EFFECTS OF COMPUTER SUPPORTED COOPERATIVE LEARNING ON SECONDARY SCHOOL STUDENTS ACHIEVEMENT AND ATTITUDES IN CHEMISTRY IN NAKURU NORTH DISTRICT, KENYA

By

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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

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DECLARATION AND RECOMMENDATION

Declaration

This MEd thesis is my original work and has not been presented before for any award in any university.

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Mary K. Nyaema — Date

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Recommendation

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

Sign _____ 24th October, 2008

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2009/79068

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Mary Kemunto Nyaema

DEDICATION

I would like to dedicate this thesis to my father, Joel D. Nyaema, my mother, Salome B. Nyaema and to my daughter, Bosibori.

ACKNOWLEDGEMENTS

I would like to express my gratitude for the assistance which I received in conducting this study. First, I would like to thank my supervisors, Prof. Samuel W.Wachanga and Dr. Edward Tanui for patiently monitoring my progress.They corrected my work and gave me useful advice on how best I could write my thesis. Secondly, I would like to thank Sister Magdalene Muinde, the Principal of Bahati Girls' Secondary School for giving me time off to work on my thesis as well as availing her students and staff whenever I needed help. Thirdly, I would like to thank Mrs Maina, Head of Science Department at Nakuru High School for her cooperation when carrying out my piloting. Fourthly, I would like to thank the teachers who were readily available and kind enough to work with me as I proceeded to collect my data at the selected sample schools. These are: Mr Njunge, a Chemistry teacher at Menengai High school; Mr. Ayaya, a computer teacher at the same school; Mr. Ndirangu, the Deputy Principal at Nakuru Day Secondary School, Mr. Waiharo, a chemistry teacher at the same school. I would also like to thank Ms. Kezia Mwanzi, an editor at Nation Media Group for her assistance in proof-reading my thesis.Last but not least, I am most grateful for the heads, staff and students of all the schools I visited. They allowed me to examine their school records and took valuable time out of their busy schedules to assist me.

ABSTRACT

Chemistry education is the acquisition of knowledge and skills about substances. In secondary schools, students are taught topics that include the study of salts and electrolysis. However, secondary school students, performance in chemistry in the past four decades in Kenya has been below the grade B- which means that they cannot be admitted into most university courses. Such poor performance has not been explained. Computer Supported Cooperative Learning (CSCL), which has proved successful in teaching of difficult topics in physics, accounting and biology, may be a solution. The purpose of this study was to determine the effects of CSCL on students' achievement and attitudes towards Chemistry. CSCL combined Cooperative Class Experiment (CCE) method and Computer Assisted Learning (CAL). Quasi- experimental research design was used because the experimental and control groups existed as intact classes. The population of study was all Form One students in Nakuru North District consisting of 159 schools. Purposive sampling was used to obtain a sample size of 81 students to participate in the study. Nakuru North District was chosen because it had adequate catchment area for schools possessing IBM-compatible computers needed for the study. The chemistry topic on 'Acids, Bases and Indicators' was taught to all students using CSCL method in the experimental group and regular teaching methods in the control group. The instruments used for data collection were the Chemistry Achievement Test (CHAT) and the Student Attitude Questionnaire (SAQ). Pilot testing was done in one other school not involved in the study to ascertain the reliability and validity of the instruments. A reliability index of 0.81 and 0.74 were obtained for the CHAT and SAQ respectively. Data were analysed using ANCOVA and t-test at a confidence level of α=0.05. The results show that CSCL teaching method does not improve student achievement better than regular methods. However, the method results in better students' attitudes towards Chemistry than regular teaching methods. Boys and girls taught through CSCL have similar achievement and attitudes towards Chemistry. This implies that the method may be appropriate for improving the attitudes of both boys and girls. It is therefore recommended that the teaching method be incorporated in all in-service programmes for teachers especially those organised by the Ministry of Education. Teacher training institutions should also incorporate this method in their training programmes.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANCOVA- Analysis of Covariance

CCE- Cooperative Class Experiment

CAL- Computer Assisted Learning

CHAT- Chemistry Achievement Test

CHEMLAB- Chemistry Laboratory

CSCL- Computer Supported Cooperative Learning

D.E.O- District Educational Officer

E.A.C.E- East African Certificate of Education

K.C.E- Kenya Certificate of Education

K.C.S.E- Kenya Certificate of Secondary Education

K.I.E- Kenya Institute of Education

K.N.E.C- Kenya National Examination Council

K.C.S.E- Kenya Certificate of Secondary Education

M.O.E- Ministry of Education

Pre-lab-Preliminary laboratory

SAQ- Student Attitude Questionnaire

SMASSE- Strengthening of Mathematics and Sciences in Secondary Schools

SSP-School Science Project

STