgments of the question items in the questionnaire.
ii) the teachers to be involved in the study were cooperative enough and conformed to all the conditions set for the study and therefore ensured successful implementation and testing of the effects of the proposed teaching approach on the variables selected.
iii) the cultural beliefs of the students and teachers did not affect learning outcomes.
iv) the KCPE marks had close correlations with the pre-test and post-test scores used in the study due to the fact that selection of form ones for every school category is based on their KCPE total mark.

1.10 Definitions of Terms

The terms that were used in the study are defined constitutively and operationally as follows:

Achievement: This is the ability to perform tasks in the areas of lower and higher order skills (Gronlund, 1993) as an outcome of an instruction process. In this study achievement meant competence of a student that enables him/her to perform well in chemistry and was measured using the Chemistry Achievement Test (CAT) (see Appendix B).

Achievement motivation: Has been defined as the extent to which individuals differ in their need to strive to attain rewards, such as physical satisfaction, praise from others and feelings of personal mastery (McClelland, 1985). In this study this implies that people with high achievement motives will act in ways that will help them to outperform others, meet or surpass some standard of excellence.

Constructivism: This is a theory of knowledge which argues that humans generate knowledge and meaning from an interaction between their experiences and their ideas. In this study constructivism refers to the idea that the learner constructs meaning in his/her learning either individually or socially in the groups assigned.

Cooperative learning: This is a successful teaching strategy in which small groups, each with students of different levels of ability, use a variety of learning activities to improve their understanding of a subject. Elements of cooperative learning include; positive interdependence, individual accountability and personal responsibility, promotive interaction, appropriate use of social skills and group processing.

Cooperative Mastery Learning Approach: This is a learning approach in which students learn together in small groups of not more than five members. The material to be learnt is broken down into small manageable units each with its own objectives and formative tests are given to the students after each unit to check on their level of mastery. Students who do not attain the expected level of mastery undergo remediation aimed at correcting their learning difficulties thus reducing their variation in achievement levels and eventually eliminate achievement gaps. Such involvement of students in active learning consequently motivates them.

Conventional Teaching Methods: These are regular teaching methods that most teachers often use during the instruction process. Conventional Teaching Methods will imply a teaching method which involves the directed flow of information from teacher as source of knowledge to a student who is a passive recipient of the knowledge.

Gender: This refers to the socially constructed roles, behaviours, activities, and attributes that a given society considers appropriate for men and women. In this study, gender refers to the difference between boys and girls in socio-cultural aspects rather than physical difference only.

Mastery Learning: Mastery Learning is an instructional method that presumes all children can learn if they are provided with the appropriate learning conditions. Specifically for this study, Mastery Learning implies an approach in which the students are not advanced to a subsequent learning objective until they demonstrate proficiency with the current one.

Motivation: This is a psychological process based on the attention, relevance, confidence and satisfaction (ARCS) model that determines a learner's behaviour. In this study, the term has been used to mean the students effort put in as a result of their desire to learn chemistry as a subject. A Student Motivation Questionnaire (SMQ) was used to measure students' motivation towards chemistry learning. (See Appendix A)

Pseudo-Learning: This is an arbitrary, verbatim, non-substantive incorporation of new ideas into the cognitive structure with no specific relevance to the existing propositional framework. Such knowledge retained only for short time. In this study this term refers to rote learning in which students cram concepts instead of understanding hence, poor retention of the knowledge acquired.

Social interdependence: This refers to the ability of individuals to work together as a team towards achieving a common goal. In this study social interdependence refers to students' efforts to achieve, develop positive relationships, adjust psychologically, and show social competence during learning.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter covers the review of literature relevant to the study. Sections dealt with in this chapter include development of Science Education since independence, Instructional Methods used in Chemistry Teaching, Mastery Learning and its Goals, Social Interdependence Theory and Cooperative Learning. It also covers Cooperative Learning Groups, The Cooperative Mastery Learning Instructional Process, Theories of motivation, students Achievement motivation as well as the ARCS Model of motivation. It finally deals with the theoretical framework as well as the conceptual framework of the study.

2.2 Development of Science Education in Kenya since independence

Science is considered an important element of secondary school education in relation to national development (Karega, 2008). Numerous innovations have been made for the improvement of the quality of secondary school science curriculum in Kenya since independence.

Over the years, Kenya's secondary school students' chemistry achievement has remained low (KNEC, 2008) necessitating several curriculum reviews. The first post-colonial chemistry curriculum was developed soon after attaining independence in 1963 formulated in the African Science Centre currently called the Kenya Institute of Education (K.I.E). This curriculum was teacher and book centred and therefore inappropriate because it overlooked the fact that students have a wide range of abilities, interests and potentials (Kenya Government, 1976; Kimiti, 1984). It did not care about the student's readiness, motivation or activities to be done by the students in the process of learning. The syllabus was content centred.

In 1967, another chemistry syllabus was developed to replace the previous one. It was called the UNESCO Pilot Project (Chemistry, Physics or Biology). The teacher did all the experiments while the pupils merely observed and wrote the information. Later, this method was developed to the demonstration method of science teaching. It was also a teacher-centred method hence did not address the need for a learner-centred curriculum.

In 1968 another curriculum which was meant to be in line with the curriculum changes that were taking place in USA and the United Kingdom was developed in Kenya. In the UK, science curriculum was developed by the Nuffield Foundation. The Nuffield approach emphasised learning of science by discovery or problem solving method. This Science Project involved the importation of huge quantities of books and apparatus into Kenya soon after its adoption. These materials proved to be unsuitable for the Kenyan African environment. Thus, although it was a learner centred curriculum, the materials used in teaching failed to meet the needs of Kenyan learners (NESC, 2007).

In 1970 a new science curriculum called the School Science Project (SSP) was developed. The SSP was similar to the Nuffield project except that it aimed at using locally available materials as far as possible in the teaching process (Wachanga, 2005). Thus two requirements were pupil-centred investigatory approach and use of locally available or locally developed materials. The SSP was implemented only in a few schools because it required properly equipped laboratories and competent teachers and generally good school environment due to the fact that many Kenyan schools could not afford the requirements (Kimiti, 1984).

In 1973 an alternative science syllabus called the traditional syllabus was introduced. This syllabus had three possible options; Pure science syllabus, Physical science or General science. The options depended on the facilities available in the school. The traditional syllabus was offered alongside the SSP in that a school could choose either the traditional syllabus or the SSP for its pupils .The SSP was offered in the best equipped schools.

The SSP course not only defined the course content but also specified the approach to be followed. This was essentially one of chemistry by investigation. Students carried out experiments either individually or in small groups. They were encouraged to contribute in the planning of experiments, carry it out carefully, to record their observations accurately and make deductions within the limits of their experimental results (Kenya Government, 1976). The students were taught that it is good for them to form ideas and opinions about what they observed, but they must check these ideas against experimental results and be prepared to modify them in light of further information and additional experiments. Since different schools in Kenya offered different syllabus as mentioned earlier, the Ministry of Education developed another curriculum in 1981 that resulted in what is called New Kenya Examination Council Syllabi.

In general, curricula attempted to ensure appropriate teaching methods were used but were not implemented successfully due to lack of qualified chemistry teachers (Kimiti, 1984; Mullei, 1987). They include the 1967 UNESCO Chemistry Pilot Project, the 1970 School Science Project and the 1973 Kenya National Examinations Council Chemistry Syllabus. With the introduction of the 8-4-4-education system in 1985, the study of chemistry became compulsory in Forms 1 and Form 2 but many schools now offered it from Form 1 to Form 4. The chemistry syllabus encouraged small group teaching and teaching through experiments and projects.

The main aim of the several curriculum changes in Kenya was to have a curriculum, which could produce school leavers that were better adapted to the local environment (Republic of Kenya, 2008) .This syllabus was revised in 1992 and later in 2002. It aimed at having a child centred investigatory approach in teaching. The use of project work in teaching service was emphasized .The option available in it was 8.4.4 Chemistry syllabus and the 8.4.4 Physical science syllabus. The revision done in 2002 resulted in pure chemistry syllabus only which is used up to date. Although, curriculum developers wanted chemistry taught through these learner-based approaches, its teaching in secondary schools remained largely expository (KIE, 2002; Kiboss, 1997; Mullei, 1987). This could be one of the reasons why performance in the subject has remained low over the years.

Cooperative Master Learning Approach is a comprehensive approach to teaching that derives from a theory of education and encompasses key assumptions that all students can learn well and truly master the unit concepts or learning goals (Blooms, 1976). Lessons in the CMLA are arranged so that each student, ranging from the fastest to the slowest learner, has a contribution to make in their respective groups (Sapon-Shevin and Schniedewind, 1990). Because the students, in this approach, receive peer-tutoring and remediation, they are likely to acquire greater mastery of the material than in the common individual study with recitation pattern. Furthermore, the shared responsibility and interaction are likely to generate better intergroup relations, and result in better self-images for students with histories of poor achievement (Joyce and Weil, 1980).

2.3 Conventional Methods used in Chemistry Teaching

Effective teaching/learning of chemistry content over the years in Kenya has been affected by a number of factors. This includes; teachers' experience, availability of materials to use, wide syllabus and teachers preparedness. Mondoh, (1994), identifies teacher's effectiveness as the most significant variable of students' achievement. Wachanga, (2002), reinforced this view by arguing that the teaching effectiveness may be influenced by the teaching method that the teacher uses. Most teachers out of lack of adequate preparation and the wide syllabus opt to teach students using conventional teaching methods such as the lecture method, question-answer method, teacher demonstration method, discussion method, class experiments method, project method and use of field trips.

While some of these methods of teaching could be good in the aspect of student involvement hence meaningful learning, most teachers prefer teacher-centred approaches which enables them to use little time to cover a wide content without much concern on whether the objectives of the lesson have been attained or not. This could be one of the reasons why the performance in chemistry has not only remained low but has also continued to decline over the years in Kenya. Innovative teaching approaches that involve the learners and consequently motivate them to learn could be an important remedy to ensure a high level of academic achievement in chemistry. Wachanga (2005) expressed teaching as an experimental process in which all techniques should be examined routinely and revised if necessary. The following methods have been identified and used by chemistry educators (Ayot & Patel, 1987) and in this constitute the Conventional Teaching Methods (CTM).

2.3.1 Lecture Method

This is the process of verbally delivering a body of knowledge according to a pre-planned scheme (Wachanga, 2002). The main feature in this method is the transmission of knowledge from teacher to student. This is a teacher-centred method since the student is passive. However, the method can be improved or made student-centred by blending it with questioning technique leading to informal lecture or discussion.

The strengths of the lecture method include the fact that it stimulates thinking to open discussion and is therefore useful for large groups. It also presents factual material in direct, logical manner and contains experience which inspires (McCarthy, 1992).

The lecture method has a number of drawbacks. Firstly, very little learnt knowledge is retained by the pupils as there is practically little understanding of the chemistry concepts. During the process pupils go through rote learning or memorisation. The method also ignores experimentation which is the basis of modern scientific knowledge neither does it give students the opportunity to exercise their intellectual abilities by denying them active participation in the class. Moreover, it provides no opportunities for students to clarify misunderstanding and there is little feedback to the teacher on the effectiveness of his or her presentation or achievement of the stated objectives.

2.3.2 Teacher Demonstration Method

In a teacher demonstration experiment, the teacher as a facilitator performs the experiment for the large group. This approach is used when there is shortage of apparatus or when safety is a priority. It is also appropriate when a particular attention is needed in certain areas of the experiment which might be overlooked when the pupils do it alone. Many schools have a shortage of apparatus and chemicals hence they opt to use teacher demonstrations and not class experiments. However, teachers should note that overdoing demonstrations can make students passive with time.

Adequate planning ensures the success of teacher demonstrations. Demonstrations must always be rehearsed before they are performed during a lesson. This implies that the teacher should get the necessary apparatus and chemicals and arrange them in the order they are supposed to be used. The apparatus to be used for the purpose of a demonstration should be as large and as simple as possible so as to improve the visibility of the demonstration. Finally, the teacher should ensure that all pupils are able to watch the demonstration and therefore contribute in the discussion thereafter.

2.3.3 Class Experiment Method

In this method the students handle the apparatus and carry out the experiments themselves either individually or in small groups. Students' participation or activity is enhanced in that they learn by doing rather than by observing the experiments done by somebody else. In addition, when students handle an experiment themselves the experience is impressed more firmly in their minds than when they see or listen.

Chemistry is a practical subject and therefore experimentation is an integral part of the programme. Experimentation trains the students in scientific method. In secondary schools students do experiments individually or in small groups depending on the nature of the experiment and availability of the apparatus, reagents, materials, the age and ability of the students.

After every class experiment, it is necessary to make a follow up on what has been done. Follow ups are important in the sense that the observations made are still fresh in their minds hence they will participate more actively in the discussion. Also, the apparatus and chemicals used for the experiment are still within reach hence any controversy with respect to the observations can readily be resolved by carrying out the experiment in front of the class. Moreover, it enables students to have a complete and comprehensive record of the content covered in a particular chemistry lesson.

2.3.4 Questioning Method

The questioning technique is a useful method in chemistry teaching because it can be used on its own, or as part of another method. It should always accompany the lecture method which will then result to a class discussion (Wachanga, 2005).

Questions have various aims. For instance they help to get feedback for the teacher as well as the pupils. They also help to understand the entry behaviour of pupils. They also help to promote interest and the change in activity will help to sustain interest during a lesson. Consequently, the motivation of the learners is enhanced to a certain degree.

However, the method cannot be used entirely in a lesson but can best be used blended with another method. This is due to the fact that monotony is likely to arise in the sense that learners will mechanically be engage in receiving a question and then search for the answer repeatedly. The method does not pay attention to stimulus variation which is an integral component for meaningful learning.

2.3.5 Discussion Method

A problem, an issue, a situation in which there is a difference of opinion, is suitable for discussion method of teaching. Ideas are initiated; there is exchange of opinion accompanied by a search for its factual basis; speech is free and responsible. The participants; the teacher and the students, are inter-related in a process of competitive co-operation. Discussion, in fact, is an ordered process of collective decision making. It seeks agreement, but if not reached, it has the value of clarifying and sharpening the nature of agreement, (Kochhar, 1992)

Discussion, as a method of teaching, may be used for a number of purposes. This includes laying plans for new work, making decisions concerning future actions, sharing information, obtaining and gaining respect for various points of view, clarifying ideas, inspiring interest and evaluating progress.

Much of the success of this method of teaching depends entirely on the person in charge i.e. the teacher. The teacher should be able to motivate the students, energise a sagging discussion, bring each student into active participation, keep the discussion focused on the problems, make both periodic and final summaries and stimulate questions from the class (Kochhar, 1992).

2.3.6 Project Method

This approach is a unique application in the teaching-learning process which provides students with the opportunity to undertake investigations for the solutions of problems hence the transfer of chemical knowledge to solving problems encountered in day-to-day experiences (Wachanga, 2005). Project work is therefore concerned with the application of acquired chemistry knowledge. It encourages students to practise their personal skills of discovery learning. This method of teaching therefore strives to individualise instruction in science. The success of any modern chemistry curriculum rests upon the presentation of concepts and ideas of the course through experiments. It is therefore necessary to integrate projects into the physical sciences curriculum to supplement class experiments.

2.4 Mastery Learning Instruction

2.4.1 Meaning and Significance of Mastery Learning

Mastery learning is defined as a teaching learning approach which asserts that under appropriate instruction conditions, all students can and almost will learn most of what is taught in schools, (Aggarwal, 2004). The ML starts with assumption that almost all students can and will master a great deal of what is taught if instruction is approached systematically, if the students are helped when and where they have learning difficulties, if they are given sufficient time to achieve mastery, and if there is some clear cut criteria of what the constitutes mastery.

According to Bloom (1968), most students can master what teachers teach them. The instructional variables can be easily manipulated so that almost all students achieve the prescribed degree of mastery. Studies by Block (1981) indicate that in many subject areas, all students can achieve some defined level of mastery. It has been found that even gifted students need individual methods of study suited to their personality, rather than the conventional teaching methods.

Through a series of researches in ML, Guskey (1986) concluded that mastery learning approach has allowed many teachers to dramatically increase the number of students in their classroom who learn, and very well what they as teachers have set out to teach. Therefore, if systematically practised, ML strategy could be of immense help to teachers and administrators in arresting the low achievement, decline in achievement and learners attitudes towards chemistry.

2.4.2 Mastery Learning Approaches

There are two approaches employed under ML. These are learning for mastery (LFM) and personalized system instruction (PSI). In LFM approach the subject matter is verbally presented while in PSI approach it is presented in a written form, (Bloom, 1968). In both approaches the contents, is divided into small units with specific objectives and arranged in hierarchical order of complexity, Keller (1987). In finding out the effects of CMLA on students' motivation and achievement in this study, LFM was used and the learners who attained the required mastery level were allowed to proceed to the subsequent unit of the topic selected while those who fail to reach the required level of proficiency were given extra tuition. The required level of knowledge proficiency and competence was assessed through formative tests, feedback, remediation and finally summative tests (Bloom, 1968, Kulik, Kulik and Bangert–Drowns, 1990).

The LFM approach relies on setting standards of mastery and excellence, followed by a strategy to bring as many students as possible to this standard. In this way students are informed of the performance required but are not in competition for grades. They are to be judged on the basis of levels of mastery actually obtained by students in the previous year. This enables a more cooperative approach; students helping each other without the fear that special advantage is being given to those who are being assisted, (Aggarwal, 2004).

2.4.3 Principles of Mastery Learning

The principles of Mastery Learning includes matching teaching to student outcomes, utilizing multiple instructional methods, giving specific feedback, and fostering correctives and extensions. Effective teachers intentionally engage their students in the multiple cognitive levels of thinking described in Bloom's Cognitive Taxonomy: knowledge, comprehension, application, analysis, synthesis, evaluation, creative and complex thinking (Aggarwal, 2004).

The planning phase of the instructional process addresses identification of the learning, a task analysis, prerequisite skills, and development of effective questions, strategies, and materials. In the teaching phase, the Cue Set is a step designed to focus student attention and ignite motivation for the learning task. Best Shot is a term which describes teacher's behaviour which models or beams instruction to students, (Bloom, 1987). It centres on a variety of strategies which empower the teacher to instruct through multiple learning modalities hence stimulus variation which is an essential component for active learning is attained.

Guided and Independent Practice activities are opportunities for students to actively participate, apply the learning, and experience success. Closure ties together the learning, instructional activities, and expectations in a meaningful summary, (Kullik et al, 1990).

Formative and Summative Assessments are terms used to describe the measurement of the student's understanding of the learning concept and their ability to apply it appropriately. Formative Assessment is diagnostic hence aimed at measuring and correcting learning problems while Summative Assessment measures the overall achievement. Formative tests do not count for a grade while summative test do (Block, 1981). Mastery learning therefore, woven into the instructional process reveals a set of sound instructional practices which crate the conditions for the philosophy, "all can learn well" to bloom in the lives of the learners.

In ML strategy, the student is motivated to interact at his own pace with a given learning segment (Aggarwal, 2004). Moreover, the course material is broken into small segments each with an interesting introduction, a list of behavioural objectives, a suggested procedure for learning and a set of self-assessment exercises. In this learning approach, the student is allowed to proceed on to the next learning segment after passing the criterion-referenced test. The criterion-referenced test is to be passed by the student with a minimum cut-off score of

80% marks indicating mastery of the learners' on-going learning segment, (Kullik et al., 1990). A student who does not pass the test is given individual guidance by the instructor and peer-tutors. The student repeats the learning segment and takes retests until he/she passes. The mastery learning model places focus on aspects such as behavioural objectives, small learning segments, self-pacing, individual attention and criterion-referenced testing (Aggarwal, 2004).

2.4.4 Criterion-Referenced Testing and Mastery Learning

Criterion-referenced tests yield measures directly interpretable in terms of specified performance standards. The data is also useful in evaluating the instructional process, (Aggarwal, 2004). Criterion-referenced tests determine the degree of mastery of the study unit and are used primarily to determine whether or not the learner is ready to advance to another study unit.

The Criterion-referenced tests has yet another advantage; that of diagnosing the specific difficulties of learners and prescribing certain remedial treatments. Also, the concern for criterion-referenced testing has gained importance with the emphasis on behavioural objectives (Bloom, 1968) while structuring and individualizing instructions. Therefore, mastery or lack of it in individualized instruction implies whether or not a learner has achieved the objectives of the instructions.

The Criterion-referenced tests are used primarily in the courses based upon the mastery learning concept. A student pursuing such a course is asked to consolidate a given subject matter at his own pace of learning assisted by an instructor. The relationship between the Criterion-referenced test and mastery learning procedure is shown in Figure 1.

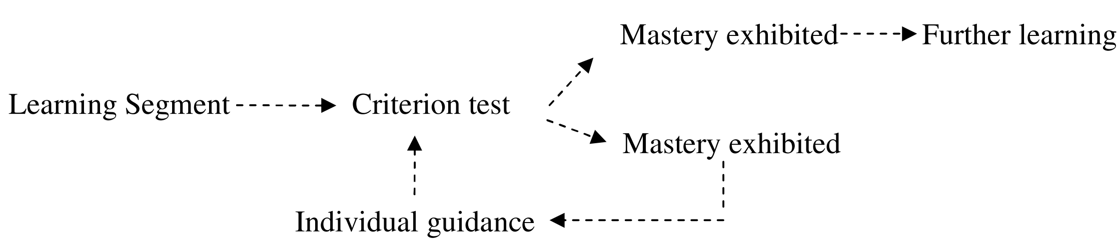


Figure 1. Relationship between Mastery Learning Approach and Criterion-Referenced Testing

2.5 Social Interdependence Theory and Cooperative Learning

The social interdependence theoretical perspective is an important guide for research on cooperation (Johnson & Johnson, 1998). Social interdependence exists when individuals share common goals and each individual's outcome is affected by the actions of others (Johnson & Johnson, 1998). It may be differentiated from social dependence in which the outcomes of one person are affected by the actions of a second person but not vice versa and social independence in which the individuals outcomes are unaffected by one another's actions (Wachanga, 2004). There are two types of social interdependence: cooperative and competitive. The absence of social interdependence and dependence results in individualistic efforts.

2.5.1 Social Interdependence Theory

Social interdependence exist when the outcomes of individuals are affected by their own and others' actions (Johnson & Johnson, 1998). Social interdependence is positive when the actions of individuals promote the achievement of joint goals and negative when the actions of individuals obstruct the achievement of each other's goals. Social helplessness exists when neither the person nor others can influence goal achievement.

Interaction with other people is essential for human survival. In an education setting, social interdependence refers to students' efforts to achieve, develop positive relationships, adjust psychologically, and show social competence.

The social interdependence perspective of cooperative learning presupposes that the way social interdependence is structured determines the way persons interact with each other. Moreover, the outcomes are the consequences of persons' interactions. Therefore, one of the cooperative elements that have to be structured in the classroom is positive interdependence or cooperation. When this is done, cooperation results in promotive interaction as group members encourage and ease each other's efforts to learn (Johnson, Johnson, & Holubec, 2008). One of the assumptions of social interdependence theory is that the cooperative efforts are based on intrinsic motivation generated by interpersonal factors in working together and joint aspirations to achieve a significant goal.

2.5.2 Essential Elements of Cooperation

Johnson (2009), focused on three variables: interdependence, interaction pattern, and outcomes. As a result of their research on and implementation of cooperation, they posited that five variables mediate the effectiveness of cooperation: positive interdependence, individual accountability, promotive interaction, the appropriate use of social skills, and group processing.

2.5.2.1 Positive Interdependence

Positive and negative interdependence were defined by Lewin and Deutsch as resulting from mutual goals. Other researchers soon added other types of interdependence. Positive and negative interdependence have been structured through complementary roles (Thomas, 1957), group contingencies (Skinner, 1968), and dividing information (or other resources) into separate pieces. Various researchers have structured interdependence through divisions of labour, mutual identity, environmental spaces and simulations involving fantasy situations (Johnson & Johnson, 1992). These ways of structuring interdependence may be subsumed into three categories: outcome, means, and boundary (Johnson & Johnson, 2004). Outcome interdependence includes goals and rewards. Goals can be real or fantasized.

Regardless of how it is undertaken, structuring positive outcome interdependence into a situation tends to result in increased achievement and productivity. These methods are overlapping and not independent from each other. Resources can be divided among group members like a jigsaw puzzle. Roles such as reader, recorder, summarizer, and encourager of participation can be assigned to group members. Individuals achieved higher with positive goal interdependence than when they worked individualistically but had the opportunity to interact with classmates (Hagman & Hayes, 1986).

2.5.2.2 Individual Accountability and Personal Responsibility

According to Johnson & Johnson (2004), the positive interdependence that binds group members together is posited to result in feelings of responsibility for (a) completing one's share of the work and (b) facilitating the work of other group members. Furthermore, when a person's performance affects the outcomes of collaborators, the person feels responsible for the collaborators' welfare as well as for his or her own (Matsui, Kakuyama & Onglatco, 1987). Failing oneself is bad, but failing others as well as oneself is worse. The more a person is liked and respected by group mates, furthermore, the more responsibility he or she will feel towards group mates (Wentzel, 1994). Responsibility forces are increased when there is group and individual accountability.

Group accountability exists when the overall performance of the group is assessed and the results are given back to all group members to compare against a standard of performance. Individual accountability exists when the performance of each individual member is assessed and the results are given back to the individual and the group to compare against a standard of performance. Hooper, Ward, Hannafin, and Clark (1989) noted that cooperation resulted in higher achievement when individual accountability was structured than when it was not. Archer-Kath, Johnson & Johnson (1994) found that by increasing individual accountability, perceived interdependence among group members was also increased.

Lack of individual accountability may reduce feelings of personal responsibility. Members may reduce their contributions to goal achievement when the group works on tasks where it is difficult to identify members' contributions, when there is an increased likelihood of redundant efforts, when there is a lack of group cohesiveness, and when there is lessened responsibility for the final outcome (Harkins & Petty, 1982); If, however, there is high individual accountability and it is clear how much effort each member is contributing, if redundant efforts are avoided, if every member is responsible for the final outcome, and if the group is cohesive, then the social loafing effect vanishes.

Generally, as the group gets larger and larger, members are less likely to see their own personal contribution to the group as being important to the group's chances of success (Kerr, 2001). As group size increases, individual members tend to communicate less frequently, which may reduce the amount of information utilized in arriving at a decision (Gerard, Wilhelmy, & Conolley, 1965; Indik, 1965), and the communication may be less truthful, as members may alter their statements to conform to the perceived beliefs of the overall group (Gerard et al, 1965; Rosenberg, 1965). Social loafing, therefore, increases as the size of the group increases. The smaller the size of the group, therefore, the greater tends to be the individual accountability (Webb, 2008). Morgan, Coates, and Rebbin (1970) found that group performance actually improved when one member was missing from five-person groups, perhaps because members believed that their contributions were more necessary.

2.5.2.3 Promotive Interaction

Positive interdependence is posited to result in promotive interaction, and negative interdependence is posited to result in oppositional interaction. Promotive interaction occurs as individuals encourage and facilitate each other's efforts to accomplish the group's goals.

Oppositional interaction occurs as individuals discourage, block, and obstruct each other's efforts to achieve their goals; individuals focus both on being productive and on preventing any other person from being more productive than they are. No interaction occurs when individuals work independently, without any interchange with each other; individuals focus only on being productive and ignore as irrelevant the efforts of others. Bandura's Social Learning Theory posits that people learn from one another, via observation, imitation, and modelling. The theory has often been called a bridge between behaviourist and cognitive learning theories because it encompasses attention, memory, and motivation (Bandura, 1997).

2.5.2.4 Appropriate Use of Social Skills

Unskilled group members cannot cooperate effectively. Effective cooperation is based on skilled teamwork as well as on task work. Students, therefore, must be taught the interpersonal and small-group skills needed for high-quality cooperation and be motivated to use them. To coordinate efforts to achieve mutual goals, participants must (a) get to know and trust each other, (b) communicate accurately and unambiguously, (c) accept and support each other, and (d) resolve conflicts constructively (Johnson & Johnson, 2009). Interpersonal and small-group skills form the basic nexus among individuals, and if individuals are to work together productively and cope with the stresses and strains of doing so, they must have a modicum of these skills.

The basic premise of social interdependence theory is that, the type of interdependence structured in a situation determines how students interact with one another which in turn determine outcomes (Johnson & Johnson, 1989). Positive interdependence tends to result in promotive interaction; negative interdependence tends to result in oppositional interaction, and no interdependence results in an absence of interaction. Depending on whether students promote or obstruct one another's goal accomplishments, there is substitutability, cathexis, and inducibility. Essentially, in cooperative learning situations, the actions of participants substitute for one another, participants positively cathect to one another's effective actions, and there is high inducibilty among the participants.

2.5.2.5 Group Processing

Group processing occurs when group members (a) reflect on which member actions were helpful and unhelpful and (b) make decisions about which actions to continue or change. The purpose of group processing is to clarify and improve the effectiveness with which members carry out the processes necessary to achieve the group's goals. Johnson & Johnson (2009), and Yager, Johnson & Snider (1986) found that high-, medium-, and low-achieving participants rated higher on daily achievement, post instructional achievement, and retention measures in the cooperation-with group-processing condition than did participants who engaged in cooperation without any group processing or individualistic efforts. Participants in the cooperation-without-group-processing condition, furthermore, achieved higher on all three measures than did the participants in the individualistic condition. Putnam, Rynders, Johnson & Johnson (1989), found that more positive relationships developed between participants who were disabled and those who were nondisabled when they were taught social skills and were engaged in group processing, as compared to participants who worked cooperatively without social skills training or group processing.

Archer-Kath, Johnson & Johnson (1994), discovered that group processing with individual feedback was more effective than was group processing with whole-group feedback in increasing participants' (a) achievement motivation, actual achievement, uniformity of achievement among group members and influence towards higher achievement within cooperative groups, (b) positive relationships among group members and between participants and the teacher, and (c) participants' self-esteem and positive attitudes toward the subject area. All three cooperative conditions performed higher than did the individualistic condition. Group processing can increase members' awareness that the group has the resources needed to succeed and thereby increase collective efficacy (Guzzo, Yost, Campbell, & Shea, 1993; Little & Madigan, 1997; Spink, 1990). Finally, group processing can increase members' involvement in the group's efforts (Brickner, Harkins, & Ostrom, 1986). During group processing, members are expected to express respect for each other's contributions to the group efforts and for each other as persons.

2.6 Cooperative Learning Groups

Wachanga (2002) explained three ways in which cooperative learning groups may be organised. These are the formal cooperative learning groups, informal cooperative learning groups and the cooperative base groups.

2.6.1 Formal Cooperative Learning Groups

These are groups which may last for one period to several weeks to complete any course requirement. The teacher introduces the lesson, assigns students to groups of two to five members, gives them the materials they need to complete the task and assigns them roles. Students work on the task until all group members have successfully understood and completed it. When the task is over the teacher evaluates the academic success of each student. In the course of working together it is expected that students will realise that they are mutually responsible for one another's learning and have a stake in one another's success.

2.6.2 Informal Cooperative Learning Groups

These are ad-hoc groups that last from a few minutes to one class period. Informal cooperative learning consists of having students work together to achieve a joint learning goal in temporary, ad hoc groups that last from a few minutes to one class period (Johnson, Johnson & Holubec, 2008). Students engage in quick dialogues or activities in temporary, ad hoc groups in response to a limited number of questions about what is being learned. The brief dialogues or activities may be used to focus student attention on the material to be learned, set a mood conducive to learning, help set expectations as to what will be covered in a class session, ensure that students cognitively process the material being taught, and provide closure to an instructional session. They are commonly used during a lecture or a demonstration to focus students' attention on the material to be learned. Informal cooperative learning groups are often organized so that students engage in 3 to 5 minute focused discussions before and after a lecture and 2 to 3 minute turn-to-your-partner discussions interspersed every 10 to 15 minutes throughout a lecture.

2.6.3 Cooperative Base Groups

These are long-term groups lasting for at least a year with stable membership. Members give one another the support, encouragement and assistance needed for academic progress (Johnson & Johnson, 1998). Cooperative base groups are long-term, heterogeneous cooperative learning groups with stable membership whose primary responsibilities are to provide support, encouragement, and assistance to make academic progress and develop cognitively and socially in healthy ways as well as holding each other accountable for striving to learn (Johnson & Johnson, 1992).

Typically, cooperative base groups (a) are heterogeneous in membership, (b) meet regularly (e.g., daily or biweekly), and (c) last for the duration of the term, year, or until all members are graduated. Students are assigned to base groups of three to four members and meet at the beginning and end of each class session (or week) to complete academic tasks such as checking each member's homework, doing routine tasks such as taking attendance, and engaging in personal support tasks such as listening sympathetically to personal problems or providing guidance for writing a paper.

2.7 The Cooperative Mastery Learning Instructional Process

Bloom found that students do attempt to work on their difficulties if they are given specific suggestions of what to do. The best procedure identified was to have small groups of students (two or three) meet regularly for up to an hour each week to review the results of formative tests and to help each other overcome difficulties. This in turn results in a hybrid of cooperative and mastery learning approaches hence the CMLA.

Ryan and Schmidt (1979) identified the most successful corrective strategies as being those which include objectives plus a problem testing the objectives of the previous lesson, discussion of the problem, specific prescriptions for using the text, class notes and handouts, and alternative resources, such as texts, workbooks, games and kits. When correctives consisted of objectives or problems only their effectiveness was considerably diminished.

The goal of CMLA is to have all students learn instructional material at roughly equivalent, high levels. Instructors who use cooperative mastery learning break down course material into manageable units and create formative tests for students to take on each of the units. In their review of mastery learning programs, Kulik, Kulik, and Bangert-Drowns (1990) cite Bloom's (1976) formulation as the classic approach. In Bloom's model, students receive individualized instruction as necessary so that they all master course material. The basic approach reduces variation in final student performance through instruction suited to all students' needs.

This combination of strategies is a good example of attacking Bloom's (1987) two-sigma problem by integrating principles that focus on different aspects of learning. Through this process of formative classroom assessment, combined with the systematic correction of individual learning difficulties, Bloom believed all students could be provided with a more appropriate quality of instruction than is possible under more conventional approaches to teaching. As a result, nearly all might be expected to learn well and truly master the unit concepts or learning goals (Bloom, 1976). This, in turn, would drastically reduce the variation in students' achievement levels, eliminate achievement gaps, and yield a distribution of achievement.

2.7.1 Distribution of Achievement in Cooperative Mastery Learning Classrooms

In describing Cooperative Mastery Learning, however, Bloom emphasized that reducing variation in students' achievement does not imply making all students the same. Even under these more favourable learning conditions, some students undoubtedly will learn more than others, especially those involved in enrichment activities. But by recognizing relevant, individual differences among students and then altering instruction to better meet their diverse learning needs, Bloom believed the variation among students in terms of how well they learn specific concepts or master a set of articulated learning goals could eventually reach a "vanishing point" (Bloom, Hastings & Madaus, 1971). As a result, gaps in the achievement of different groups of students would be closed.

2.7.2 Essential Elements of Cooperative Mastery Learning

After Benjamin Bloom presented his ideas on mastery learning, others described procedures for implementation and numerous programs based on mastery learning principles sprung up in schools and colleges throughout the United States and around the world (Block, 1981; Block & Anderson, 1975). While these programs differed from setting to setting, those true to Bloom's ideas included two essential elements:

(1) The feedback, corrective, and enrichment process; and

(2) Instructional alignment (Guskey & Gates, 1986).

While feedback, correctives, and enrichment are extremely important, they alone do not constitute Cooperative Mastery Learning. To be truly effective, Bloom stressed they must be combined with the second essential element of mastery learning: instructional alignment. Reducing variation in student learning and closing achievement gaps requires clarity and consistency among all instructional components (Bloom, Hastings & Madaus, 1971).

The teaching and learning process is generally perceived to have three major components. To begin, there must be some idea about what we want students to learn and be able to do; that is, learning goals or standards. This is followed by instruction that, hopefully, results in competent learners-students who have learned well and whose competence can be assessed through some form of assessment or evaluation. Cooperative Mastery Learning adds the feedback and corrective component, allowing teachers to determine for whom their initial instruction was appropriate and for whom learning alternatives may be needed.

2.8 Theories of Motivation

Motivation is a force used within the educational system to encourage student learning and understanding. In the educational setting, motivation is either an internal force or external force (Ames, 1990). There are different theories of motivation in the educational setting, including those that state that student behaviour is dictated due to either external or internal factors: Instinct Approaches, Drive-reduction Approaches, Arousal Approaches, Incentive Approaches and Cognitive Approaches.

2.8.1 Instinct Theory

Instinct is a biologically determined behaviour pattern that we are born with. Biological variables drive our behaviour. People and animals are born with pre-programmed sets of behaviours essential to their survival. Instinct is inborn patterns of behaviour that are biologically determined rather than learned. Instincts provide the energy that channels behaviour in appropriate directions (Lepper, 1988).

2.8.2 Drive-Reduction Theory

Our physiological needs create an aroused or tension producing state that motivates us to fulfil them. When the basic biological requirements are lacking, and the need is unfulfilled, then arousal is produced in the organism energizing it to obtain the requirement in order to satisfy the need.

Drive is an arousal or motivational tension that provides energy for action or behaviour while Homeostasis is a stable, well-maintained state of internal biological balance is required for the proper functioning of the body; homeostasis is the process whereby this balance is maintained (Ellis, 1994).

Primary Drives is entirely biological in nature. This includes; hunger, thirst, sleep, sex and air. Primary drives are satisfied by reducing the underlying need such as hunger followed by food, thirst followed by water while Secondary Drives are psychological as well as social in nature. Prior learning and experiences are what brings about such needs as academic achievement (Lepper, 1988). In this study, CMLA motivated the learners because of the immediate feedback and remediation that is offered to those who have not attained the expected level of mastery.

2.8.3 Arousal Theory

A certain level of arousal and excitement is needed by our system. We try to maintain that level of stimulation and activity; the maintenance may require off and on reduction or increase in the existing level, depending upon the circumstances. When our arousal state becomes too high, it needs to come down for optimal functioning and vice versa (Lepper, 1988). Too high a motivational arousal may affect performance negatively; it may produce anxiety and irritability in the organism. Similarly too low arousal may also have adverse effect. A consistent, well balanced, and levelled arousal is needed for the optimal functioning for instance in case of exams, athletics and interviews.

2.8.4 Incentive Theory

Motivational state of the organism is understood and explained in terms of positive or negative environmental stimuli. As opposed to the drive- reduction and arousal theory, this theory explains motivation in terms of external events that stimulates the organism's behaviour, rather than innate instincts or drives (Ames, 1990). Characteristics of the external environment are important variables in a person's motivation. Incentives are rewards that energize and drive our behaviour. Any thing that provides us with a reward triggers motivation for action. Incentives may generate behaviour even in the absence of an active, unsatisfied, instinct or drive. In many cases drives and incentives go together and have a deeper effect.

2.8.5 Cognitive Theory

Theories that give importance to the cognitive processes of the individual in explaining motivational process; thoughts, feelings, expectations, understanding and evaluating all are important when explaining the motivation of the person (Ames, 1990). Two types of cognitive processes underlie human behaviour.

Expectation: The expectation, hope, or anticipation that our behaviour will help us attain a certain goal.

Value: The perception, appraisal, or understanding of the value of the goal to us.
The level of expectation and the value attached to it, together, determine the level of motivation. In case of a high expectation along with high value; the motivation will also be higher. However, if any of the two is weak or low, the corresponding motivation will also be low (Ellis, 1994).

2.8.6 Self-Determination Theory

Self-determination theory (SDT) is a macro theory of human motivation and personality, concerning people's inherent growth tendencies and their innate psychological needs. It is concerned with the motivation behind the choices that people make without any external influence and interference. SDT focuses on the degree to which an individual's behavior is self-motivated and self-determined (Deci & Ryan, 1985).

In the 1970s, research on SDT evolved from studies comparing the intrinsic and extrinsic motives, and from growing understanding of the dominant role intrinsic motivation played in an individual's behavior but it was not until mid-1980s that SDT was formally introduced and accepted as a sound empirical theory. Research applying SDT to different areas in social psychology has increased considerably since the 2000s.

Edward L. Deci and Richard M. Ryan later expanded on the early work differentiating between intrinsic and extrinsic motivation and proposed three main intrinsic needs involved in self-determination. According to Deci and Ryan, the three psychological needs motivate the self to initiate behavior and specify nutriments that are essential for psychological health and well-being of an individual. These needs are said to be universal, innate and psychological and include the need for competence, autonomy, and psychological relatedness.

SDT guided the construction of the SMQ which was an important instrument in measurement of motivation of the learners before and after intervention.

2.8.7 ARCS Model of Motivation

The ARCS Motivation Model relates various instructional procedures to the theoretical concepts of motivation. According to John Keller's ARCS Model of Motivational Design, there are four steps for promoting and sustaining motivation in the learning process: Attention, Relevance, Confidence, and Satisfaction (ARCS).

2.8.7.1 Attention

According to Keller (1987), attention is a state of responding to achievement-related stimuli and it must be initially gained for learning to occur. Keller attention can be gained in two ways: this can be through Perceptual arousal which uses surprise or uncertainly to gain interest. This uses novel, surprising, incongruous, and uncertain events; or through Inquiry arousal which stimulates curiosity by posing challenging questions or problems to be solved. Methods for grabbing the learners' attention include the use of: Active participation, Variability, Humour, Incongruity and Conflict, Specific examples and Inquiry.

2.8.7.2 Relevance

This is a learning perception that content to be learned will be significant and valuable to them. Students must be convinced that mastery of materials will allow them to achieve an important instructional goal (Wachanga, 2002). Establishment of relevance in order to increase a learner's motivation is important. To do this, use concrete language and examples with which the learners are familiar. Six major strategies described by Keller include: Experience, Present Worth, Future Usefulness, Needs Matching, Modelling, and Choice.

2.8.7.3 Confidence

Confidence is a belief that one can perform successfully in a particular learning situation. Hohn (1995) suggests that, the management of students' success is an important role of the teacher. Teachers must understand how important it is that a student perceives these triumphs as attributable to their own effort. Teachers should help students understand their likelihood for success. If they feel they cannot meet the objectives or that the cost is too high, their motivation will decrease. For this to be meaningful, teachers who are the facilitators of learning should do the following: Provide objectives and prerequisites, grow the Learners, Feedback, and Learner Control.

2.8.7.4 Satisfaction

Learning must be rewarding or satisfying in some way, whether it is from a sense of achievement, praise from a higher-up, or mere entertainment. Satisfaction results from successful completion of tasks. Reinforcement occurs when learners get information that allows confirmation or rejection of their expectancies regarding the outcome of learning (Wachanga, 2002). Teachers should make the learner feel as though the skill is useful or beneficial by providing opportunities to use newly acquired knowledge in a real setting. They should also provide feedback and reinforcement. When learners appreciate the results, they will be motivated to learn. Satisfaction is based upon motivation, which can be intrinsic or extrinsic. However, they should be careful not to patronize the learner by over-rewarding easy tasks.

2.9 Students' Achievement Motivation

In a classic study to assess the differences in strengths of people's achievement motives McClelland and Colleague in Aire & Tella (2003) developed a projection technique using selected picture cards from the Thematic Apperception Test (TAT). Hamack (1995) noted that motivation cannot be observed directly but can be inferred from behaviour called ability. According to Wachanga (2002), ability is what an individual is able to do while motivation refers to what a person wants to do. The motivation to achieve, however may evidence itself only in behaviour that children value. Thus, academic motivation may be seen as a psychological process that determines intensity, direction and persistence of behaviour related to learning (Husen & Postlethwaite, 1993).

Individuals' actual achievement behaviour depends not only on their motivation to achieve but also on whether they expect to achieve and whether they fear failure. Spaulding (1992) notes that teachers describe good students as those are hardworking, cooperative and interested with little emphasis on intelligence. Wachanga (2002) notes that intelligence is desirable but motivation is even more desirable because a motivated student will learn according to his or her academic abilities; therefore, working to enhance students' academic motivation is worthwhile.

Children with high expectation for success on a task usually persist at it longer and perform better than children with low expectations (Ames, 1990). When teachers are caring and supportive and emphasise the teaching learning process over the performance outcomes, and when they give feedback, children tend to be motivated to achieve and to expect success (McClelland, Atkinson, Clark & Lowell, 2004).

Cooperative learning situations enables students to work together by themselves most of the times. This in turn maximises learning and motivates students. Motivated students make the teacher's job of managing instruction program simpler. When students are academically motivated, their teacher often becomes professionally motivated.

All ARCS conditions should exist in a good learning environment. The use of CMLA is likely to improve the four conditions discussed above by improving the attention of students as the work together in the cooperative learning groups. Since group goals were set in advance, the students are likely to have felt that the chemistry content is valuable to them. Furthermore, the encouragement from fellow group members boosted the students' confidence. It is also expected that the achievement of the set goals resulted in a sense of satisfaction in the students.

The instrument used in this study to measure motivation was a Student Motivation Questionnaire (Appendix A) which contained 23 Likert-scale type items based on the Keller's ARCS Motivation Theory and other motivational theories such as Instinct, Drive-Reduction, Arousal, Incentive and Cognitive theories outlined as follows:

(i) Perceived Interest:-items on the extent to which the students found the lesson interesting and applies the information learned to solve related problems
(ii) Perceived Competence:-items on the extent to which students found the information easy or difficult or unclear to enable them perform competently in chemistry
(iii) Perceived Choice:- items on the extent to which student found themselves doing chemistry against their will or having made a choice
(iv) Perceived Tension:- items on the extent to which the student felt tense or confident to carry out chemistry tasks successfully

These are the four domains under which motivation was measured in the study to determine the level of motivation of the learners before and after intervention. The results obtained from the SMQ were then analysed so as to know the effect of CMLA on motivation of the learners.

2.10 Theoretical Framework

Good and Brophy's (1995) constructivist model of learning is one that emphasizes students' development of knowledge through active discussion processes that link new knowledge to prior knowledge. The theoretical framework of this study was based on constructivist theories; cognitive constructive theory advanced by David Ausubel and social constructivist theory advanced by Lev Vygotsky and social learning theory advanced by Bandura.

According to Okere (1996), cognitive constructivists view learners as active constructors of meaning from input by processing it through existing cognitive structures and then retaining it in the long-term memory. The cognitive approach to learning tries to understand individuals thought process by studying the structure of thinking and remembering. On the other hand social constructivism emphasizes on how meaning and understanding grows out of social interactions (Vygotsky, 1978). For social constructivists, culture gives the child the cognitive tools such as cultural history, social context and language needed for development.

In the constructivists' model, students actively mediate the input by trying to make sense of it and relating it to what they already know about the topic (Wachanga, 2005). This constructivist process is important because students build their own representation of new learning which would otherwise have been retained as relatively meaningless and inert rote memory (Good & Brophy, 1995).

Views of constructivism include the fact that knowledge can never be totally transferred to another person; knowledge is as a result of a person's interpretation of experiences influenced by factors such as age, gender, race or knowledge base. In essence some aspects of it are lost during translation when knowledge is transferred. Secondly, individuals make observations, test hypotheses and draw conclusions about events that are consistent with one another. This leads to consensus about different people's view of the world. Thirdly, it has to do with the formation and changing of knowledge structures, addition to, deletion from and modification of these interpretations. The process of concept formation involves identifying and enumerating the data that are relevant to the problem, grouping those items according to some basis of similarity and developing categories and labels for the groups (Joyce & Weil, 1980).

The social learning theory of Bandura emphasizes the importance of observing and modelling the behaviours, attitudes, and emotional reactions of others. Bandura (1977) states: "Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. Fortunately, most human behaviour is learned observationally through modelling: from observing others one forms an idea of how new behaviours are performed, and on later occasions this coded information serves as a guide for action." Social learning theory explains human behaviour in terms of continuous reciprocal interaction between cognitive, behavioural, an environmental influences. The component processes underlying observational learning are: (1) Attention, including modelled events (distinctiveness, affective valence, complexity, prevalence, functional value) and observer characteristics (sensory capacities, arousal level, perceptual set, past reinforcement), (2) Retention, including symbolic coding, cognitive organization, symbolic rehearsal, motor rehearsal), (3) Motor Reproduction, including physical capabilities, self-observation of reproduction, accuracy of feedback, and (4) Motivation, including external, vicarious and self reinforcement.

Because it encompasses attention, memory and motivation, social learning theory spans both cognitive and behavioural frameworks. Bandura's theory improves upon the strictly behavioural interpretation of modelling provided by Miller & Dollard (1941). Bandura's work is related to the theories of Vygotsky and Lave which also emphasize the central role of social learning.

The highest level of observational learning is achieved by first organizing and rehearsing the modelled behaviour symbolically and then enacting it overtly. Coding modelled behaviour into words, labels or images results in better retention of the concepts learnt. Individuals are more likely to adopt a modelled behaviour if it results in outcomes they value (Bandura, 1997). They are also more likely to adopt a modelled behaviour if the model is similar to the observer and has admired status and the behaviour has functional value.

CMLA is one example of a group task in which students can work together to accomplish a given task. Through this approach, students were expected to learn in their cooperative groups to achieve a certain level of mastery of the content by constructing knowledge about the topic. The students work on the task until all group members have successfully understood and when the task is over the teacher evaluates the academic success of each student, (Wachanga, 2002). The knowledge learnt, should enable them to apply in real life situations and show how it affects people in their daily lives. The approach is therefore likely to motivate students by engaging them in a group task in which they are expected to realise that they are mutually responsible for one another's learning and academic success.

2.11 Conceptual Framework

The conceptual framework which was used in this study is based on the constructivist theory of learning. In this theory, the teacher serves as a facilitator who attempts to structure an environment in which the learner organises meaning at a personal level (Cooper, Jackson, Nye & Lindsay, 2002). The conceptual framework to guide the study was based on the Systems Approach (Joyce & Weil, 1980), which holds that the teaching and learning process has inputs and outputs. To achieve good results then, the inputs must have suitable materials. The study was also based on the assumption that the blame for a students' failure rests on the quality of instruction and not lack of student's ability to learn. (Bloom, 1981; Levine, 1985). The framework is represented diagrammatically in Figure 2.

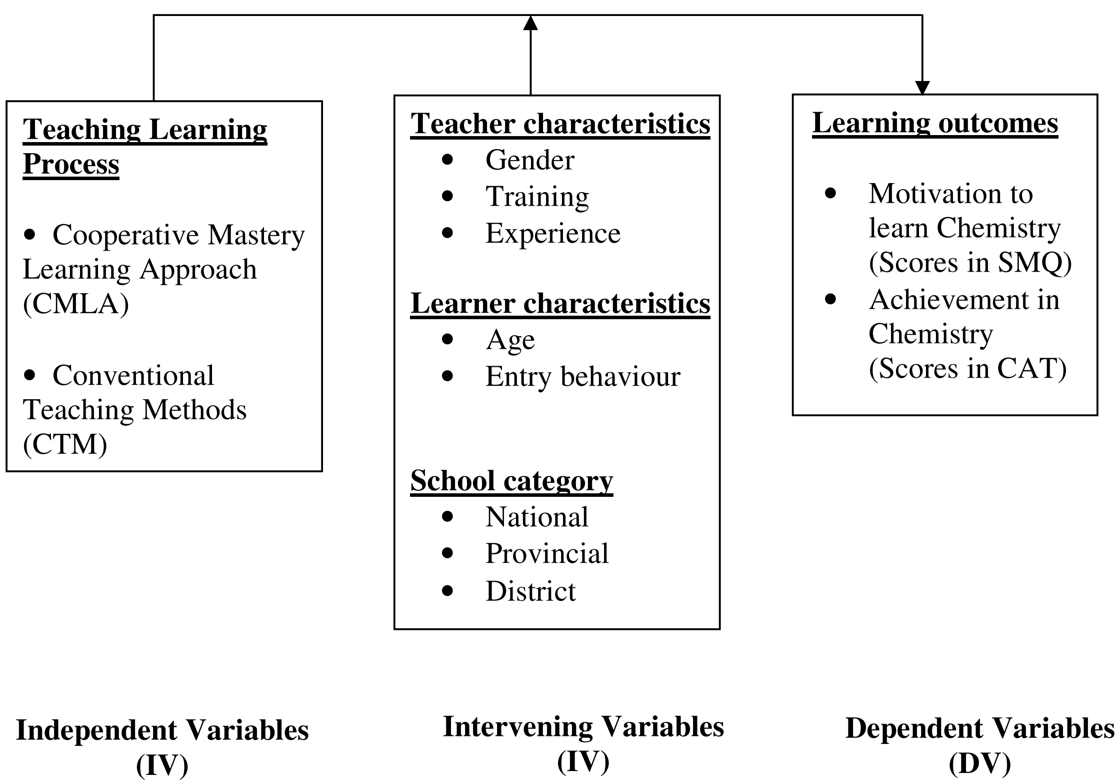


Figure 2. Conceptual Framework for determining the effect of using Cooperative Mastery Learning Approach (CMLA) on students' motivation and achievement in chemistry

Figure 2 shows the relationship of variables for determining the effects of using CMLA on secondary school Students' Achievement in Chemistry. Learning outcomes are influenced by various factors. These include: learner characteristics, classroom environment and teacher characteristics as shown in the figure. These are extraneous variables which had to be controlled.

Teacher training determines the teaching approach a teacher uses and how effective the teacher uses the approach. The learners' age, gender, entry behaviour and hence their class determine what they are taught. The type of school as a teaching environment affects the learning outcomes. To control for teachers characteristics as sources of internal invalidity, only male teachers of equivalent training and experience were chosen. The types of school selected for the study were district co-educational schools to control the effect of the classroom environment. Form Two students who were approximately of the same age were involved in the study to avoid the threat of maturity to internal validity.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter deals with the description of the procedures to be followed while conducting the research. The chapter describes the research design and specifies the target and accessible population as well as its characteristics. It also outlines the sampling procedures, sample size, the instruments to be used in data collection, data collection procedures and finally the statistical methods that were used in data analysis.

3.2 Research Design

The study involved quasi-experimental research in which the researcher used Solomon's Four Non-Equivalent Control Group Design. The design is considered rigorous enough for experimental and quasi-experimental studies. Secondary school classes once constituted exists as intact groups and school authorities do not normally allow such classes to be broken up and reconstituted for research purposes (Borg & Gall, 1989; Fraenkel & Wallen, 2000). This design has an advantage over others since it controls the major threats to internal validity except those associated with interaction and history, maturity and instrumentation (Cook & Campbell, 1979).

The research design enabled the researcher to determine the cause and effect of the treatment on learners' achievement and motivation. A researcher who decides to use this design must be certain of the independent and dependent variables and must guard against the influence of the extraneous variables (Kombo & Delno, 2006)

The groups were organised as follows; Group I received a pre-test, treatment (X) and then a post-test while group II received a pre-test and post-test. On the other hand, group III were not given a pre-test but received the treatment(X), followed by a post-test while Group IV received the post-test only as shown in Figure 3. This implies that, in this study Groups I and III were taught using the CMLA and therefore are the experimental groups while Groups II and IV were taught using the Conventional Teaching Methods and are therefore the control groups.

Group I	O_1	X	O_2	E1
- -				
Group II	O_3	____	O_4	C1
- -				
Group III	___	X	O_5	E2
- -				
Group IV	___	___	O_6	C2

Key: Pre-tests: O_1 and O_3 Treatment: X

Post-tests: O_2, O_4, O_5 and O_6 No pre-test or no-treatment: ___

Experimental groups: E_1 and E_2 Control groups: C_1 and C_2

Non-equivalent control groups:- - - - - - - - - - - - - - - - - -

Figure 3. Solomon's Four Non-Equivalent Control Group Research Design. Source: Fraenkel and Wallen, (2000 P.291)

To control for interaction between selection and interaction, the schools were randomly assigned to control and treatment groups, while that of interaction between selection and instrumentation were controlled by ensuring that the conditions under which the instruments were administered were kept as similar as possible in all the schools (Borg & Gall, 1989; Zechmesh & Shanghnessy, (1994). The effect of Maturation was taken care of by the short time of five weeks that the study took.

Teachers training and experience was controlled by choosing teachers of equivalent training and experience. Therefore, teachers from the schools selected were graduate male teachers with minimum of three years teaching experience. According to Borg and Gall, (1989), this design will help the researcher to achieve four main purposes:

i) To asses the effect of the experimental treatment relative to the control condition
ii) To asses the interaction between pre-test and treatment condition
iii) To asses the effect of the pre-test relative to non-pre-test
iv) To asses the homogeneity of the groups before administration of the treatment

3.3 Target Population

This study was carried out in Bomet County and the target population was secondary school students from district co-educational schools in Bomet East and Bomet Central sub-counties. These two sub-counties were chosen for the study based on three main reasons; first, to date no study on the effect of CMLA on students' motivation and achievement in chemistry has been done. Secondly, the proportion of students in these sub-counties enrolling for science-based courses in institutions of higher learning is among the lowest in the country (Maritim, 1995; Kerich, 2004). Moreover, the Performance in chemistry at K.C.S.E level in the county has been poor relative to that of other science subjects (KNEC report, 2008).

The accessible population was that of form 2 chemistry students since the topic selected for study is that of Effect of Electric Current on Substances which is usually covered in form 2 as per the KIE Syllabus. The topic was chosen for the study due to the fact that though there are a number of practicals that can be done in the topic, most teachers opt to teach it theoretically. Moreover, the topic provides the learners with pre-requisite knowledge needed for understanding the topic; Electrochemistry covered in form four. It was also assumed that by the beginning of the second year in secondary school, the students have developed stable attitude towards chemistry after their exposure to the subject for one year as they prepare to select subjects based on their area of specialisation. At this level also, the students were assumed to have developed a stable internal motivation towards chemistry learning. These conditions were necessary to allow for manipulation of intervention and determine the effect of the treatment on students' motivation as well as their achievement in chemistry.

3.4 Sampling Procedures and Sample Size

A stratified random sample of four co-educational district schools was drawn from Bomet East and Bomet Central sub-counties from the County. The County Education Office (CEO) provided a list of all secondary schools in the sub-counties and the demographic characteristics on chemistry teachers teaching in each of these schools. The unit of sampling was secondary schools rather than individual learners because secondary schools operate as intact groups (Borg & Gall, 1989). The county has 42 established co-educational secondary schools in the two sub-counties with approximately 3,414 Form Two students. The distribution of schools in each of the sub-counties is as shown in Table 4.

The units for sampling in this study however were secondary schools rather than individual students. Based on the research design adopted, 4 co-educational district secondary schools were randomly selected for the study. Stratified random sampling procedure was used in selecting these schools. Nkapa (1997) argues that there is no strict rule for obtaining a sample size but Fraenkel and Wallen (2000), recommended at least 30 subjects per group. In the present study however, approximately 205 Students from 4 co-educational schools were selected for the study.

Table 4

Categories of Co-educational Secondary Schools in the two Sub-Counties

School type	School Category	Bomet East Sub-County	Bomet Central Sub-County	TOTAL
Co-educational	Provincial	7	11	18
	District	8	16	24
	TOTAL	**15**	**27**	**42**

(Source data: C.E.Os office Bomet, 2012)

Only co-educational district schools were sampled for the study. This was done to avoid excessive stratification that results in complexities that stem from logistics involved in handling many schools in quasi-experimental designs. Also district co-educational schools dominate in the county and accounts for about 46% of all the schools in the two sub-counties. To ensure the schools selected are far apart from each other, two co-educational schools were selected randomly from each of the two sub-counties. This helped to minimise experimental treatment diffusion and gave rise to a total of four schools. These schools were randomly assigned to treatment and control conditions to form four groups. In the case of schools with more than one stream per class, all streams were selected for the study.

In the sampling process, a list of all secondary schools in Bomet County was obtained from the County Education Office (CEO). Preliminary information on these secondary schools was collected on the following areas:

a) Chemistry teachers gender, age, qualification and experience
b) Students enrolment and number of streams in each school; Form 2 composition (number of girls and boys) in each class

c) Number of co-educational schools in each category; whether national, provincial, district.
d) Students' ability at KCPE Level based on the performance in science and also the grand total of each student.

Based on the preliminary information collected, a provisional list was drawn and the schools visited to ascertain that they are suitable for the study. During the visits the researcher interviewed head teachers and respective chemistry teachers to obtain information on their experience and qualification as well as the much they have done in terms of syllabus coverage in form two chemistry classes. A final list of schools that qualified for sampling was drawn. Four co-educational district secondary schools were obtained from this sample to participate in the study. The selected schools were then randomly assigned to experimental and control groups. The sample size, N per school was as follows:

Table 5

Sample size, N per school

Group		**Sample Size, N**
Group I	Experimental 1 (E1)	51
Group II	Control 1 (C1)	53
Group III	Experimental 2 (E2)	51
Group IV	Control 2 (C2)	50
	Total	**205**

3.5 Instrumentation

In the present study data were collected using two instruments namely, Student Motivation Questionnaire (SMQ) and Chemistry Achievement Test (CAT). The researcher adopted the SMQ developed and used by Barchok (2006). This SMQ was based of likert scale type and measured students' motivation towards the learning of chemistry. The Chemistry Achievement Test (CAT) was constructed by the researcher using Kenya National Examination Council past papers and administered to determine the students' achievement on the topic; Effect of Electric Current on Substances.

3.5.1 Student Motivation Questionnaire (SMQ)

The questionnaire (Appendix A) contained items on the students' socio-background factors and psychological concept of motivation which is related to various outcomes such as curiosity, persistence, learning, and performance, Deci and Ryan (1985). Self-Determination Theory (SDT) guided the construction of the instrument. This instrument was be used in assessing students' motivation and interest towards chemistry course and was constructed based on motivation theories including Keller's ARCS Motivation Theory (Hohn, 1995; Kiboss, 1997).

The instrument contained items on favourable and unfavourable statements of students' motivation towards CMLA versus CTM. Items in the instrument were based on chemistry course on the topic Effect of Electric Current on Substances and Motivation for Academic Study Scale (MASS) by Osiki (2001).The researcher adopted the SMQ developed and used by Barchok (2006). The instrument was divided into two parts. The first part required the participants' demographic information like sex, age and name of school; while the second part contains the items from the four dimensions of motivation. MTC was measured along four dimensions: Perceived confidence, Perceived choice, Perceived interest/enjoyment and perceived pressure/tension. The interest/enjoyment subscale was considered the self-report measure of intrinsic motivation; perceived choice and perceived competence were theorized to be positive predictors of both self-report and behavioural measures of intrinsic motivation. Pressure/tension was theorized to be a negative predictor of intrinsic motivation. All these aspects of MTC were assessed through 23 close-ended question items on a 5-point Likert scale ranging from Strongly Agree (SA) to Strongly Disagree (SD).

The instrument was then pilot tested in four co-educational district secondary schools in the neighbouring Narok South Sub-County in which respondents have similar characteristics with those that were used in the actual study.

3.5.2 Chemistry Achievement Test (CAT)

The chemistry achievement test (CAT) (Appendix B) was adapted from the Kenya National Examinations past examination papers and modified to make them suitable for the study. The test contained items to asses the students' general achievement (CAT 1) before the treatment and also the conceptual understanding of the topic; Effect of Electric Current on Substances after the treatment (CAT 2). The items in this instrument were structured in such a way as to start with those of low order thinking and progressive move to more complex ones. The concepts, skills and principles measured included;

a) electrical conductivity in solids
b) electrical conductivity in molten substances
c) electrical conductivity of substances in aqueous state
d) electrolysis
e) application of electrolysis

3.6 Validity and Reliability

3.6.1 Validity

Both the SMQ and CAT were validated with the help of five education specialists from the Department of Curriculum, Instruction and Educational Management of Egerton University who scrutinized the instruments to check for suitability, face (relevance) and content validity. The assessment by these specialists enabled the researcher to gather suggestions that were used to improve the instruments. Items which were found inadequate for measuring the variables were either discarded or modified.

3.6.2 Reliability

To estimate the reliability of the instruments after modification, it was administered on 50 respondents who are secondary school students selected from another four secondary schools which were not be part of the study sample. This pilot study was conducted in the neighbouring Narok South Sub-County in schools which had similar conditions to the sample schools.

The reliability of the SMQ was determined by computation of Cronbach's coefficient alpha. This coefficient determines how items correlated among themselves, and hence tested the internal consistency of the instrument in measuring the construct of interest (Nkapa, 1997). According to Frankel and Wallen (2000), a reliability coefficient of 0.70 or higher is recommended. In this study a reliability coefficient of 0.82 was obtained implying that the items were suitable to measure the underlying construct. The instrument was therefore acceptable for use in the study.

Data on academic performance was gathered through Chemistry Achievement Test (CAT) constructed by the researcher on the Topic; Effect of Electric Current on Substances. This instrument was tested for reliability using Kuder-Richardson method, particularly formula 21(K-R21) (Nkapa, 1997; Popham, 1990). The reliability coefficient was found to be 0.78. According to Fraenkel & Wallen (2000), an alpha value of 0.70 is considered suitable to make inferences that are accurate. Therefore, the instrument was suitable for collection of data.

3.7 Conduction of the Study and Data Collection Procedures

Before the study was conducted, the researcher obtained preliminary information from Bomet County Education Office. This information assisted in sampling process. An introductory letter from the Board of Postgraduate Studies of Egerton University was obtained. Thereafter, a research permit was obtained from the National Council for Science and Technology (NCST). Other stakeholders notified of the study includes: the CEO and the head teachers of the four selected schools. After permission had been granted by the head teachers from the sampled schools, the researcher then carried out an induction of the chemistry teachers from the participating schools on the expectations and procedures of CMLA approach. To minimize the differences in teachers teaching approaches and ensure that emphasis was given to certain aspects of teaching; the researcher met with all the four chemistry teachers involved in the study on weekly basis. During these meetings the content being taught was discussed together with the challenges faced so far in the instructional process. Teachers in the experimental group were also issued with instructional manuals specifically designed for the topic of Effect of Electric Current on Substances (Appendix C). These procedures allowed for adjustment of individual teacher's needs and at the same time ensured that all instructional conditions were adhered to. The teachers involved in the study adopted a common schemes of work developed for the topic of Effect of Electric Current on Substances (Appendix D); this ensured that the intended content was covered uniformly for all the groups in the study.

The teachers' instructional manual (Appendix C) described the methodology that was used in teaching the topic in question. This included a detailed description of the procedure of CMLA Teaching Strategy which is being tested in the present study. This detailed description of the procedures ensured uniformity among the teachers involved in the study. The manual laid much emphasis on grouping of students to enable them learn together in cooperative learning groups as well as dividing of the content into small units to be covered one after the other while using a set of quizzes to ascertain whether the objectives have been met or whether mastery has been achieved before proceeding to the next unit of study. For those who did not attain the expected mastery level, remediation was done to bridge the gap. The topic was sub-divided into small units of study as follows:

a) Introduction
b) electrical conductivity in solids
c) electrical conductivity in molten substances
d) electrical conductivity of substances in aqueous state
e) electrolysis
f) application of electrolysis

The students in the experimental groups were put into groups of mixed ability and then trained by the respective teacher on cooperative learning skills and mastery learning for a period of two weeks prior to the treatment period. This was then followed by a pre-test administered to group I and II. The treatment period lasted for five weeks as outlined by the scheme of work. The control groups were taught using Conventional Teaching Methods. At the end of the treatment period, a post-test was administered to all the 205 participants from the four groups. The administration of all the questionnaires for both pre-test and post-test was done simultaneously with the help of the subject teachers from the selected schools. Instructions on how to respond to the questionnaires was read to the participants. This ensured its proper filling. All the 205 response sheets were retrieved from the respondents and verified to ensure that they are valid for the analysis on the study.

3.8 Data Analysis

For convenience, the pre-test on achievement was labelled as CAT 1 and the post-test, as CAT 2. Both CAT 1 and CAT 2 were marked by the researcher and analysed for conceptual understanding based on a concept-evaluation scheme developed by Abraham, Gzybowski, Renner, and Marek (1990) and used by BouJaoude and Barakat (2003). This analysis gave rise to two levels of achievement. The first level of achievement obtained from the CAT 1 was superficial and gave a clue on the level of understanding of the participants before treatment. The second level of achievement was obtained from the post-test CAT 2. This second level of achievement gave level of students' understanding of the concepts taught during the treatment period.

The SMQ administered as a pre-test to the first two groups (E1 and C1) were also scored by the researcher based on the four domains of motivation to enable the researcher understand the level of motivation of the participants before treatment. Also the SMQ administered as a post-test to all the four groups were scored to determine their level of motivation after treatment and hence the effect of the treatment on the participants level of motivation.

Consequently, the results obtained from all the questionnaires administered were coded and analysed by the researcher. Descriptive as well as inferential statistics were used in data analysis. Hypotheses were tested using means, t-test, ANOVA & ANCOVA. This analysis was applied to both data from Chemistry Achievement Tests (CAT 1 & CAT 2) as well as the Student Motivation Questionnaire (SMQ). This analysis was done with the help of Statistical Package for Social Sciences (SPSS) computer package version 19.0. The sequence of the presentation of the results is in accordance with that of the hypotheses. To make reliable inferences from the data, all statistical tests were tested for significance at alpha (α) level at 0.05. Table 6 summarizes the variables and statistical techniques which were used in the study.

Table 6

Summary of the Variables and Statistical Tests of the study

HYPOTHESIS	INDEPENDENT VARIABLE	DEPENDENT VARIABLE	TYPE OF TEST
$H_0$1: There is no statistically significant difference in motivation to learn chemistry between students exposed to CMLA and those taught using CTM	CMLA CTM	Post-test scores on SMQ	t-Test ANOVA
$H_0$2: There is no statistically significant difference in students' achievement in chemistry between those exposed to CMLA approach and those taught using CTM	CMLA CTM	Post-test scores on CAT	ANOVA ANCOVA
$H_0$3: There is no statistically significant difference in motivation to learn Chemistry between boys and girls exposed to CMLA approach	Gender	Post-test scores on SMQ	t-Test
$H_0$4: There is no statistically significant difference in achievement in chemistry between boys and girls exposed to CMLA approach	Gender	Post-test scores on CAT	t-Test

CHAPTER FOUR

PRESENTATION, INTERPRETATION AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter covers presentations on data analysis and the findings on the effect of Cooperative Mastery Learning Approach (CMLA) teaching strategy on secondary school students' achievement and motivation towards chemistry learning. Gender differences on students' motivation and achievement in chemistry is also covered in this chapter. Descriptive as well as inferential statistics were used in data analysis. The statistics used include mean, t-tests, ANOVA and ANCOVA. Inferential statistics were used to test the four hypotheses of the study. Each of the hypothesis is restated, results of analysis presented in a tabular form and a conclusion made indicating whether the hypothesis was rejected or accepted at a stated significance α-level of 0.05.

4.2 Presentation of Results

The results of both pre-test and post-test were analysed based on the four hypotheses of the study to determine the effects of CMLA on students motivation and students' achievement as well as the effect of gender on motivation and achievement when CMLA is used.

4.2.1 Effects of CMLA on Students' Motivation

To determine the effects of CMLA on Students' Motivation towards Effect of Electric Current on Substances, an analysis of the SMQ scores on the pre-test for groups E1 and C1 as well as the post-test for all the four groups was carried out using SPSS.

4.2.1.1 Pre-Test Scores on SMQ

At the beginning of this study, the assumption was that the groups to be used in the study were similar. The researcher, therefore, sought to assess the homogeneity of the groups before the application of treatment as recommended by Borg & Gall (1996); Wiersma and Jurs (2005). A pre-test of the SMQ was administered to the first two groups, Experimental 1 and Control 1.

Motivation Towards Chemistry (MTC) was conceived in a model having four dimensions and therefore implied the results obtained from the SMQ. The interest/enjoyment subscale was considered as the self-report measure of intrinsic motivation; perceived choice and competence were theorized to be positive predictors of both self-report and behavioural measures of intrinsic motivation as suggested by SDT. Pressure/tension was theorized to be a negative predictor of intrinsic motivation. Operationally, MTC was defined as a composite variable derived from mean score of non-missing students' response on 23 items measuring the construct on a 5-point Likert Scale, that is: Strongly Disagree (SD)=1; Disagree (D)=2; Undecided (U)=3; Agree (A)=4 and Strongly Agree (SA)=5. Negative statements were scored in a reverse order.

The SMQ had a maximum score of 115. The groups that were pre-tested were experimental group (E1) and the control group (C1). Results show that the mean score for group E1 was 20.38 while that of C1 was 20.23.

To find out whether there were any significant differences in the means of the two groups, an independent t-test was carried out.

Table 7

Independent Samples t-Test on Pre-test Scores on MTC

		Levene's Test for Equality of Variances				
		F	**Sig.**	**T**	**df**	**Sig. (2-tailed)**
MTC	Equal variances assumed	.332	.566	.290	102	.772
	Equal variances not assumed			.290	98.986	.773

$t_{(102)} = 0.290, p>0.05$

The results in Table 7 showed that there was no significant difference in the means of the two groups ($t_{(102)} = 0.290, p>0.05$). These results implied that the level of students' MTC in the two groups were similar before exposure to the intervention. The two groups were therefore suitable for use in the study.

4.2.1.2 Post-Test Scores on SMQ

The post-test sum, mean and standard deviation (SD) of the four groups based on the four dimensions of motivation as well as the overall MTC are summarized in Table 8.

Table 8

Means on MTC Results on Post-test on SMQ

Type of group		INTEREST	COMPETENCE	CHOICE	PRESSURE/ TENSION	**MTC**
E1	N	51	51	51	51	**51**
	Sum	1742.00	1033.00	1127.00	1061.00	**1240.75**
	Mean	34.1569	20.2549	22.0980	20.8039	**24.3284**
	SD	3.62972	2.79172	2.08091	2.42503	**2.04664**
	Skewness	-.482	-.606	-.344	-.655	**-.139**
	Kurtosis	-.313	.224	-.174	.017	**-.585**
C1	N	53	53	53	53	**53**
	Sum	1512.00	804.00	973.00	782.00	**1017.75**
	Mean	28.5283	15.1698	18.3585	14.7547	**19.2028**
	SD	7.70515	4.24597	4.36372	2.75196	**3.87641**
	Skewness	-.904	-.512	-.596	.214	**-.709**
	Kurtosis	.041	.103	-.200	.072	**.154**
E2	N	51	51	51	51	**51**
	Sum	1742.00	1033.00	1127.00	1061.00	**1240.75**
	Mean	34.1569	20.2549	22.0980	20.8039	**24.3284**
	SD	3.62972	2.79172	2.08091	2.42503	**2.04664**
	Skewness	-.482	-.606	-.344	-.655	**-.139**
	Kurtosis	-.313	.224	-.174	.017	**-.585**
C2	N	50	50	50	50	**50**
	Sum	1628.00	901.00	986.00	676.00	**1047.75**
	Mean	32.5600	18.0200	19.7200	13.5200	**20.9550**
	SD	4.92872	3.03376	3.68139	2.85886	**2.62430**
	Skewness	-1.289	-.047	-1.340	.153	**-.943**
	Kurtosis	1.984	.088	2.328	.122	**.734**
Total	**N**	**205**	**205**	**205**	**205**	**205**
	Sum	**6624.00**	**3771.00**	**4213.00**	**3580.00**	**4547.00**
	Mean	**32.3122**	**18.3951**	**20.5512**	**17.4634**	**22.1805**

Generally the Kurtosis and Skewness statistics depicted in Table 8 showed that the distribution of students' scores on MTC was almost normal in all the four groups. The MTC means were 24.33, 19.20, 24.33 and 20.96 for group I, group II, group III and group IV respectively. These results showed that the students in all the four groups have moderately favourable MTC with highest mean being that of the two Experimental groups, E1 and E2. The overall means on MTC for the four groups are represented graphically in Figure 4.

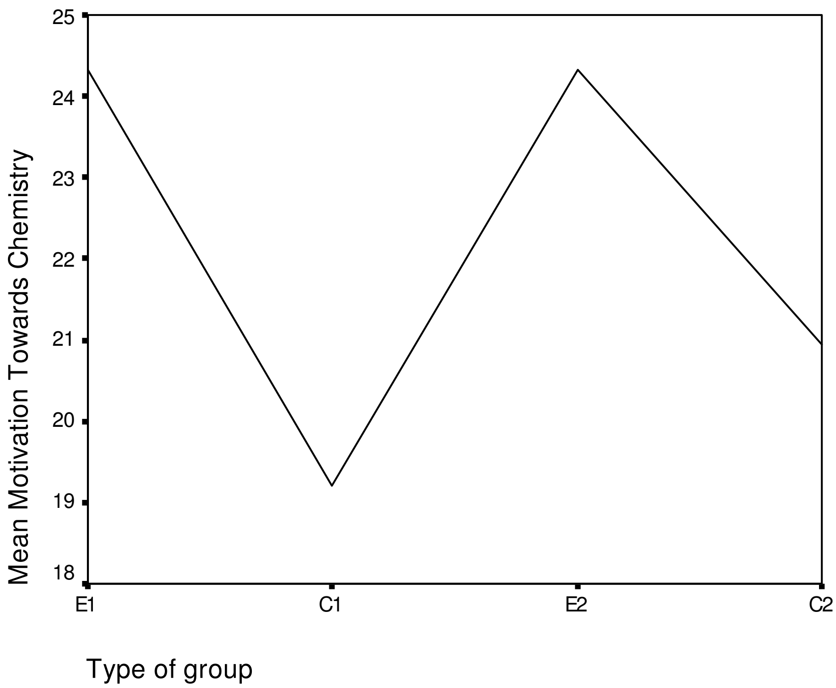


Figure 4. Graph of Mean MTC against Type of Group

One-way ANOVA was carried out to find out whether these means were significantly different. The results in Table 9 shows that the difference in the mean scores between the four groups were significant $F_{(3,201)} = 44.251, p<0.05$.

Table 9

Analysis of Variance (ANOVA) of the Post-test Scores on SMQ

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
MTC	Between Groups	1015.606	3	338.535	44.251	.000
	Within Groups	1537.716	201	7.650		
	Total	2553.322	204			

$F_{(3,201)} = 44.251, p<0.05$

After establishing that there was a significant difference between motivation of students taught the topic of Effect of Electric Current on Substances using CMLA and those taught using Conventional Teaching Methods, it was important to carry out further tests to show where the difference occurred. This was done using *Bonferroni post-hoc* analysis tests of multiple comparisons. The results are presented in Table 10. *Bonferroni* analysis was preferred for this study because it controls for the overall error rate hence the observed significance level is adjusted for the fact that multiple comparisons were being made. Whenever there is a significant difference between the means of different groups, this test in particular shows where the differences occurred.

Table 10

Bonferroni post-hoc Pair-wise Comparisons of the Post-test SMQ for the four groups

(I) Type of group	(J) Type of group	Mean Difference (I-J)	Std. Error	Sig.
E1	C1	5.1256(*)	.54254	.000
	E2	.0000	.54773	1.000
	C2	3.3734(*)	.55047	.000
C1	E1	-5.1256(*)	.54254	.000
	E2	-5.1256(*)	.54254	.000
	C2	-1.7522(*)	.54530	.009
E2	E1	.0000	.54773	1.000
	C1	5.1256(*)	.54254	.000
	C2	3.3734(*)	.55047	.000
C2	E1	-3.3734(*)	.55047	.000
	C1	1.7522(*)	.54530	.009
	E2	-3.3734(*)	.55047	.000

* The mean difference is significant at the .05 level.

The results indicate that the differences in mean scores of groups E1 and C1, groups E1 and C2, groups E2 and C1, groups E2 and C2 and group C1 and C2 were statistically significant at 0.05 α-level. The significant difference in the means between group C1 and C2 indicates that the SMQ pre-test did not sensitize group C1 as was likely.

These results therefore indicate that the use of CMLA resulted in a higher students' motivation to learn chemistry than the CTM groups since group E1 and E2 obtained scores that were significantly higher than the other groups on SMQ. Hypothesis, $H_0 1$ was therefore rejected.

4.2.2 Effects of CMLA on Students' Achievement

The two levels of achievement were measured by of use of Chemistry Achievement Test (CAT). The first level of achievement measured as pre-test was recorded as CAT 1 while the second level measured as post-test was recorded as CAT 2.

4.2.2.1 Pre-Test Scores on CAT 1

In the pre-test, only one level of achievement was measured (CAT 1); that is students scoring or not scoring the correct answer(s) as expected. The Sum, Mean, Standard Deviation (SD), Kurtosis and Skewness on students' achievement in pre-test CAT1 are presented in Table 11.

Table 11

Summary on Students' Pre-Test Scores in CAT 1

Type of Group	N	Sum	Mean	Std. Deviation	Kurtosis	Skewness
E1(Experimental 1)	51	475.00	9.3137	3.96732	-.509	.048
C1(Control 1)	53	478.00	9.0189	4.57624	-.130	.721
Total	**104**	**953.00**	**9.1635**	**4.27026**	**-.311**	**.443**

From Table 11 it was observed that the distribution of scores obtained from CAT 1 was almost a normal distribution in both the experimental and control group despite the slight Kurtosis to the left and slight Skewness to the right compared to a standard normal distribution. The mean values for pre-test scores was 9.31 and 9.02 for experimental and control group respectively out of a maximum score of 50 marks.

To test whether there was any significant difference in the two means, an independent t-test was performed and the results are presented in Table 12.

Table 12

Independent Samples t-Test on Pre-test Scores on CAT 1

		Levene's Test for Equality of Variances					
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference
Pre-Test Scores on CAT1	Equal variances assumed	.298	.586	1.548	102	.125	1.3126
	Equal variances not assumed			1.570	92.231	.120	1.3126

$t_{(102)} = 1.548$, $p>0.05$

The results in Table 12 shows that there was no significant difference in the two means ($t_{(102)} = 1.548$, $p>0.05$). This implies that the level of achievement prior to administration of the intervention for the two groups were similar; that is the groups were equivalent before administration of treatment and therefore appropriate for use in the study.

4.2.2.2 Post-Test Scores on CAT 2

The means on post-test scores on CAT 2 for the four groups involved in the study are presented in Table 13.

Table 13

Summary of Mean Scores on Post-test CAT 2

Type of Group	Mean	N	Std. Deviation	Sum	Kurtosis	Skewness
E1 (Experimental 1)	32.9804	51	7.84982	1682.00	-.603	-.229
C1 (Control 1)	25.6981	53	7.23396	1362.00	-.826	.053
E2 (Experimental 2)	31.1569	51	7.19548	1589.00	-.749	-.339
C2 (Control 2)	24.8600	50	7.08263	1243.00	-.596	-.038

The results indicate that the distribution of post-test mean scores of the four groups was normal. From Table 13 the highest mean score was attained by group I (Experimental 1) followed by group III (Experimental 2) then group II (Control 1) and finally group IV (Control 2). These means are represented graphically in Figure 5.

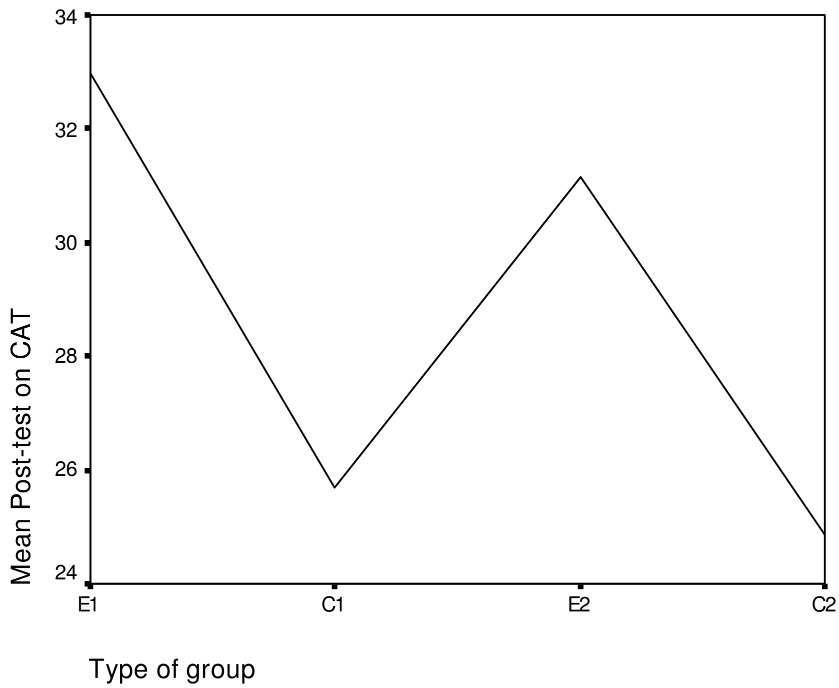


Figure 5. Graph of CAT 2 Post-Test Mean against Type of Group

Table 14

One-way ANOVA of the Post-test Scores on CAT 2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2456.860	3	818.953	15.173	.000
Within Groups	10848.915	201	53.975		
Total	13305.776	204			

$F_{(3,201)} = 15.173, p<0.05$

Table 14 shows the results of one-way ANOVA of the post-test scores of CAT 2. An examination of Table 14 reveals that there was a significant difference between the groups ($F_{(3,201)} = 15.173, p<0.05$). To find out where the difference existed, a *Bonferroni post-hoc* analysis was carried out. The results of this analysis are presented in Table 15.

Table 15

Bonferroni post-hoc Pair-wise Comparisons of the Post-test CAT 2 for the four groups

(I) Type of group	(J) Type of group	Mean Difference (I-J)	Std. Error	Sig.
E1	C1	7.2823(*)	1.44108	.000
	E2	1.8235	1.45487	1.000
	C2	8.1204(*)	1.46213	.000
C1	E1	-7.2823(*)	1.44108	.000
	E2	-5.4587(*)	1.44108	.001
	C2	.8381	1.44841	1.000
E2	E1	-1.8235	1.45487	1.000
	C1	5.4587(*)	1.44108	.001
	C2	6.2969(*)	1.46213	.000
C2	E1	-8.1204(*)	1.46213	.000
	C1	-.8381	1.44841	1.000
	E2	-6.2969(*)	1.46213	.000

* The mean difference is significant at the .05 level.

Table 15 shows the results of *Bonferroni post-hoc* pair-wise comparisons of significance for a difference between any two means. These results show that there was a statistically significant difference between the pairs of CAT 2 post-test means for groups E1 and C1, groups E1 and C2, groups C1 and E2 and groups E2 and C2 at 0.05 α-level. However, there was no statistically significant difference in the means between Groups E1 and E2 and Groups C1 and C2. Therefore, this shows that CMLA improved the achievement of students who were in the experimental groups compared to those in control groups. This study involved non-equivalent control group design and since entry behavior may affect performance it was necessary to run analysis of covariance (ANCOVA) using the students' Kenya Certificate of Primary Education (KCPE) total mark as covariate. It was also necessary to check whether the KCPE scores correlate closely with the scores obtained from this study.

Table 16

Actual and Adjusted Means on CAT 2 for KCPE Total Mark

Type of group	N	Actual Mean	Adjusted Mean
EXPERIMENTAL 1 (group 1)	51	32.9804	32.042(a)
CONTROL 1 (group 2)	53	25.6981	25.946(a)
EXPERIMENTAL 2 (group 3)	51	31.1569	31.211(a)
CONTROL 2 (group 4)	50	24.8600	24.780(a)

a Covariates appearing in the model are evaluated at the following values:
KCPE Total Mark = 300.7317.

ANCOVA on post-test scores in CAT 2 resulted in adjusted means on KCPE Total Mark for the students. The actual as well as the adjusted means were presented in Table 16.

Table 17

ANCOVA of the Post-test Scores of CAT 2 with KCPE Total Mark as covariate

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4583.650(a)	7	654.807	14.790	.000
Intercept	.487	1	.487	.011	.917
GROUP	430.396	3	143.465	3.240	.023
KCPE	1191.781	1	1191.781	26.918	.000
GROUP * KCPE	547.579	3	182.526	4.123	.007
Error	8722.126	197	44.275		
Total	181732.000	205			
Corrected Total	13305.776	204			

a R Squared = .344 (Adjusted R Squared = .321)
$F_{(3,197)} = 4.123$, $p<0.05$

Table 17 shows the results of ANCOVA of the post-test scores of CAT 2 with the KCPE Total Mark as the Covariate. A close examination of the results in this table reveals that the differences between the groups is statistically significant ($F_{(3,197)} = 4.123$, $p<0.05$). To find out where the difference existed, another *Bonferroni post-hoc* analysis was carried out. The results of this analysis are presented in Table 18.

Table 18

Bonferroni post-hoc Pair-wise Comparisons of the Post-test CAT 2 for the four groups

(I) Type of group	(J) Type of group	Mean Difference (I-J)	Std. Error	Sig.(a)
E1	C1	6.096(*)	1.322	.000
	E2	.831	1.333	1.000
	C2	7.262(*)	1.346	.000
C1	E1	-6.096(*)	1.322	.000
	E2	-5.265(*)	1.307	.000
	C2	1.166	1.321	1.000
E2	E1	-.831	1.333	1.000
	C1	5.265(*)	1.307	.000
	C2	6.431(*)	1.331	.000
C2	E1	-7.262(*)	1.346	.000
	C1	-1.166	1.321	1.000
	E2	-6.431(*)	1.331	.000

Based on estimated marginal means
* The mean difference is significant at the .05 level.
a Adjustment for multiple comparisons: *Bonferroni*.

The results showed that the mean difference between group E1 and group C1 were significant in favour of group E1 while the mean difference between group E1 and C2 were significant in favour of group E1. The mean difference between group C1 and group E2 was significant in favour of group E2 while the mean difference between group E2 and group C2 was significant in favour of group E2. This would, therefore, suggest that CMLA improved the achievement of students who were in the experimental groups compared to those in control groups. This implies that CMLA has a positive effect on chemistry achievement. Consequently $H_0 2$ was rejected.

4.2.3 Effects of Gender on Motivation when CMLA is used

Determination of the effects of gender on motivation when CMLA is used was carried out by running a t-test on the SMQ scores based on gender.

4.2.3.1 Pre-test Scores on SMQ Based on Gender

To find out whether there were any significant gender differences in the means of the two groups before treatment, an independent t-test based on gender was necessary.

Table 19

t-Test Results of the Pre-test Scores on SMQ by Gender

Gender	N	Mean	SD	St. Error	df	t-value	p-value
Male	62	20.4274	2.49113	.31637	102	.602	.549
Female	42	20.1190	2.67169	.41225			

$t_{(102)} = 0.602, p>0.05$

The results in Table 19 show that the mean for male students was 20.43 while that of their female counterparts was 20.12. The t-test results indicates that there was no significant difference in the means of the two groups ($t_{(102)} = 0.602, p>0.05$) before treatment. This, therefore, means that the groups used in this study exhibited similar gender characteristics before treatment and were therefore found to be suitable for the study.

4.2.3.2 Post-test Scores on SMQ Based on Gender

To establish the effect of CMLA on gender motivation in chemistry, the post-test mean scores of the SMQ were analyzed. Table 20 shows the t-test results.

Table 20

t-Test Results of the Post-test Scores on SMQ by Gender

	Gender of respondent	N	Mean	Std. Deviation	Std. Error Mean	df	t-value	p-value
MTC	Male	64	22.2439	3.21484	.29106	100	.310	.757
	Female	38	22.0873	3.98404	.43731			

$t_{(100)} = 0.310$, $p > 0.05$

The data in Table 20 indicates that the difference in SMQ mean scores between the male and the female students were not statistically significant $t_{(100)} = 0.310$, $p > 0.05$. Male students who had a mean of 22.24 were slightly more motivated by CMLA teaching strategy by the females who had a mean of 22.09. After treatment, the level of motivation for both male and female students went up. However, there was no significant gender difference in motivation. Therefore, both boys and girls were motivated to the same level by the teaching approach. Consequently, the null hypothesis, $H_0 3$ was accepted.

4.2.4 Effects of Gender on Achievement when CMLA is used

Gender differences in science have long been discussed among educators and researchers.
The findings of this study were consistent with previous research results. Research has demonstrated a decline in gender differences in science performance; however, female representation in science-related field is still low (Jacobs, 2005).

4.2.4.1 Pre-test Scores on CAT 1 Based on Gender

The pre-test scores on CAT 1 by gender are shown by Table 21.

Table 21

Summary on students' Pre-Test Scores on CAT 1 by Gender

Gender of Respondent	N	Sum	Mean	Std. Deviation	Kurtosis	Skewness
Male	62	601.00	9.6935	4.35923	-.296	.343
Female	42	352.00	8.3810	4.06023	-.158	.596
Total	104	953.00	9.1635	4.27026	-.311	.443

Table 22

Independent Samples t-Test on Pre-test scores based on Gender on CAT 1

		Levene's Test for Equality of Variances					
		F	**Sig.**	**t**	**Df**	**Sig. (2-tailed)**	**Mean Difference**
Pre-test on CAT 1	Equal variances assumed	.298	.586	1.548	102	.125	1.3126
	Equal variances not assumed			1.570	92.231	.120	1.3126

$t_{(102)} = 1.548, p>0.05$

The results in Table 21 show that before intervention, the mean for male students was 9.69 while that of their female counterparts was 8.38. Table 22 further indicates that the t-value was 0.125 and therefore shows that no statistically significant difference existed between the two means before the treatment ($t_{(102)} = 1.548, p>0.05$). This implies that the groups used in this study exhibited similar characteristics and were therefore suitable for the study.

4.2.4.2 Post-test Scores on CAT 2 Based on Gender

To determine whether there was any gender difference in achievement between boys and girls exposed to CMLA, the analysis of post-test scores on CAT 2 was done and the results are shown in Table 23.

Table 23

Summary on Students' Post-Test Scores on CAT 2 by Gender

	Gender of Respondent	N	Mean	Std. Deviation	Std. Error Mean
Post-Test Scores on CAT 2	Male	122	28.0328	8.19386	.74184
	Female	83	29.5904	7.85701	.86242
	Total	205	28.6634	8.07616	.80213

The results in Table 23 show that after intervention, the mean for male students went up from 9.69 to 28.03 while that of their female counterparts went up from 8.38 to 29.59. This implies that CMLA teaching strategy had a positive effect on the students' chemistry achievement.

Table 24

Independent Samples t-Test on Post-test scores based on Gender on CAT 2

		Levene's Test for Equality of Variances					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Post-test on CAT 2	Equal variances assumed	1.218	.271	-1.358	203	.176	-1.5576
	Equal variances not assumed			-1.369	181.062	.173	-1.5576

$t_{(203)} = -1.358$, $p>0.05$

A more critical look at the results in Table 23 indicates that the performance of the girls taught through CMLA was slightly higher than that of boys taught through the same approach. However, the results in Table 24 indicates that there was no significant difference in the means of the two groups ($t_{(203)} = -1.358$, $p>0.05$). This therefore, means that there was no significant difference in achievement between boys and girls taught using CMLA. Therefore, $H_0$4 was accepted.

4.3 Discussion of the Results

This study was guided by four hypotheses:

$H_0$1 There is no statistically significant difference in motivation to learn chemistry between students exposed to CMLA and those taught using CTM.

$H_0$2 There is no statistically significant difference in students' achievement in chemistry between those exposed to CMLA and those taught using CTM.

$H_0$3 There is no statistically significant difference in motivation to learn Chemistry between boys and girls exposed to CMLA

$H_0$4 There is no statistically significant difference in achievement in chemistry between boys and girls exposed to CMLA

The discussion of results of the study was handled in accordance with the objectives and hypotheses.

4.3.1 Effects of using CMLA Teaching Strategy on the Students' Motivation

In this study students' motivation to learn chemistry was assessed using Students Motivation Questionnaire (SMQ). The items constructed on five point Likert-Scale were 23. The information sought through these SMQ items was based on the four dimensions of motivation: Perceived confidence, Perceived choice, Perceived interest/enjoyment and Perceived pressure/tension.

Hypothesis one ($H_0$1) of the study sought to determine whether there was any significant difference in motivation to learn chemistry between students taught through CMLA and those taught through CTM.

The results of the pre-test showed that there was no significant difference in the means of the two groups ($t_{(102)} = 0.290$, $p>0.05$). These results implied that the level of students' MTC in the two groups were similar before exposure to the intervention. However, the results of the post-test shows that the post-test mean scores for the four groups were different. The experimental groups, E1 and E2 had means of 24.33 and 24.33 respectively while the control groups C1 and C2 had means of 19.20 and 20.96 respectively. One-way ANOVA was carried out to find out whether these means were significantly different. The results in Table 9 shows that the differences in the mean scores between the four groups were significant $F_{(3,201)} =44.251$, $p<0.05$. *Bonferroni post-hoc* analysis indicates significant difference in the means between the groups, E1and C1, E1and C2, E2 and C1, E2 and C2 and C1 and C2.The null hypothesis ($H_0$1) which states that there is no statistically significant difference in motivation to learn chemistry between students exposed to CMLA and those taught using CTM was therefore rejected. This implies that Cooperative Mastery Learning Approach enhances students' motivation to learn Chemistry.

The findings of this study is in accordance with earlier studies by Keraro, Wachanga and Orora (2007) conducted to investigate the effects of Cooperative Concept Mapping (CCM) teaching approach on secondary school students' motivation to learn biology. Their findings indicate that the CCM teaching approach significantly enhanced students' motivation to learn because the students were actively engaged during the instructional process. A study by Wachanga (2002) that compared the effects of traditional and Cooperative Class Experiment (CCE) learning strategies on achievement and motivation in secondary school chemistry also found significant difference in motivation. Those taught through CCE were found to have a higher level of motivation to learn chemistry than their counterparts taught through traditional methods.

Motivating students to learn is a topic of great concern for educationists today. Moreover, motivating students so that they can succeed in school is one of the greatest challenges of this century. Lack of motivation is a big hurdle in learning and a pertinent cause of deterioration in education standards. According to Deci and Ryan (2000) motivation is greatly appreciated because of the consequences it produces. The attitude that is often used in conjunction with motivation to achieve is self concept, or the way one thinks about oneself to perform a task successfully. There is considerable evidence to support the contention that positive academic self-concept contributes to academic achievement by enhancing the motivation to achieve. This study's purpose was to explore effects of CMLA on students' motivation to learn chemistry and consequently how these factors impacts on the learners' achievement in the subject.

Motivation is generally defined as internal condition that stimulates, directs and maintains behaviour. There is a strong relationship between learning and motivation. According to Abraham Maslow when the need for love and belongingness are met, individuals can then focus on higher level needs of intellectual achievement. At this stage, the urge to learn increases (Woolfolk, 2004).

It is therefore evident that a relationship between motivation and achievement exists. This gives rise to achievement motivation. Achievement motivation has been defined as the extent to which individuals differ in their need to strive to attain rewards, such as physical satisfaction, praise from others and feelings of personal mastery (McClelland, 1985). People with high achievement motives will act in ways that will help them to outperform others, meet or surpass some standard of excellence, or do something unique (Frieze, 1975). All students are influenced by a need to achieve to a certain degree. Those students, who hold a high desire for success, work hard to achieve (Pullmann & Allik, 2008).

Weiner (1986) presented the most ambitious attribution theory of achievement motivation and emotions. This theory deals with the perceived causes of success and failure, the characteristics of causal thinking, and subsequent emotional experiences in relation to achievement behaviours. Another important leap in motivational research is goal orientation theory. The basic premise of achievement goal orientation theory (Elliot & McGregor, 2001) is that when students engage in academic tasks, they set various personal goals and the types of goals that students adopt can directly influence their academic outcomes.

Elliot and McGregor's (2001) model of achievement motivation, discussed two broad classes of goals: mastery goals i.e. to "master" the task at hand and performance goals i.e. demonstrating superior performance relative to others. Research indicates that when students adopt mastery goals, they tend to engage in more effective cognitive processing strategies (Noar, Anderman, Zimmerman, & Cupp, 2005). Social goals are another important type of goals, although not examined at length as mastery and performance goals (Dowson & McInerney, 2001). In these goals social reasons are the main concerns for trying to achieve in academics. According to Maehr (2008) achievement motivation is largely social psychological in nature. It often occurs within groups, where interpersonal interactions can undermine or facilitate engagement in the tasks to be done. This study has been designed in such a way as to explore the effect of CMLA on both motivation and achievement through mastery of goals and interpersonal interactions when students learn in small groups.

The findings of the present study have shown that CMLA enhances students' motivation to learn. The use of CMLA therefore, enabled learners to be active cognitively while learning in groups and hence motivated to learn chemistry. A study by Solomon (1986) on motivation shows that active involvement of learners enhances their understanding of new situations. In this study, learners worked together in groups, therefore, active involvement captured their interest hence their MTC was enhanced.

Kithaka (2004) working for the Strengthening of Mathematics and Science in Secondary Education (SMASSE) project in Kenya argued that there is a general feeling among students that science subjects are difficult. This feeling according to Kithaka is as a result of poor performance at National examinations, where anticipation of negative outcomes blocks or inhibits learning efforts; saturation of the job market which discourage students; socio-cultural attitudes; and too much theoretical teaching of sciences. The CMLA teaching strategy is one approach that can help direct the teaching-learning process to move away from the theoretical approaches of teaching that renders the learners passive and fail to recognize their important contribution to learning through active involvement.

Science teachers are with students most of the time hence, they are the most important agents that can influence change in the students' attitude towards science through stimulating and motivating instructional strategies like CMLA. The use of CMLA proved interesting and stimulating since the learners worked together in groups to accomplish a common task and finally gain mastery of the content of the small unit being handled. Parkinson (1994) points out that it is up to teachers to ensure that they make science as inviting as possible. Indeed, as demonstrated in this study, this can be achieved by the use of CMLA.

4.3.2 Effects of CMLA Teaching Strategy on Students' Achievement

In an effort to improve students' cognition and achievement in science, educational psychologists and science educators have continued to search for variables that could be manipulated in favour of academic gains. Of all the personal and psychological variables that have attracted researchers in this area of educational achievement, motivation seems to be gaining more popularity and leading other variables (Tella, 2003).

There is a strong relationship between learning and motivation. According to Abraham Maslow when the need for love and belongingness are met, individual can then focus on higher level needs of intellectual achievement. At this stage the urge to learn increases (Woolfolk, 2004). It therefore follows that a motivated student is more likely to move to a higher level of achievement in chemistry than one who is not motivated at all. CMLA teaching strategy is one kind of an approach that puts together mastery learning and cooperative learning approaches. It is therefore a hybrid of the two approaches and therefore, likely to motivate the students by not only appealing to their cognitive domain but also their affective domain. This will consequently promote students achievement.

In this study, Cooperative Mastery Learning Approach was defined as an instructional strategy in which students at various performance levels work together in small groups towards a common goal. The teachers' role is to facilitate learning by grouping the students in groups of mixed ability, assigning roles to group members, organising subject matter, selecting and organising learning resources, construction of worksheets for practical lessons and ensuring that the learning environment is organised well in advance.

Students working cooperatively are responsible for one another's learning as well as their own (Wachanga, 2002). In this learning approach, the student was allowed to proceed on to the next learning segment after passing the criterion test. The criterion test had to be passed by the student with a minimum cut-off score of 80% marks indicating mastery of the learners' on-going learning segment (Kullik et. al., 1990). A student who does not pass the criterion-referenced test is given individual guidance by the instructor and peer-tutors. This remediation enables the student to repeat the learning segment and take retests until he attains the required pass-mark. The mastery learning model places focus on aspects such as behavioural objectives, small learning segments, self-pacing, individual attention and criterion-referenced testing (Aggarwal, 2004).

CMLA is one example of a group task in which students can work together to accomplish a given task. Through this approach, students were expected to learn in their cooperative groups to achieve a certain level of mastery of the content by constructing knowledge about the topic. The students work on the task until all group members have successfully understood and when the task is over the teacher evaluates the academic success of each student, (Wachanga, 2002). The knowledge learnt, should enable them to apply in real life situations and show how it affects people in their daily lives. The approach is therefore likely to motivate students by engaging them in a group task in which they are expected to realise that they are mutually responsible for one another's learning and academic success hence a higher level of achievement is likely to be attained.

In this study, achievement was perceived at two levels. The first level was a superficial one, where students' presentation in CAT 1 (pre-test) was scored in terms of whether the answer given was correct or wrong with an aim of establishing homogeneity in the level of achievement of the participants from the two groups before treatment. The second level of achievement was deeper in that the student's work was assessed for understanding. Here the students' responses were scored in terms of their ability to demonstrate understanding of concepts and principles tested irrespective of whether the final answer was correct or wrong. Assessment in the second level was achieved by scoring students' detailed responses as well as reasons given for their answers in addition to the brief explanations given for all the steps involved to the final answer. All these responses were analyzed for depth of understanding and scored accordingly based on Concept-evaluation scheme developed by Abraham, Gzybowski, Renner, and Marek and used by BouJaoude and Barakat (2003).

To determine the relative effects of CMLA teaching strategy on students' achievement in chemistry, an analysis of students' post-test scores on CAT 2 was carried out. Hypothesis two ($H_0$2) of the study sought to determine whether there was any significant difference in achievement in chemistry between students exposed to CMLA and those taught using CTM.

The results indicates that the performance of the experimental groups (E1 and E2) was higher i.e. 32.98 and 31.16 respectively as compared to that of the control groups (C1 and C2) which was 25.70 and 24.86 respectively. This shows that CMLA had an effect that led to improvement of performance in the subject as compared to CTM. These findings were subjected to further tests to determine whether to reject or accept the hypothesis.

The ANOVA results show that the difference between the groups is statistically significant $F_{(3,201)}=15.173$, $p<0.05$. This would, therefore, suggest that CMLA improved the achievement of students who were in the experimental groups compared to those in control groups.

Moreover, the results of *Bonferroni post-hoc* pair-wise test for significance difference between any two means, Table 15 shows that the pairs of CAT 2 mean of groups E1 and C1, groups E1 and C2, groups C1 and E2 and groups E2 and C2 were statistically significant different at the 0.05 α-level. However there was no statistically significant difference in the mean between Groups E1 and E2 and Groups C1 and C2. This study involved non-equivalent control group design and there was therefore, need to confirm these results by performing analysis of covariance (ANCOVA) using the students' Kenya Certificate of Primary Education (KCPE) scores as covariate.

KCPE scores correlate closely with the scores used in this study. ANCOVA results of the post-test scores of CAT 2 with the KCPE Total Mark as the covariate reveals that the difference between the groups is statistically significant ($F_{(3,197)} = 4.123$, $p<0.05$). *Bonferroni post-hoc* analysis indicates that the difference between the groups was in favour of the experimental groups. This would, therefore, suggest that CMLA improved the achievement of students who were in the experimental groups compared to those in control groups. Therefore, the null hypothesis ($H_0 2$) of the study, which states that there is no statistically significant difference in students' achievement in chemistry between those exposed to CMLA and those taught using CTM was rejected at 0.05 α-level, in favour of the alternative hypothesis.

From these findings it is evident that weak students benefit from interaction with brighter students. This is because of the fact that when bright students explain their ideas to others, they learn the material they are explaining in more depth and remember it longer (Johnson and Johnson, 1992; 1998). In a cooperative learning group, bright students are also seen as resources and are valued by team-mates (Wachanga, 2002). The CMLA teaching strategy exhibited these qualities, hence the higher achievement reported.

The findings of this study is in accordance with earlier studies by Wachanga, (2002) that compared the effects of traditional and Cooperative Class Experiment (CCE) learning strategies on achievement and motivation in secondary school chemistry also found significant difference in achievement. Moreover, a research done in the teaching of physics by Wambugu (2006) using Mastery Learning Approach (MLA) revealed that students taught using the approach outshined their counterparts taught using CTM. An earlier study by Sherman (1989) studied the effects of using Group Investigation Cooperative Learning and found no significant difference in achievement between cooperative and competitive groups.

4.3.3 Effects of Gender on Motivation when CMLA is used.

The determination of the effect of gender on motivation when CMLA Teaching Strategy is used to teach the topic Effect of Electric Current on Substances was guided by hypothesis three ($H_0 3$).

To establish the effect of CMLA on gender motivation in chemistry, the post-test mean scores of the SMQ were analyzed. The data analysis indicates that the difference in SMQ mean scores between the male and the female students were not statistically significant. Male students with a mean of 22.24 were slightly more motivated by CMLA teaching strategy than the females with a mean of 22.09. After treatment, the level of motivation for both male and female students went up. However, there was no a significant gender difference in motivation. The null hypothesis $H_0$3, which states that there is no statistically significant difference in motivation to learn Chemistry between boys and girls exposed to CMLA was therefore accepted.

Researches focused on gender studies have indicated that the motivation towards science education differ between males and females. A declining interest in chemistry and the under-representation of females in the chemical science was found (Banya, 2005). Self-confidence towards chemistry, the influence of role models, and knowledge about the usefulness of chemistry affect the decision of young female students about the study of chemistry (Banya, 2005). In the event of young female students finding difficulty in constructing knowledge of chemistry, self-confidence is lowered with subsequent alternation of motivation towards chemistry (Banya, 2005). Despite the studies done, and the recommendations made, the attitudes of young female students toward science and chemistry are still than positive (Banya, 2005). The present study therefore sought to find out whether there was any significant gender difference in motivation when CMLA is used in teaching.

Sex differences in motivation have been studied widely (Meece, Glienke, & Burg, 2006). In the context of academic achievement, gender role stereotypes are confirmed when motivation is studied domain-specifically, with boys being more confident and interested in mathematics and science compared to girls, while girls prefer, and feel more confident about language-related domains compared to boys. Researchers have studied whether these sex differences in motivation can predict sex differences in academic achievement. Personality and motivation play important roles in explaining sex differences in school attainment (Steinmayr and Spinath, 2008).

Many different motivational models have emerged to explain gender differences in motivation (Eccles-Parsons et al., 1983; Wigfield & Eccles, 2002). Theoretical models of achievement motivation relate this topic to future student success, learning outcomes, student choices, and student desire to engage in behaviour (Deci, Vallerand, Pelletier, & Ryan, 1991). Student's choice of academic major has its relation with their level of achievement motivation (Upadhyay and Tiwari, 2009). There are several reports that show students select their academic major based on some factors such as personality type, self-esteem and expectation (Pike, 2006; Pullmann & Allik, 2008). Ahmadi, Fathi-Ashtiani, Ghaffari and Hossein-Abadi (2009) reported that in terms of educational adjustment there was a meaningful difference between medical students and other academic majors. There are many other influencing factors that affect the selection of majors by students. These factors include interest in the major, peer pressure, family pressure, academic ability, the major's reputation, job availability, achievement motivation and others.

In addition to difference in science performance, motivation factors might underlie gender differences in educational and vocational choices. Eccles et al. Expectancy Value Model suggests that people's choices are strongly determined by their values and self-concepts of ability (Eccles et al., 1983; Jacobs & Eccles, 2002). Previous research indicates that even the males and females score equally well on standardized tests of math ability, the males hold higher self-concept of science ability and science value than females do, and males select more difficult math course than the female do (Simpkins, Davis-Kean, & Eccles, 2006). Thus, gender differences in attitudes toward science need to be closely examined.

The other major finding in this study was that there was no significant gender difference in motivation to learn chemistry (see Table 20). Wachanga (2002) argued that teachers treat boys and girls differently and in ways that often are not beneficial to girls motivation and achievement. Puhan & Hu (2006) in their study also found that motivation is an important predicator of science achievement than gender. Proko, Tuncer & Chuda (2007) also posit that teacher characteristics have a significant role on students' attitude towards chemistry. This also seems to suggest that more research needs to be devoted to the role of teacher characteristics on students' motivation to learn science.

4.3.4 Effects of Gender on Achievement when CMLA is used

The determination of the effects of gender on achievement when CMLA Teaching Strategy is used in the topic, Effect of electric current on substances was guided by hypothesis four ($H_0$4) of the study.

The researcher found out that the students who were taught through the CMLA teaching strategy were found to be at a higher level of motivation and achieved statistically significantly higher scores in the CAT compared to those that were taught through the CTMs.

This implies that CMLA teaching approach is more effective in enhancing students' achievement.

The results show that after intervention, the mean for male students went up from 9.69 to 28.03 while that of their female counterparts went up from 8.38 to 29.59. A more critical look at these results indicates that the achievement of girls taught through CMLA was slightly higher than that of boys taught through the same approach. However, t-test results indicates that there was no significant difference in the means of the two groups ($t_{(203)} = -1.358$, $p>0.05$). This therefore, means that there was no gender difference in achievement between boys and girls taught using CMLA. The null hypothesis $H_0 4$, which stated that there is no statistically significant difference in achievement in chemistry between boys and girls exposed to CMLA was therefore accepted at $\alpha=0.05$ significance level. The results of the present study concur with a study by Wachanga and Mwangi (2004) who investigated the effects of Cooperative Class Experiment (CCE) teaching method on high school students' educational achievement in Nakuru district. 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.

The non-significant difference between the male and female students' academic achievement in Chemistry could be due to the free interaction between male and female students in the district co-educational schools used in the study. It may also be because both male and female students have equal perception of what success is all about. In other words, the female students did not feel inferior to their male counterparts and thus they were able to compete favourably with them. It appeared that the male students did not also feel superior to their female counterparts. Thus, it implies that both have a level playing ground hence, no gender differences occurred in their achievement.

The CMLA teaching strategy used in this study stressed on both motivation and achievement through stepwise mastery of content, corrective feedback, remediation as well as cooperative skills and the results showed that CMLA is superior to CTM in terms of motivating the learners towards chemistry and achieving higher scores in the subject. The cooperative activities supplement, but do not replace, direct instruction. However, they involve individual accountability because group success depends on members' contribution to a team task. This study was done with these issues in mind and the results show that use of CMLA teaching strategy leads to better students' achievement than the CTM. Positive interdependence is critical to successful application of the CMLA teaching strategy. It benefits both the weak and bright students because group memberships and interpersonal interaction are not, in themselves, sufficient to produce higher achievement and productivity. Weak students benefit from interaction with brighter students and when bright students explain their ideas to others, they learn the material they are explaining in more depth and remember it longer (Wachanga, 2002). In a cooperative group, bright students are also seen as resources and are valued by group members. The CMLA method exhibited these qualities hence higher achievement was reported in the study.

Research conducted on comparing effects of Mastery Learning alone, and regular teaching methods on student achievement (Mevarech, 1985) showed that Mastery Learning was the indicator that significantly increased achievement. Wentling (1973) when comparing Mastery Learning and non Mastery Learning as to how feedback relates to achievement found that students who received feedback in MLA had higher achievement scores for both immediate achievement and long-term retention. The present study on CMLA being a hybrid of Mastery Learning and Cooperative Learning was able to reap immensely from the benefits of both the two approaches that forms it hence a high level of achievement was recorded. CMLA helped the students to have a deeper understanding of the chemistry concepts by not only appealing to the cognitive domain of the learner but also the affective domain. The approach allows students to have enough time to master the prerequisites before making progress.

However, in the implementation of this treatment, time is a limiting factor. Apart from the time required for feedback, more time is required for remediation and peer-tutoring especially for those who fail to attain the mastery level expected before proceeding to the next unit of study. Mastery Learning theorists especially Bloom (1984) contend that MLA reduces the amount of time needed to achieve Mastery. Arlin and Webster (1983) raised an important issue regarding the use of instructional time in Mastery Learning. He argued that low achievers in grouped Mastery Learning do better because of corrective instruction, but faster students may be slowed down waiting for the other students. This would require the chemistry teacher to be willing to use extra time outside the normal school timetable for corrective procedures and retesting. This is in agreement with a research conducted by Arlin and Webster (1983) on achievement, time and learning rate. The study revealed that the use of MLA significantly raises achievement levels but the time needed for this increase is considerable.

Wachanga and Gamba (2004), in their study on effects of using MLA on secondary school students' achievement in Chemistry found that MLA facilitates students learning Chemistry better than the regular teaching methods. This agrees with Ngesa (2002) who reported that MLA resulted in higher student achievement in Agriculture than the regular teaching method. He argued that the results were significant with regard to classroom Instruction and Teacher Education in Agriculture. The Cooperative Concept Mapping approach teaching method enhanced the teaching of secondary school biology in Gucha district (Orora, Wachanga & Keraro, 2005). Moreover, a research done in the teaching of agriculture by Kibett and Kathuri (2005) revealed that students who were taught using project based learning out performed their counterparts in regular teaching approach. Wambugu (2006), in her study on the effects of MLA on secondary school physics achievement found that MLA facilitates students learning in physics better as compared to regular teaching methods.

The current study was carried out with these issues in mind and also that the students' performance in Chemistry at KCSE examinations has been quite low compared to that of the other two sciences. In the general, the results have shown that the use of CMLA in Chemistry results in better motivation of students towards chemistry and consequently higher achievement in the subject than the Conventional Teaching Methods. This agrees with previous studies done by other researchers. In this study, peer tutoring was encouraged in and out of class time where the students checked each other for their achieved level of mastery. They tutored one another and verified that everyone mastered the subtopic and was ready for the Criterion Referenced Test (CRT). Since CMLA Teaching Strategy stresses the need for formative assessment and feedback for each unit, a variety of remediation materials were prepared. This included student worksheets for practical lessons and sample questions from every small unit covered to be used during group discussions and individual revision by the learners. This was done by using a variety of the recommended books by the ministry of education as sources of information as well as KCSE and Mock Past papers.

The results also show that CMLA is beneficial to both boys and girls. If secondary school Chemistry teachers appreciate and incorporate the use of this method, they might be able to overcome the challenge of general decline in performance, dismal performance and gender disparity in achievement in KCSE examinations which has triggered a lot of concerns among educationists and other stakeholders. CMLA assumes that virtually all students can learn what is taught in school if their instruction is approached systematically and students are helped when and where they have learning difficulties (Bloom, 1984). The most important feature of CMLA is that, it accommodates the natural diversity of ability with any group of students. With careful preparation and greater flexibility all students can be appropriately accommodated according to their respective levels of understanding and they can progress at their own rate (Kibler et. al, 1981).

Several researchers like Nagarathanamma and Rao (2007) and Kaushik and Rani (2005) found no significant difference between boys and girls with regard to achievement level. In summary, the research on gender differences in achievement for males and females has resulted in inconsistent findings. Some researchers have found no difference (e.g., Ligon, 2006), whereas others have found differences (e.g., Vermeer, Boekaerts, & Seegers, 2000).

In the present study the results indicate that there was no significant difference in achievement between boys and girls exposed to CMLA Teaching Approach but both performed significantly better than those taught through CTM. The Forum for African Women Educationists (FAWE) (1999) indicates that science achievement for girls in Kenya was lower than for boys partly due to their poor attitudes towards science and discouragement by their teachers. Some teachers assumed, for instance, that girls could not answer certain questions or perform certain tasks. They made remarks that indicated their biased beliefs or feelings that girls were unintelligent and lazy while using positive reinforcement more on boys than on girls (FAWE, 1997). The CMLA Teaching Strategy helped chemistry teachers to balance classroom interaction between boys and girls enabling them to give similar attention to both sexes, which led to improved achievement by both. This teaching approach could therefore be used to reduce gender disparity in achievement at KCSE chemistry examination.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter covers the discussion of major findings of the study based on the four hypotheses that guided the study as stated in chapter one and discussed in details in chapter four. Conclusions were made based on the findings and generalized to form two chemistry students in secondary schools in Kenya. Implications of the findings of the study in chemistry education are also discussed in this section. The last part of this chapter shall discuss the recommendations for chemistry educators and all stakeholders on how chemistry teaching can be structured to ensure effective and efficient learning by all the students. Recommendations for further research are also outlined in this chapter.

5.2 Summary of Major Findings

The following are the major findings of the study:

i. The results of the pre-test on SMQ show that there was no significant difference in the means of the two groups; Experimental 1 and Control 1. These results implies that the level of students' Motivation Towards Chemistry (MTC) in the two groups were similar before exposure to the intervention.

ii. The results of the post-test on SMQ shows that the post-test mean scores for the four groups were significantly different. One-way ANOVA and ANCOVA results show that the differences in the mean scores between the four groups were significant. These results therefore indicated that CMLA has a positive effect on motivation of students towards chemistry learning.

iii. The results of an independent t-test on the pre-test scores of CAT 1 showed no significant difference in the two means. Therefore, the level of students' achievement prior to administration of the intervention for the two groups was similar; that is the groups were equivalent before administration of treatment and therefore suitable for the study.

iv. The results of analysis of post-test scores on CAT 2 indicate that the performance of the experimental groups (E1 and E2) was higher as compared to that of the control groups (C1 and C2). This shows that CMLA had an effect that led to improvement of performance in the subject as compared to CTM. Results of ANCOVA test with the KCPE Total Mark as the covariate indicates that the difference between the groups is statistically significant. *Bonferroni post-hoc* analysis results on pair-wise comparison revealed that there was a significant difference in favour of the experimental groups. This implies that CMLA improved the achievement of students who were in the experimental groups that received the treatment compared to those in control groups which were taught using Conventional Teaching Methods.

v. The results of analysis on pre-test scores of SMQ by gender indicate that the difference in SMQ mean scores between the male and the female students were not statistically significant. This implies that the boys and girls exhibited similar characteristics before treatment. The groups were therefore suitable for the study.

vi. The results of analysis of post-test of the SMQ by gender indicate that the level of motivation for both male and female students went up for those that received the treatment. However, there was no a significant gender difference in motivation when students are taught through CMLA.

vii. The results on the analysis of post-test on CAT 2 indicate that the mean for both male and female students went up. A more critical look at these results indicates that girls' achievement improved slightly higher than that of the boys due to the effect of CMLA teaching strategy. However, t-test analysis indicates that there was no significant gender difference in the means of the two groups. Therefore, this means that there was no difference in achievement between boys and girls taught using CMLA.

5.3 Conclusions

On the basis of the findings of this study, the researcher made a number of conclusions in relation to the four hypotheses of the study. These conclusions include:-

i. The CMLA results in higher students' motivation to learn chemistry than the conventional teaching methods.

ii. Students taught through CMLA have a high level of academic achievement than those taught through CTM.

iii. Gender does not affect students' motivation to learn chemistry when they are taught through CMLA.

iv. Gender does not affect students' achievement in chemistry when they are taught through CMLA.

5.4 Implications of the Findings

The findings of this study indicated that the use of CMLA teaching strategy results in higher students' motivation and achievement in chemistry irrespective of gender. Based on these findings the following implications were arrived at.

i) The strategy should be incorporated into the teaching of chemistry at secondary school level. This in turn would improve students' motivation to learn chemistry and consequently achievement will be higher.
ii) Curriculum developers in their efforts to improve the effectiveness of chemistry teachers should encourage the use of CMLA.
iii) Teacher training institutions should also make the use of CMLA as part of their teacher education curriculum.
iv) The CMLA teaching strategy would be suitable for teaching both male and female students whether the school was single sex or co-educational.
v) Education authorities in Kenya should encourage chemistry teachers to use this teaching strategy and teacher education institutions to make it part of their teacher training curriculum content.
vi) If the CMLA teaching strategy is used, it would minimize the gender disparities experienced in the performance in science subjects in school.

vii) That, teachers should motivate and encourage students to work hard in order to achieve their goals. For example, teachers can motivate students to learn chemistry by showing them the value or importance of chemistry, teaching them how to set high academic goals and cultivating in them the importance of achieving these goals by working together with others in cooperative learning groups or using other motivational strategies.

viii) The chemistry course content should be changed in order to provide teachers more time for developing instructional methods to obtain better understanding of scientific concepts.

5.5. Recommendations

Based on the findings of the study, the following recommendations were made:

i) Students taught through the CMLA method performed better than those taught through the CTM irrespective of gender, implying that the CMLA method would be suitable for teaching both male and female students. Therefore, education authorities in Kenya should encourage chemistry teachers to use this method and teacher education institutions to make it part of their teacher training curriculum content.

ii) All students irrespective of their gender and family background should be given the same level of encouragement and attention for better cognitive achievement in chemistry.

iii) All stakeholders in education should ensure that students are highly motivated by providing necessary materials, enabling environment and adequate reward system.

iv) Curriculum developers should use CMLA concepts when preparing teaching materials to support the syllabus. They should also include CMLA in teacher training syllabus as one of the modern teaching approaches so as to equip student teachers to be able to design programmes that encourage the learners to be active participants in knowledge construction.

v) CMLA should be incorporated in the regular in-service training of teachers to enable them use the approach effectively.

vi) The Heads of Science departments, Heads of subject and chemistry teachers should adopt CMLA as one of their teaching approach since it enhances learning of scientific concepts and skills by the chemistry students.

5.6 Recommendations for Further Research

The researcher identified some areas, which require(s) further investigation in order to have more insight into the effect CMLA as a teaching strategy on CAT and MTC as well as enrich the present knowledge.

i) There is need for more research to test further the effect of CMLA as a teaching strategy on achievement and motivation using other topics in chemistry other than the one used in the present study.

ii) There is also need to determine the amount of time needed to reap maximum benefits from the use of CMLA as a teaching strategy in a chemistry class setting.

iii) There is need to explore on the possible benefits that can be derived from incorporating the use of computers in the CMLA process.

iv) A similar study on the effect of CMLA on CAT and MTC should be carried out using both qualitative and quantitative methods of data collections approach for concurrent triangulation and corroboration.

v) The present study is exploratory in nature and more research needs to be carried out in order to have a better understanding of the relationships between motivational orientations and students' achievement in chemistry.

vi) A larger sample of students should be studied so that a clearer pattern of students' achievement in chemistry in relation to their motivational orientations is obtained.

vii) The scope of the study should also be widened to include other school subjects, as well as, employing structural equation modelling to determine the relationships between motivation and achievement.

REFERENCES

Aduda, D. (2003, September 30). Meeting gives Tips on How to Improve Science Subjects. *The Daily Nation,* Nairobi, Kenya: Nation Media group Ltd (p.15).

Aggarwal, J.C. (2004). *Essentials of Educational Technology: Teaching Learning. Innovations in Education.*UBS Publishers' Distributors PVT Ltd. New Delhi,

Ahmadi, K., Fathi-Ashtiani, A., Ghaffari, A., & Hossein- Abadi F. H. (2009). Medical Students' educational adjustment and motivation power in compare with other academic majors: A prospective study. *Journal of Applied Sciences, 9,* 1350-1355. http://dx.doi.org/10.3923/jas.2009.1350.1355

Aire, J.E. and Tella, Yinka (2003). The Impact of Motivation on Student's School Academic Performance in Nigeria. *Journal of Personality Study and Group Behaviour,* 23(1), 107-114.

Ames, C.A. (1990). *Motivation: What Teachers Need to Know*. Teachers College: Columbia University.

Ames, R. & Ames, C. (1984). *Research on motivation in Education.* Orlando, F.L.: Academic.

Archer-Kath, J., Johnson, D. W., & Johnson, R. (1994). Individual versus group feedback in cooperative groups. *Journal of Social Psychology, 134*, 681–694.

Arlin, M., & Webster (1983). Time Costs of Mastery Learning. *Journal of Educational Psychology,* 75 (2), 187-195.

Ayot, H.O., & Patel, M.M. (1987). *Instructional methods*. Nairobi, Kenya: Kenyatta University.

Bandura, A. (1977). *Social learning theory*. New York: General Learning Press.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W.H. Freeman.

Banya, S.K. (2005). *Study of factors affecting attitudes of young female students towards chemistry at the high school level*. Ph.D. dissertation. College of Science and Technology of the University of Southern Mississippi.

Barchok, H.K. (2006). *The influence of secondary school students' self-concept of ability and gender stereotyping of science subjects on their attitudes towards science*: *A case study of Bomet District*, Kenya. Unpublished M.Ed Thesis. Egerton University, Kenya.

Block, J. H. (1981). *Mastery Learning. Theory and Practice.* New York NY: Holt, Rinehart and Winston.

Block, J., & Anderson, L. (1975). *Mastery learning in classroom instruction*. New York: MacMillan

Bloom, B. S. (1984). The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-on- One Tutoring". *Educational Researcher,* 13(6), 4-16.

Bloom, B.S. (1968) *.Learning For Mastery., (UCLA-CSEIP) The Evaluation Comment, 1(2). In B.S. Bloom (Ed) All Our Children Learning*. London: McGraw-Hill.

Bloom, B.S. (1976) *Human Characteristics and School Learning*. New York: McGraw-Hill.

Bloom, B.S. (1981). *All Our Children Learning*: New York, NY: McGraw-Hill.

Bloom, B.S. (1987) .A response to Slavin.s mastery learning reconsidered. *Review of Educational Research,* 57(4), 507-508.

Bloom, B.S., Hastings, J.T. and Madaus, G.F. (1971) *Handbook on Formative and Summative Evaluation*. London: McGraw-Hill.

Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: How different are they really? *Educational Psychology Review*, *15*(1), 1-40. http://dx.doi.org/10.1023/A:1021302408382

Borg, W. R., & Gall, M. D. (1989). *Educational Research; An Introduction (5th ed.).* White Plains, NY: Longman

Borg, W. R., & Gall, M. D. (1996). *Educational Research; An Introduction (6th ed.).* White Plains, NY: Longman

BouJaoude, S., & Barakat, H. (2003). Students' problem solving strategies in Stoichiometry and their relationships to conceptual understanding and learning approaches. *Electronic Journal of Science Education,* 7*, (3).*

Brickner, M., Harkins, S., & Ostrom, T. (1986). Effects of personal involvement: Thought-provoking implications for social loafing. *Journal of Personality and Social Psychology, 51*, 763–770.

Burnett, P. C. (1999). Children's Self-Talk and Academic Self-Concepts, *Educational Psychology in Practice*, 15: 3, 195-200

Changeiywo, J.M. (2000). *Students' image of science in Kenya: A Comparison by gender difference of Schooling and Regional Disparities.* Unpublished PhD Thesis, Egerton University Kenya.

Cook, T.D. & Campbell (1979). *Quasi experimentation: Design and Analysis issues for field settings*. New York, NY: Rand McNally

Cooper, H., Jackson, K., Nye, B., & Lindsay, J. J. (2002). A model of homework's influence on the performance of elementary school students. *Journal of Experimental Education, 69,* 181–199.

D'Amico, M. & Schmid, R.J.F. (1997). *Psychology applied to teaching*, 8th ed. New York: Houghton Mifflin.

Deci, E. L., & Ryan, R. M. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well being. *American Psychologist,* 55(1), 68-78.

Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. *Educational Psychologist*, *26*(3 & 4), 325-346. http://dx.doi.org/10.1080/00461520.1991.9653137

Deci, E., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Dowson, M., & McInerney, D. M. (2001). Psychological parameters of students' social and work avoidance goals: A qualitative investigation. *Journal of Educational Psychology,* 93(1), 35-42.

Eccles-Parsons, J., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., et al. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 75–146). San Francisco: Freeman.

Elliot, A. J., & McGregor H. A. (2001). A 2x2 achievement goal framework. *Journal of Personality and Social Psychology,* 80, 501-519.

Ellis, R. (1994).The Study of Second Language Acquisition. Oxford: Oxford University Press. *Encyclopaedia of education.* (Vol.6, pp.3425-3435) New York, Pergamon press.

FAWE (1997). *Teachers' attitudes to the study of science, mathematics and technical subjects by girls in secondary schools. Report Number 7* (pp. 7-16). Nairobi, Kenya.

FAWE (1999). *Improving performance of girls in schools*. (pp. 8-10). Nairobi, Kenya.

Fraenkel, J.R & Wallen, N.E. (2000). *How to Design and Evaluate Research in Education,* New York, NY: Mc Grawhill Companies Inc.

Gerard, H., Wilhelmy, R., & Conolley, E. (1965). Conformity and group size. *Journal of Personality and Social Psychology, 8*, 79–82.

Good, T., and J. Brophy. (1995). *Contemporary Educational Psychology*. (5th ed.) New York: Harper Collins.

Government of Kenya (1976). *Report on national committee on educational objectives and policies*, (pp.69-72). Nairobi, Kenya. Government printer.

Gronlund, N. E. (1993). *How to construct achievement tests and assessments* (5th ed.). Englewood Cliffs, NJ: Prentice Hall.

Guay, F., Marsh, H. W., & Boivin, M. (2003). Academic self-concept and academic achievement: Developmental perspectives on their causal ordering. *Journal of Educational Psychology*, *95*(1), 124-136. http://dx.doi.org/10.1037/0022-0663.95.1.124

Guskey, T., & Gates, S. (1986). Synthesis of Research on the effects of Mastery Learning in Elementary and Secondary Classrooms. *Educational Leadership,* 43(8), 73-80.

Guzzo, R., Yost, P., Campbell, R., & Shea, G. (1993). Potency in groups: Articulating a construct. *British Journal of Social Psychology, 32*, 87–106.

Hagman, J., & Hayes, J. (1986). *Cooperative learning: Effects of task, reward, and group size on individual achievement* (Tech. Rep. No. 704).

Hamack, F. M.(1995). "Schools for Social Mobility: What it Takes for Kids to Succeed in High Achieving Schools" Presented at the 2011 Annual Meetings of the American Educational Research Association, New Orleans.

Harkins, S., & Petty, R. (1982). The effects of task difficulty and task uniqueness on social loafing. *Journal of Personality and Social Psychology, 43*, 1214– 1229.

Harlen, W. (1993). *Education for Teaching Science and Mathematics in the Primary School,* Edinburgh: Scottish Council for Research in Education.

Hohn, R. L. (1995). *Classroom learning and teaching*. Boston: New York, Longman publishers.

Hooper, S., Ward, T., Hannafin, M., & Clark, H. (1989). The effects of aptitude composition on achievement during small group learning. *Journal of Computer Based Instruction, 16*, 102–109.

Husen, T. & Postlethwaite, T. N. (Eds) (1993). *Motivation. In The international.* India.

Indik, B. P. (1965), “Organization size and member participation: Some empirical tests or alternative explanations”, *Human Relations,* Vol. 18, pp. 334-350.

Jacobs, J. E., & Bleeker, M. M. (2005). *Girls’ and boys’ developing interests in math and science: Do parents matter?* In H. Bouchey, & C. Winston (Eds.), Social and self processes underlying math and science achievement. New directions for child and adolescent development, Vol. 106.

Jacobs, J. E., & Eccles, J. S. (2002). The impact of mothers’ gender-role stereotypic beliefs on mothers’ and children’s ability perceptions. *Journal of Personality and Social Psychology*, 63(6), 932– 944.

Johnson, D. W. (2009). *Reaching out: Interpersonal effectiveness and self actualization* (10th ed.). Boston: Allyn & Bacon.

Johnson, D. W., & Johnson, R. (1989). *Cooperation and competition:Theory and research*. Edina, MN: Interaction Book Company.

Johnson, D. W., & Johnson, R. (1992). *Positive interdependence: Activity manual and guide*. Edina, MN: Interaction Book Company.

Johnson, D. W., & Johnson, R. (1998). *Learning together and alone: Cooperative, competitive, and individualistic learning* (5th ed.). Boston:Allyn & Bacon.

Johnson, D. W., & Johnson, R. (2004). Training for cooperative group work. In M. West, D. Tjosvold, & K. Smith, *International Handbook of Organizational Teamwork and Cooperative Working* (pp. 167–183). London: Wiley.

Johnson, D. W., Johnson, R., & Holubec, E. (2008). *Cooperation in the classroom* (8th ed.). Edina, MN: Interaction Book Company.

Joyce, B. & Weil, M. (1980). *Models of Teaching*. New Jersey; N.J: Prentice Hall

Karega M. (Prof.) (2008) *Increasing Effectiveness of South-South Cooperation: the Case of SMASSE Kenya and SMASE-WECSA,* for South-South Cooperation and the Launch of the Global South-South Development Expo on 18 December 2008 at U.N. Headquarters/New York)

Kaushik, N., & Rani, S. (2005). A Comparative study of achievement motivation, home environment and parent child relationship of adolescents. *Journal of Psychological research, 49*, 189-194.

Keller, J. M. (1987). Development and use of the ARCS model of motivational design. *Journal of Instructional Development*, 10(3), 2-10.

Kenya Government (1976). *Report of the national committee on education objectives and policies,* (pp.69-72). Nairobi, Kenya: Government Printer.

Kenya Institute of Education (KIE), (2002). *Secondary School Syllabus* (Vol. 2) Nairobi: Kenya Literature Bureau.

Kenya Institute of Education (KIE), (2010). *Secondary School Syllabus* (Vol. 2) Nairobi: Kenya Literature Bureau.

Kenya National Examinations Council (2008). *Kenya National Examinations Council Regulation and syllabus (2006-2007).*Nairobi Kenya: Kenyatta University.

Keraro, F. N., Wachanga, S. W., & Orora, W. (2007). Effects of cooperative concept Mapping teaching approach on secondary school students motivation in Biology in Gucha District, Kenya. *International Journal of Science and Mathematics Education,* 5, 111-124.

Kerich, K.R. (2004). *The importance of Science and Mathematics in SecondarySchool Education in Kenya.* A paper presented during the opening ceremony for Bomet and Transmara Districts SMASSE Course at Siongiroi, 24th August, 2004.

Kerr, N. (2001). Motivational gains in performance groups: Aspects and prospects. In J. Fargas, K. Williams, & L. Wheeler (Eds.). *The social mind: Cognitive and motivational aspects of interpersonal behaviour* (pp. 350–370). New York: Cambridge University Press.

Kibe, Odhiambo and Ogwel (2008), *Impact of SMASSE INSET on students' capacity through improved teaching and learning in the classrooms*. A paper presented at the 8th Regional conference for SMASSE WECSA, Nairobi.

Kibett, J.K. & Kathuri, N. J. (2005). Effects of Projected- Based Learning on Student Performance in Secondary School Agriculture. *Zimbabwe Journal of Educational Research,* 17(1), 30-38.

Kibler R.J, Cegala D.J, Watson K.W, Barkel L.L and David T.M (1981*); Objectives for Instruction and Evaluation*. Allyn and Bacon Inc. Toronto, U.S.A

Kiboss, J.K. (1997). Relative effects of computer based in physics on students' attitudes, motivation and understanding about measures and perceptions of classroom environment. PhD Thesis, University of Western Cape.

Kimiti, D. K. (1984). *Chemistry curriculum in Kenya secondary schools since independence*. Unpublished PGDE Report. Nairobi Kenya: Kenyatta university.

Kithaka, J. N. (2004). Attitudes towards mathematics and science. Paper Presented During SMASSE Project Cycle One, Nairobi, April 2004.

KNEC (2007). *Kenya certificate of secondary education examination report*. Nairobi, Kenya: Kenya National Examinations Council.

KNEC (2008). *Kenya certificate of secondary education examination report*. Nairobi, Kenya: Kenya National Examinations Council.

KNEC (2009). *Kenya certificate of secondary education examination report*. Nairobi, Kenya: Kenya National Examinations Council.

Kochhar, S.K (1992). *Teaching of History.* 2nd ed. New York: Sterling Private Limited.

Kombo, D.K. & Delno, L.A.(2006).*Proposal and Thesis writing*. Nairobi: Paulines Publications Africa.

Kulik, C.C., Kulik, J.A. and Bangert-Drowns, R.L. (1990) .Effectiveness of mastery learning programmes - a meta-analysis., *Review of Educational Research,* 60(2), 265-299.

Lepper, M. R.(1988). Motivational Considerations in the Study of Instruction. Cognition and Instruction, 5, 4, 289-309.

Levin, D. (1985). *Improving Student Achievement through Mastery Learning Programs.* San Francisco: Jossey-Bass

Ligon, N. Y. (2006). Assessing the achievement motivation across grades and gender. Dissertation Abstracts International Section A. *Humanities and Social Sciences*, *67*(6-A), 2052.

Little, B., & Madigan, R. (1997). The relationship between collective efficacy and performance in manufacturing work teams. *Small Group Research, 28*, 517–534.

Maehr, M. L. (2008). Culture and achievement motivation, *International Journal of Psychology*, 43: 5, 917-918

Maritim, E. K. (1995). Observed classroom interaction and academic performance of primary school pupils. *Kenya journal of Education* 1 (1), 1-21

Matlin, M. W. (1994). *Cognition* (3rd Ed.). NY: Harcourt Brace

Matsui, T., Kakuyama, T., & Onglatco, M. (1987). Effects of goals and feedback on performance in groups. *Journal of Applied Psychology, 72*, 407–415.

McCarthy, John (1992): "Programs with Common Sense", in *Proceedings of the Teddington Conference on the Mechanization of Thought Processes*, Her Majesty's Stationery Office, London.

McClelland, D. C. (1985). *Human motivation*. Chicago: Scott Foresman.

McClelland, D., Atkinson, J. W., Clark, R. A., & Lowell, E. L. (2004). *The achievement motive*. New York7 Appleton-Century-Crofts.

Meece, J. L., Glienke, B. B., & Burg, S. (2006). Gender and motivation. *Journal of School Psychology*, *44*, 351–373. http://dx.doi.org/10.1016/j.jsp.2006.04.004

Messick, D., & Brewer, M. (1983). Solving social dilemmas: A review. *Review of Personality and Social Psychology, 4*, 11–44.

Mevarech, Z. (1985). The effects of Cooperative Mastery Learning Strategies on Mathematics Achievement. *Journal of Educational Research,* 78(3), 372-377.

Miller, N. & Dollard, J. (1941). Social Learning and Imitation. New Haven, NJ: Yale University Press.

Ministry of Education, Science and Technology, Kenya. (2003). *Report of the Sector Review and Development.* September 2003. Nairobi.

Mondoh, H. O. (1994). *An investigation of teaching effectiveness and students' achievement in mathematics*. Unpublished doctoral theses Hindu University India.

Montalvo, G. P., Mansfield, E. A., & Miller, R. B. (2007). Liking or Disliking the Teacher: Student Motivation, Engagement and Achievement. *Evaluation and Research in Education, 20*(3), 144-158.

Morgan, B., Coates, G., & Rebbin, T. (1970). *The effects of phlebotomus fever on sustained performance and muscular output* (Tech. Rep. No.ITR-70–14). Louisville, KY: University of Louisville, Performance Research Laboratory.

Mullei, V.M. (1987). *Comparative analysis of attitudes towards inquiry and non-inquiry science teaching methods between pre-service and in-service secondary school science teachers*. Unpublished Ph.D. Thesis, Kenyatta University, Nairobi, Kenya.

Mwamwenda, T. S. (1995). *Educational Psychology*: An African perspective. Kampala: Heinemann Bulterworth Publisher Ltd.

Nagarathnamma, B., & V. Thirumal, Rao. (2007). Achievement motivation and Academic Achievement of adolescent Boys and Girls. *Indian Psychological Review, 68*, 131 – 136.

National Economic and Social Council of Kenya (NESC), (2007). Kenya Vision 2030. Retrieved March 17, 2009, from http://www.investmentkenya.com/Documents/Publications/Vision_2030_BROCHURE %20_July_2007.pdf

Ngesa, F.U. (2002). *Impact of Experiential and Mastery Learning Programmes on Academic Achievement in Secondary School Agriculture.* Unpublished PhD Thesis, Egerton University, Kenya.

Njoku, Z. C. (2007). Comparison of students' achievement in the three categories of questions in *SSCE practical chemistry examination Journal of the Science Teachers Association of Nigeria*, 42 (1&2), 67 - 72.

Nkapa, N. (1997). *Educational Research for Modern Scholar*. Enugu: Fourth Dimension Publishers, Nigeria.

Noar, S. M., Anderman, E. M., Zimmerman, R. S. & Cupp, P. K. (2005). Fostering Achievement Motivation in Health Education, *Journal of Psychology & Human Sexuality*, 16: 4, 59-76

Novak, J. D. (1998).Learning theory applied to the biology classroom. A useful tool for science education. *The American biology teacher*, 42, (*5*) 280-285).

Odalo B. (2000, March 20). Alarm over poor grades. The Daily Nation, (p.23). Nairobi Kenya: Nation Media Group Ltd

Okere, M. (1996). *Physics Education*. Njoro: Egerton University Material Centre & Lectern Publication Ltd.

Opare, J.A. (1996). Boys and Girls in science: Does the gender composition of the school matters. *Zimbabwe Journal of Education Research*, 5, 26-48.

Orora, W., Wachanga, S. W. & Keraro, F. N. (2005). Effects of Concept Mapping Teaching Approach on Secondary School Students' Achievement in Biology in Gucha District Kenya. *Zimbambwe Journal of Educational Research,* 17(1), 1-18.

Osborn, R. J. & Wittrock, M.C. (2003). *The generative learning model and its implication for science education. Studies in Science Education*, 12, 59-87.

Osiki, J.O. (2001).*Motivation for academic study scale*. Ibadan. Stirling-Horden Publisher

Parkinson, J. (1994). *The effective teaching of secondary science*. New York: Addison Wesley Longman Inc.

Pike, G. R. (2006). Students' personality types, intended majors and college expectations: Further evidence concerning psychological and sociological interpretations of Holland's theory. *Research in Higher Education, 47*, 801-822. http://dx.doi.org/10.1007/s11162-006-9016-5

Popham, W.J. (1990). *Modern educational measurement: A practitioners perspective,* (2nd ed. Pp.120-145). Englewood Cliffs, NJ:Prentice-Hall, Inc.

Prokop, P., Tuncer, G. & Chuda, J. (2007). Slovakian students' attitudes towards biology. *Eurasia Journal of Mathematics, Science and Technology Education*, **3(** 4), 287-295.

Puhan, G., & Hu, H. (2006). Motivation or cognition: What leads to performance differences in science? On-line. http://www.educ.ualberta.ca/educ/psych/crame. Retrieval date 21. 07. 2008.

Pullmann, H., & J. Allik. (2008). Relations of academic and general self-esteem to school achievement. *Personality and Individual Differences, 45*, 559-564. http://dx.doi.org/10.1016/j.paid.2008.06.017

Putnam, J., Rynders, J., Johnson, R., & Johnson, D. W. (1989). Collaborative skills instruction for promoting positive interactions between mentally handicapped and nonhandicapped children. *Exceptional Children, 55*, 550–557.

Ramsden, P. (1992). *Learning to Teach in Higher Education*. London: Routledge. Record, 91, 3, 409-21.

Renner, J.W. & Marek, E.A. (1990). An educational theory base for science teaching. *Journal of Research in Science Teaching*, 27, 241-246.

Republic of Kenya (2008). *The Kenya Vision 2030*, Nairobi: Government printers.

Robinson, P. (1993). *Freud and his critics* [Electronic version]. Berkeley: University of California Press. Retrieved from http://escholarship.cdlib.org/ucpress/robinson.xml

Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press.

Ryan, D.W. and Schmidt, M. (1979) *Mastery Learning: Theory, Research, and Implementation*. Toronto, Ontario: The Ontario Institute for Studies in Education.

Sapon-Shevin, M. and Schniedewind, N. (1990). Selling cooperative learning without selling it short. *Educational Leadership, 47* (4), 63-65.

Sherman, L. W. (1989). A Comparative Study of Cooperative and Competitive achievement in two secondary biology classrooms; the group investigation on model versus individually competitive structure. *Journal of research in science teaching, 26, 55-64.*

Shuel, T. J. (1993). Towards an integrated theory of teaching and learning. *Educational Psychology*, 28, (4), 291-311.

Shumba, O. (2003). Attitudes Towards science: an exploratory survey of pupils preparing for National Examination. *Zimbabwe Journal of Educational Research*, 5,(1), 62-85.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and belief. *Developmental Psychology*, 42, 70-83.

Skinner, B. (1968). *The technology of teaching*. New York: Appleton- Century- Crofts.

Solomon, J. (1986). Motivation for learning science. *The School Science Review,* 67 (240) 436-442.

Spaulding, C. L. (1992). *Motivation in the classroom*. The United States: McGraw-Hill.

Spink, K. (1990). Collective efficacy in the sort setting. *International Journal of Sport Psychology, 21*, 380–395.

Steinmayr, R., & Spinath, B. (2008). Sex differences in school achievement: what are the roles of personality and achievement motivation? *European Journal of Personality, 22*, 185–209. http://dx.doi.org/10.1002/per.676

Tella, A. (2007). The impact of motivation on students' academic achievement and learning outcomes in mathematics among secondary school students in Nigeria. *Eurasia Journal of Mathematics, Science and Technology Education. 3(2), 149 – 156.*

Thomas, D. (1957). Effects of facilitative role interdependence on group functioning. *Human Relations, 10*, 347–366.

Trowbridge, W.L, & Bybee, R.W. (2004). *Teaching Secondary School Science: Strategies for Developing Scientific Literacy*. New Jersey, Pearson Education, Inc.

Upadhyay. S., & Tiwari.A. (2009). Achievement Motivation across different academic majors. *Indian Journal of Social Science Researches, 6*(2), 128-132.

Vermeer, H. J., Boekaerts, M., & Seegers, G. (2000). Motivational and gender differences: Sixth-grade students' mathematical problem-solving behavior. *Journal of Educational Psychology*, *92*(2), 308-315. http://dx.doi.org/10.1037/0022-0663.92.2.308

Vygotsky, L.S. (1978). *Mind and Society, the Development of Higher Psychological Process*. Havard University Press.

Wachanga S. W. (2002). *Effect of co-operative class experiments teaching method on secondary school students motivation and achievement in Kenya*. Unpublished PhD Thesis, Egerton University.

Wachanga, S. W. (2005). *Chemistry Education*. Njoro: Egerton University Material Centre & Lectern Publication Ltd.

Wachanga, S.W., & Gamba, P.P (2004). Effects of mastery learning approach on secondary school students' achievement in Chemistry in Nakuru District Kenya: *Egerton Journal. Humanities Social Sciences and Education,* 5(2), 221-235

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

Wambugu P. (2006). *Effects of mastery learning approach on secondary school students achievement, motivation and self-concept in Physics in Kieni East Division of Nyeri District, Kenya*. Unpublished MEd Thesis, Egerton University.

Webb, N. M. (2008). Learning in small groups. In T. L. Good (Ed.), *21st Century Education: A Reference Handbook* (pp. 203-211). Los Angeles: Sage.

Weiner, B. (1986). *An attributional theory of motivation and emotion.* New York: Springer-Verlag.

Wentling F. (1973). Mastery versus Non-Mastery Instruction with Varying Test item, Feedback items. *Journal of Educational Psychology,* 65(1), 50-58.

Wentzel, K. (1994). Relations of social goal pursuit to social acceptance, classroom behavior, and perceived social support. *Journal of Educational Psychology, 86*, 173–182.

Wiersma, W, & Jurs, S. G. (2005). *Research methods in education*: An introduction 8th Edition. Boston: Pearson Publications.

Wigfield, A., & Eccles, J. S. (2002). *Development of achievement motivation*. San Diego, CA: Academic Press.

Woollfolk, A. (2004). *Educational psychology*. Boston, MA: Allyn & Bacon.

Yager, S., Johnson, R., Johnson, D. W., & Snider, B. (1986). The impact of group processing on achievement in cooperative learning groups *Journal of Social Psychology, 126*, 389–397.

Zechmesh, E. & Shaughnessy, J.J. (1994). *A practical Introduction to Research Methods in Psychology* (2nd Ed.) New York; NY:McGraw. Hill, Inc.

APPENDICES

APPENDIX A: STUDENT MOTIVATION QUESTIONNAIRE (SMQ)

Instructions

1. The questionnaire contains a large number of statements. It is NOT A TEST. The purpose of this questionnaire is to find out what you think about chemistry as a subject. Please indicate what you think about each of them. The information obtained will be used for research, which aims at improving the learning of chemistry in schools. Only the researcher will have an access to the information about your responses.
2. THERE ARE NO RIGHT OR WRONG ANSWERS to the questions. What is required is your PERSONAL FEELINGS OR OPINIONS ON EACH STATEMENT OR QUESTION. Please answer ALL questions as sincerely as possible.
3. NO NAMES ARE REQUIRED.
4. Read the items carefully and try to understand before choosing what truly agrees with your thought
5. Use a pencil to circle the letter(s) that corresponds to your feelings towards the chemistry course. Circle only one of the choices. If you change your opinion on any statement or question, clearly erase the response before making the necessary adjustments.

SECTION I

DEMOGRAPHIC DATA

1. Sex. Male ☐ Female ☐

2. Age (years) ☐

3. K.C.P.E Total Marks ☐

SECTION II

PERSONAL OPINION ON THE LEARNING OF CHEMISTRY

For the following section, please indicate the extent to which you agree with the statement in each of the following questions. Indicate whether you Strongly Agree, Agree, Uncertain, Disagree or Strongly Disagree by CIRCLING the letters that best describe your level of agreement.

For example: Learning chemistry is:

Fun SD D U (A) SA

KEY

SD = STRONGLY DISAGREE. **D** = DISAGREE **U** =UNDECIDED **A** = AGREE and **SA** =STRONGLY AGREE

4.	I do not feel nervous at all in leaning chemistry	SD	D	U	A	SA
5.	Learning chemistry in class is frustrating	SD	D	U	A	SA
6.	I feel that it is my choice to learn chemistry	SD	D	U	A	SA
7.	I think I am pretty good in chemistry	SD	D	U	A	SA
8.	I feel tense while learning chemistry	SD	D	U	A	SA
9.	I think I do pretty well in chemistry activities compared to other students	SD	D	U	A	SA
10.	Doing chemistry tasks is fun	SD	D	U	A	SA
11.	I feel relaxed while learning chemistry	SD	D	U	A	SA
12.	I enjoy learning chemistry	SD	D	U	A	SA
13.	I don't really have a choice in learning chemistry	SD	D	U	A	SA
14	I am satisfied with my performance in chemistry tasks	SD	D	U	A	SA
15.	I am anxious while learning chemistry	SD	D	U	A	SA
16.	I think learning chemistry is very boring	SD	D	U	A	SA
17.	The hours I spend learning chemistry are the ones I enjoy most	SD	D	U	A	SA
18.	I feel I am doing what I want to do while I am learning chemistry	SD	D	U	A	SA
19.	I feel pretty skilled in chemistry activities	SD	D	U	A	SA
20.	I find learning chemistry to be very interesting	SD	D	U	A	SA
21.	I feel pressured while learning chemistry	SD	D	U	A	SA
22.	I always look forward to chemistry lessons	SD	D	U	A	SA

23.	I feel like I have to learn chemistry	SD	D	U	A	SA
24.	I can describe chemistry lessons as very enjoyable	SD	D	U	A	SA
25.	I believe I have a choice in learning chemistry	SD	D	U	A	SA
26.	Having learnt chemistry for a while, I feel pretty competent	SD	D	U	A	SA

APPENDIX B: CHEMISTRY ACHIEVEMENT TEST (CAT)

NAME..ADM NO.................CLASS.................

SCHOOL...

Instructions

Attempt all the questions in the spaces provided

1. Name the particles that are responsible for electrical conductivity in:

   a) Solids (1mk)

   ....

   b) Molten substances (1mk)

   ....

   c) Aqueous solutions (1mk)

   ....

2. Give two properties of graphite that make it suitable for use as an electrode

   ....

   ....

   (2mks)

3. Define the following terms

   a) Conductor (1mk)

   ....

   ....

   b) Electrode (1mk)

   ....

   ....

4. Differentiate the following terms

   a) Electrolyte and non-electrolyte (2mks)

   ....

   ....

   ....

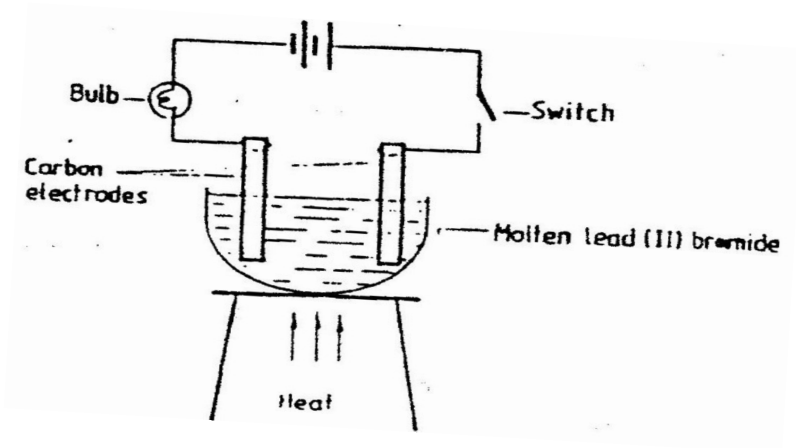
   b) Cathode and anode (2mks)

   ....

   ....

   ....

5. Study the set-up below and answer the question that follows.



a) Identify the electrodes labelled A and B (2mks)

A………………………………

B………………………………..

b) Explain why solid lead (II) bromide does not allow the passage of electricity?

....

....

(2mks)

c) State the observations that would be made when the circuit is completed. (2mks)

....

....

....

d) Write equations to show the reactions taking place:

(i) At the cathode (1mk)

....

(ii) At the anode (1mk)

…………………………………………………………………

e) Why is it necessary to carry out the experiment in a fume chamber (2mks)

……………………………………………………………………………………

……………………………………………………………………………….......................

f) Lead (II) bromide is a binary electrolyte.

(i) Define the term 'binary electrolyte' (1mk)

……………………………………………………………………………

…………………………………………………………………….....................

(ii) Give two other examples of binary electrolytes (2mks)

…………………………………………………………………………………
…………………………………………………………………………......................

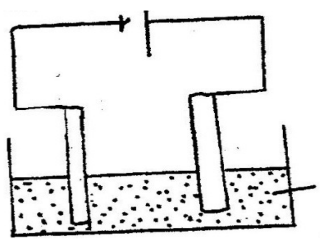
6. Aluminium metal is a better conductor than magnesium. Explain. (2mks)

……………………………………………………………………………………….
……………………………………………………………………………………...
……………………………………………………………………………………
……………………………………………………………………………………

7. One of the applications of electrolysis is electroplating of metals such as iron, state any other two applications of electrolysis. (2mks)

…………………………………………………………………………………………….
…………………………………………………………………………………………….
…………………………………………………………………………………………….
…………………………………………………………………………………………….

8. The set – up below was used to (*electrolyse molten lead (II) iodide).*



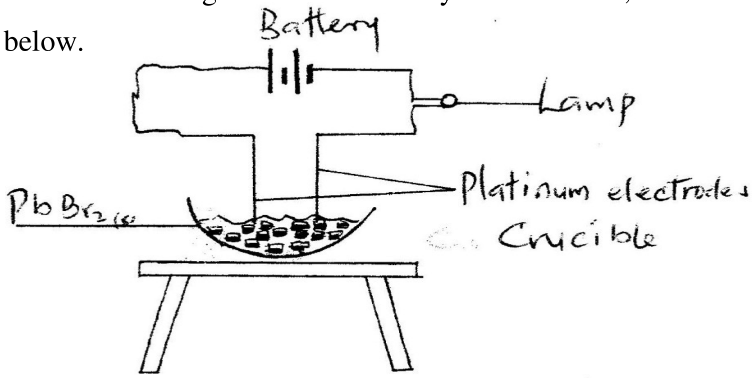
i) State the observation that was made at the anode during the electrolysis. (2mks)

……………………………………………………………………………………………..
…………………………………………………………………………………………….
…………………………………………………………………………………………….

ii) Give a reason for your answer. (2mks)

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
……………………………………………………………………………………………….

9. In an experiment to investigate the conductivity of substances, a student used the set – up shown below.



The Student noted that the bulb did not light

(a) What had been omitted in the set- up?

……………... ………………………………………… (1mk)

(b) Explain why the bulb lights when the omission is corrected

……………………………………………………………………………….

……………………………………………………………………………....(2mks)

10. a) What is an electrolyte?

……………………………………………………………………………………… (1mk)

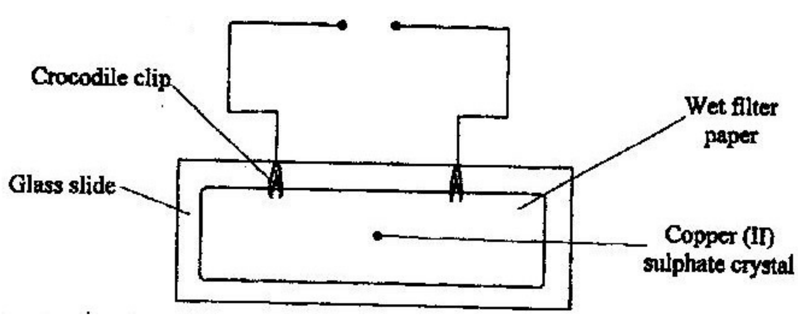
……………………………………………………………………………………….

b) Name the particles responsible for conduction of electricity in the following substances.

i) Molten calcium chloride ………………… (1mk)

ii) Graphite. ………………………. (1mk)

11. The diagram below represents an experiment that was set up to investigate movement of ions during electrolysis.



When the circuit was completed, it was noticed that a blue colour spread towards the right.

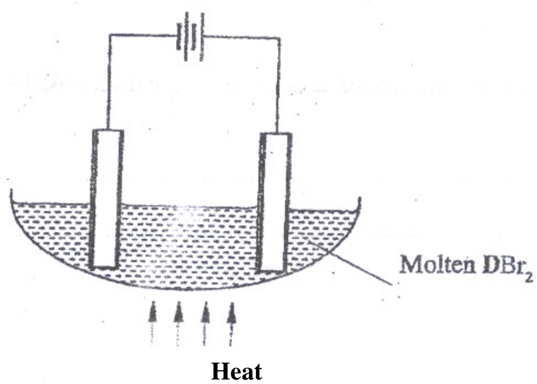
a) Explain this observation (2mks)

b) Explain the reaction that occurred at the anode. (1mk)

…………………………………………………………………………………

…………………………………………………………………………………

12. The set-up below was used to electrolyse a bromide of metal D, DBr_2.



i) Identify the ions that migrated to the:

I cathode …... (1mk)

II anode ……………………………………………. (1mk)

ii) The electrodes used in the experiment were made of carbon and metal D.

Which of the two electrodes was used as the anode? Give a reason. (2mks)

……………………………………………………………………………..

……………………………………………………………………………..

……………………………………………………………………………..

13. Name the particles responsible for the electrical conductivity of:

(a) Graphite. (1mk)

…………………………………………………………………………

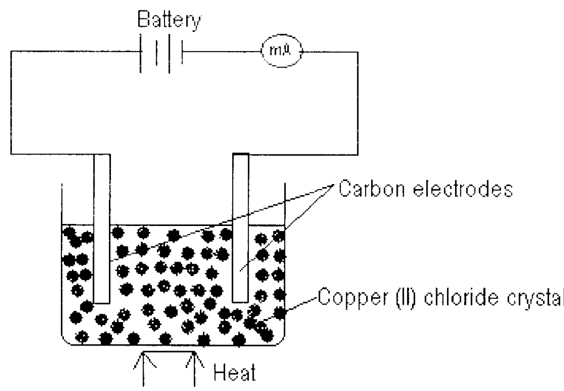
…………………………………………………………………………

(b) Magnesium Sulphate solution (1mk)

…………………………………………………………………………

…………………………………………………………………………

14. The diagram below shows copper (II) chloride crystals being heated until all has melted.



(a) State what was observed in the ammeter

(i) At the beginning. (1mk)

……………………………………………………………………………………………

……………………………………………………………………………………………

(ii) As copper (II) chloride was melted (1mk)

……………………………………………………………………………………………

……………………………………………………………………………………………

(b) Explain your answer in (a) (ii) above. (2mks)

……………………………………………………………………………………………

……………………………………………………………………………………………

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……………………………………………………………………………………………

APPENDIX C: CHEMISTRY TEACHERS' MANUAL

Teachers guide to planning and implementing CMLA

Introduction

This guide is intended to assist the chemistry teachers to plan and implement a teaching-learning program based CMLA Model in which the students will be taught in small groups of mixed ability. The instructional materials to be used in the study will be based on the K.I.E approved syllabus (KNEC, 2002). This manual will be used throughout the treatment period.

The subject matter to be learned will be divided into small units. Instructional objectives will be developed for each unit and at the end of the unit the learners will be tested to determine if they have acquired a pre-determined mastery level. However, those who will not have acquired the desired competence will be provided with extra tuition until they perform at or above the desired level.

The guide will be organised into the following sections:

1.0 Essentials of effective teaching

The key to effective teaching is adequate planning. In order to achieve the desired objectives in the learning of chemistry, chemistry teachers should bear in mind that it is their role to define where learners should be at the end of the teaching-learning process, prepare and organise the subject matter. The chemistry teacher should also select and organise the resources that will be used for learning. This includes grouping students and ensuring that each group member has a role to play, construction of worksheets for practical lessons, making check lists of apparatus and chemicals needed for experiments and ensuring that the learning environment has been organised well in advance before the lesson starts.

2.0 Instructional objectives

Instructional objectives are statements that describe what students will be able to do after completing a prescribed unit of instruction. They can be defined as the end result of learning stated in terms of changes in the learners' behaviour. Instructional objectives should be stated in terms of learning outcomes because we are concerned with the products of learning rather than with the process of learning. The objectives should be stated in terms of terminal behaviour of the learner. The terminal behaviour should be measurable, that is objectives should be stated in measurable terms, Wachanga, (2005).

Elements of a well stated instructional objective

A well stated instructional objective should have the following features:

Participant- this specifies the target individual for whom the objective is intended

Behaviour- this specifies the behaviour that will be accepted as indicating that the student has met the objective

Product object- this specifies the content, concepts, skills, attitudes or other learning outcomes which is the focus of the objective and instruction

Condition- this specifies the conditions under which the behaviour will occur

Measurement criterion- the objectives should be stated in measurable terms.

Importance of stating Instructional objectives:

- Instructional objectives are of immense significance in today's education process. They provide organizers of the process with the opportunity to delve into learners mind and know where they are heading.
- Instructional objectives provide teachers the opportunity to design proper assessment procedure through tests and evaluation.
- Students know what they are supposed to do, use before or after a particular class.
- Instructional objectives also help trace the amount of change that has been brought about in a student.
- It gives a definite direction to the whole teaching-learning and evaluation process of a particular class in classroom situations.
- It also helps both the teacher as well as students in determining particular educational goals and enables them to focus their attention on specific learning activities to achieve those goals.
- Through instructional objectives – the organizers of educational process can determine the resources, course materials, curricular and co-curricular activities, relevant contents and references etc. which are so vital to make the process functional.
- Instructional objectives also lead the teacher into discovering the best learning situations, strength and weaknesses of the prevalent learning process, level of growth and development of learners through a pre-determined evaluation process.

- Instructional objectives help in monitoring and evaluating the whole educational process in minute details.

By the end of the lesson, the learner should be able to:

- Distinguish between conductors and non-conductors
- Distinguish between an electrolyte and non –electrolyte
- Define the term electrolysis.
- Explain electrolytes and non electrolytes in terms of the particles they contain.
- State the products of electrolysis of lead (II) bromide
- Write equations for the reactions at electrodes State the products formed at the anode and cathode during electrolysis of copper(II)chloride
- Write equations for the reactions at the electrodes
- State and explain some applications of electrolysis

3.0 The theory of CMLA

Cooperative Mastery Learning Approach (CMLA) is an instructional method, where students in small groups of mixed ability are allowed unlimited opportunities to demonstrate mastery of content taught. It involves breaking down the subject matter to be learned into units of learning, each with its own objectives. The strategy allows students to study material unit after unit until they master it (Dembo, 1994). Mastery of each unit is shown when the student acquires the set pass mark of a diagnostic test. The approach helps the student to acquire prerequisite skills to move to the next unit. The teacher also is required to do task analysis and state the objectives before designating the activities. It can also help the teacher to know students area of weakness and correct it thus breaking the cycle of failure.

When using CMLA, Students who do not achieve mastery receive remediation through tutoring, peer monitoring, small group discussions, or additional assignments (Aggarwal, 2004). Additional time for learning is prescribed for those requiring remediation. Students continue with the cycle of studying and testing until mastery is met. Block (1981) states that students with minimal prior knowledge of material have higher achievement through mastery learning than with traditional methods of instruction.

The goal of cooperative mastery learning approaches is to have all students learn instructional material at roughly equivalent, high levels. Instructors who use cooperative mastery learning break down course material into manageable units and create formative tests for students to take on each of the units. In their review of mastery learning programs, Kulik, Kulik, and Bangert-Drowns (1990) cite Bloom's (1976) formulation as the classic approach. In Bloom's model, students receive individualized instruction as necessary so that they all master course material. The basic approach reduces variation in final student performance through instruction suited to all students' needs.

This combination of strategies is a good example of attacking Bloom's (1987) two-sigma problem by integrating principles that focus on different aspects of learning. Through this process of formative classroom assessment, combined with the systematic correction of individual learning difficulties, Bloom believed all students could be provided with a more appropriate quality of instruction than is possible under more conventional approaches to teaching. As a result, nearly all might be expected to learn well and truly master the unit concepts or learning goals (Bloom, 1976). This, in turn, would drastically reduce the variation in students' achievement levels, eliminate achievement gaps, and yield a distribution of achievement.

3.0.1 Distribution of Achievement in Cooperative Mastery Learning Classrooms

In describing Cooperative Mastery Learning, however, Bloom emphasized that reducing variation in students' achievement does not imply making all students the same. Even under these more favourable learning conditions, some students undoubtedly will learn more than others, especially those involved in enrichment activities. But by recognizing relevant, individual differences among students and then altering instruction to better meet their diverse learning needs, Bloom believed the variation among students in terms of how well they learn specific concepts or master a set of articulated learning goals could eventually reach a "vanishing point" (Bloom, 1971). As a result, gaps in the achievement of different groups of students would be closed.

3.0.2 Essential Elements of Cooperative Mastery Learning

After Benjamin Bloom presented his ideas on mastery learning, others described procedures for implementation and numerous programs based on mastery learning principles sprung up in schools and colleges throughout the United States and around the world (e.g., Block, 1971, 1974; Block & Anderson, 1975). While these programs differed from setting to setting, those true to Bloom's ideas included two essential elements:

(1) The feedback, corrective, and enrichment process; and

(2) Instructional alignment (Guskey, 1986).

While feedback, correctives, and enrichment are extremely important, they alone do not constitute Cooperative Mastery Learning. To be truly effective, Bloom stressed they must be combined with the second essential element of mastery learning: instructional alignment. Reducing variation in student learning and closing achievement gaps requires clarity and consistency among all instructional components.

The teaching and learning process is generally perceived to have three major components. To begin there must be some idea about what we want students to learn and be able to do; that is, learning goals or standards. This is followed by instruction that, hopefully, results in competent learners – students who have learned well and whose competence can be assessed through some form of assessment or evaluation. Cooperative Mastery Learning adds the feedback and corrective component, allowing teachers to determine for whom their initial instruction was appropriate and for whom learning alternatives may be needed.

3.0.3 Goals of Cooperative Mastery Learning

The goal of Cooperative Mastery Learning approaches is to have all students learn and create formative tests for students to take on each of the units. In their review of mastery learning programs, Kulik, Kulik, and Bangert-Drowns (1990) cite Bloom's (1976) formulation as the classic approach. In Bloom's model, students receive individualized instruction as necessary so that they all master course material. The basic approach reduces variation in final student performance through instruction suited to all students' needs.

4.0 Testing and CMLA

Bloom found that students do attempt to work on their difficulties if they are given specific suggestions of what to do. The best procedure identified was to have small groups of students (two or three) meet regularly for up to an hour each week to review the results of formative tests and to help each other overcome difficulties. This in turn results in a hybrid of cooperative and mastery learning approaches hence the CMLA.

Ryan and Schmidt (1979) identified the most successful corrective strategies as being those which include objectives plus a problem testing the objectives of the previous lesson, discussion of the problem, specific prescriptions for using the text, class notes and handouts, and alternative resources, such as texts, workbooks, games and kits. When correctives consisted of objectives or problems only their effectiveness was considerably diminished.

Instructors using the CMLA should prepare multiple forms of tests that measure student progress and provide feedback. The periodic tests given during the instruction process helps in monitoring students learning progress and to provide ongoing feedback to students and the teachers. Such tests provide reinforcement of successful learning and reveals learning weaknesses in need of correction. The test is designed such that corrective prescription can be given for missed test items. Students are also expected to finish assignments at their own pace. This principle stems from the recognition that students have many other obligations and learn at different rates. Finally, students must demonstrate mastery on formative tests or correct deficiencies before they move on in their work.

For this study on CMLA feedback on the effect of the treatment will be obtained by using two key instruments; the Student Motivation Questionnaire (SMQ) and Chemistry Achievement Test (CAT) were used in all the schools selected. The test is uniform for all the schools whether experimental or control and should be done at the same time and therefore give results that are reliable for comparison of treatment versus non-treatment.

5.0 Guide on Effect of Electric Current on Substances

In this study, the topic: Effect of Electric Current on Substances will be covered. With reference to the CMLA which recommends that the content should be divided into small units of study, the topic will be subdivided basing on the sub-topics as follows:

g) Introduction
h) electrical conductivity in solids
i) electrical conductivity in molten substances
j) electrical conductivity of substances in aqueous state
k) electrolysis
l) application of electrolysis

Each of these units will have its own objective and will be clearly stated in the scheme of work (Appendix E). Sample questions will be given to the learners after every unit in the form of assignments. This will assist learners in carrying out a self-check assessment on whether they have understood the concepts covered in the topic or sub-topic. Moreover, it will give learners an overview of the test items they are likely to find in the formative tests to be given as well as the summative test to be administered at the end of the topic. Four formative tests will be administered on a weekly basis namely; Quiz 1, 2, 3 and 4 covering each of the small units covered per week. The results of the scores by the chemistry students in these formative tests will guide the teacher in planning for remedial lessons for those who do not attain the required pass mark.

6.0 Chemistry Students' Worksheets

6.0.1 Introduction

Chemistry students are expected to carry out class experiments on the topic; Effect of Electric Current on Substances, make and record observation accurately and be able to make relevant and correct conclusions based on these observations while working together in small groups of mixed ability.

The subject matter to be learned will be divided into small units. During lessons each and every student is expected to participate actively in carrying out experiments and any other activity assigned by the teacher. Instructional objectives will be developed for each unit and at the end of the unit the learners will be tested to determine if they have acquired a pre-determined mastery level. However, those who will not have acquired the desired competency will be provided with extra tuition until they can perform at or above the desired level.

It is important for every chemistry student to understand that learning together in groups creates promotive interaction. This occurs as students encourage and facilitate one another's efforts to reach the groups goals. Group members promote one another's success by:

i) giving and receiving help and assistance
ii) exchanging resources and information
iii) giving and receiving feedback on teamwork behaviours
iv) challenging one another's reasoning

v) advocating increased efforts to achieve

vi) mutually influencing one another's reasoning and behaviour

vii) engaging in the interpersonal and small group skills needed for effective teamwork

viii) processing how effectively group members are working together and how the groups effectiveness can be continuously improved

6.0.2 Chemistry Worksheets

A worksheet is a systematic outline of instructions that guide students when carrying out class experiments. Worksheets must have the following:

i) an introduction including the basic principles in that piece of work to be done

ii) main body which has the experimental procedure and the method of recording results e.g. use of tables

iii) statement of safety precautions

iv) Summary statement which includes the conclusion to the experiments. This summary links the practical to its applications in life.

In this topic to be covered the following worksheets will be used

WORKSHEET 1

EXPERIMENT 1

NAME...ADM NO.............CLASS..........

GROUP NAME/NO..........................

TOPIC: EFFECT OF ELECTRIC CURRENT ON SUBSTANCES

SUB-TOPIC: Electrical Conductivity of Solids

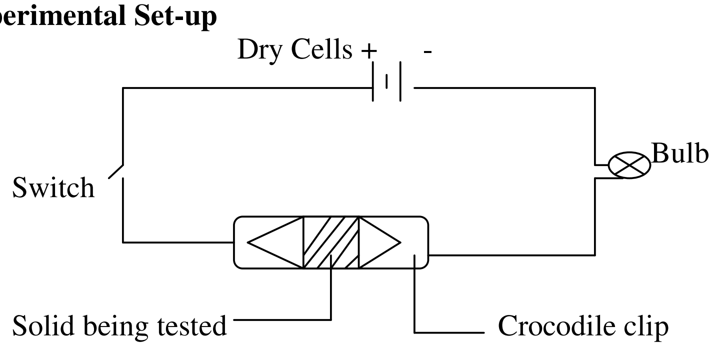
Experiment
Aim: To find out whether all types of solids conduct an electric current

Apparatus and materials

- Switch
- Connecting wires
- Crocodile clips
- Dry cells
- Solids under test

Procedure
Set up the apparatus as shown in the figure below. Connect a piece of aluminium strip to the circuit using crocodile clips. Close the switch and record your observations.

Experimental Set-up



Repeat the experiment using the following solids instead of aluminium: magnesium, zinc, graphite, wood, sugar, sulphur, sodium chloride, lead (II) bromide, lead (II) iodide and urea. Record your observations as shown in the table below

Name of substance	Type of substance	Observation
Aluminium		
Magnesium		
Zinc		
Graphite		
Wood		
Sugar		

Sulphur		
Sodium chloride		
Lead (II) bromide		
Lead (II) iodide		
Urea		

Sample Questions/ Assignments-QUIZ 1

1. What is the purpose of the bulb in this experiment

2. Name the substances used in this experiment which:
   (i) conduct an electric current

   (ii) do not conduct an electric current

3. What type of substances:
   (i) conduct an electric current

   (ii) do not conduct an electric current

4. Suggest a reason for the electrical conductivity in the substances that conduct

WORKSHEET 2

EXPERIMENT 2

NAME..ADM NO.............CLASS..........

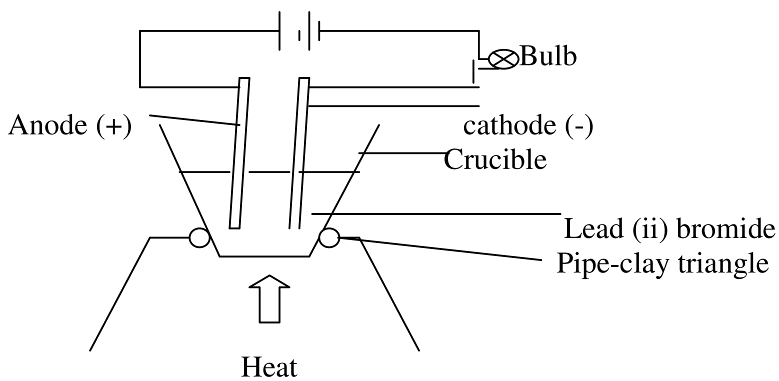
GROUP NAME/NO..........................

TOPIC: EFFECT OF ELECTRIC CURRENT ON SUBSTANCES

SUB-TOPIC: Electrical Conductivity of molten substances

Experiment
Aim: To find out the type of substances which conduct electric current when in molten state.

Procedure
CAUTION: This experiment must be done in a fume cupboard.
Set up the apparatus as shown in the figure below.



Fill the crucible up to a third with lead (II) bromide. Ensure that graphite rods do not come close to each other. Close the switch and heat the lead (II) bromide until it melts. Record your observations

Substance	Type of structure	Observation
Lead (II) iodide		
Sugar		
Sulphur		
Wax		

Sample Questions/ assignments-QUIZ 2

1. Name the substances in this experiment which do not conduct electricity when in solid state but conduct when in molten state

2. Explain why it is necessary to ensure that graphite rods are prevented from coming into contact

3. Give an explanation can on those substances which do not conduct whether in solid or molten state.

WORKSHEET 3

EXPERIMENT 3

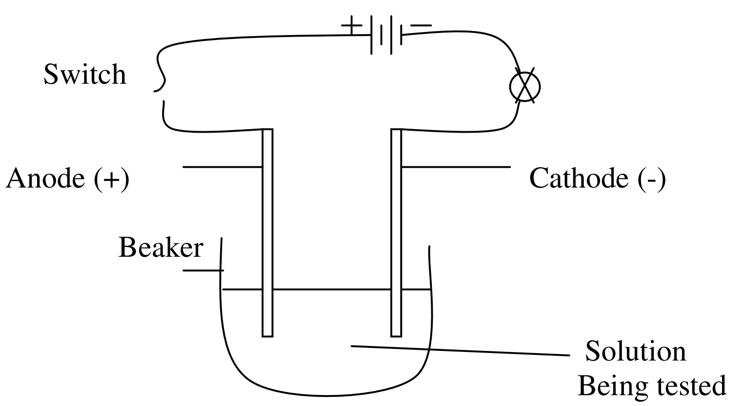
NAME..ADM NO.............CLASS..........

GROUP NAME/NO..........................

TOPIC: EFFECT OF ELECTRIC CURRENT ON SUBSTANCES

SUB-TOPIC: Electrical Conductivity of Substances in aqueous solution

Half fill a 100ml beaker with distilled water. Add a spatulaful of sodium chloride crystals. Stir with a clean glass rod to dissolve the Sodium chloride completely. Using graphite electrodes set-up a circuit as shown below



Close the switch and record your observations. Discard the solution and rinse both electrodes and the beaker. Repeat the experiment using solutions of the following substances; Copper (II) chloride, Copper (II) sulphate, Hydrochloric acid, Sulphuric acid, Sodium hydroxide, Ammonia, Urea and Sugar. Record your observations as shown in the table below.

Substance	Type of structure	Observation
Sodium chloride		
Copper (II) chloride		
Copper (II) sulphate		
Hydrochloric acid		
Sulphuric acid		
Sodium hydroxide		
Ammonia		
Urea		
Sugar		

Sample Questions/ Assignments-QUIZ 3

1. Name the substances in the experiment which do not conduct electricity in the solid state but conduct when dissolved in water

2. What do those do substances which conduct electricity when dissolved in water have in common?

3. Which substances do not conduct electricity either in solid state or when dissolved in water?

WORKSHEET 4

EXPERIMENT 4

NAME..ADM NO.............CLASS...........

GROUP NAME/NO..........................

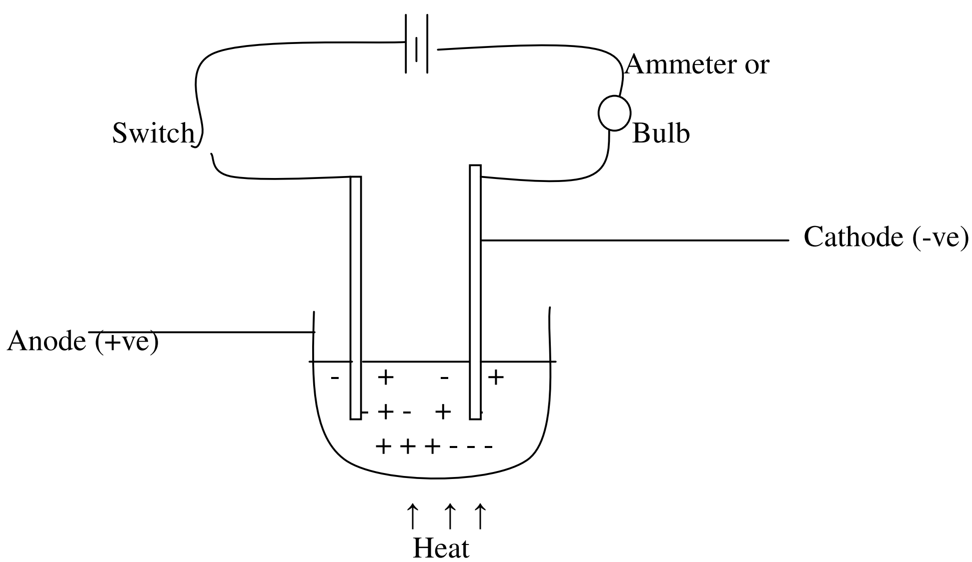
TOPIC: EFFECT OF ELECTRIC CURRENT ON SUBSTANCES

SUB-TOPIC: Electrolysis

Experiment
Aim: To find out what products are formed when an electric current is passed through molten lead (II) bromide

CAUTION
This experiment should be carried out in a fume chamber or open air

Fill a crucible up to a third with lead (II) bromide. Set-up the apparatus as shown in the figure below



Close the switch and heat the lead (II) bromide until it melts. Record your observations as shown in the table below.

OBSERVATIONS	
At the Anode	At the Cathode

Sample Questions/ Assignments-QUIZ 4

1. What is observed at each electrode when molten lead (II) bromide is electrolysed?

2. Explain the observations recorded in 1 above using relevant ionic equations.

APPENDIX D: SCHEME OF WORK

APPENDIX E: RELIABILITY ANALYSIS ON THE 23 MTC ITEMS

	Scale mean If item deleted	Scale Variance if item deleted	Corrected Item-Total Correlation	Cronbach's Alpha if item deleted
I do not feel nervous at all in leaning chemistry	79.9608	120.0384	.5135	.8026
Learning chemistry in class is frustrating	79.6275	130.8384	.1083	.8196
I feel that it is my choice to learn chemistry	79.6078	121.9231	.5413	.8030
I think I am pretty good in chemistry	80.2549	118.8337	.4467	.8054
I feel tense while learning chemistry	80.5294	124.8941	.2652	.8150
I think I do pretty well in chemistry activities compared to other students	80.6471	115.3129	.5660	.7983
Doing chemistry tasks is fun	80.7255	125.1631	.2394	.8167
I feel relaxed while learning chemistry	81.9020	140.7302	-.2875	.8396
I enjoy learning chemistry	79.7647	116.2235	.7091	.7937
I don't really have a choice in learning chemistry	79.9216	119.3937	.4391	.8058
I am satisfied with my performance in chemistry tasks	82.2157	123.5725	.3945	.8084
I am anxious while learning chemistry	82.0588	143.1765	-.4208	.8403
I think learning chemistry is very boring	79.5490	121.1325	.4923	.8039
The hours I spend learning chemistry are the ones I enjoy most	80.3725	111.1984	.7440	.7880
I feel I am doing what I want to do while I am learning chemistry	80.3529	126.7929	.2070	.8176
I feel pretty skilled in chemistry activities	80.3725	119.3584	.5529	.8009
I find learning chemistry to be very interesting	79.7843	120.0925	.6648	.7987
I feel pressured while learning chemistry	80.3529	126.3529	.2474	.8151
I always look forward to chemistry lessons	80.0000	123.2800	.5015	.8050
I feel like I have to learn chemistry	79.7647	128.5435	.2348	.8148
I can describe chemistry lessons as very enjoyable	79.8627	117.0408	.6794	.7953
I believe I have a choice in learning chemistry	79.7843	127.3725	.3427	.8112
Having learnt chemistry for a while, I feel pretty competent	80.5882	122.9271	.3690	.8095

N of Cases = 51.0 N of Items = 23 Alpha = .8165

APPENDIX F: RESEARCH PERMIT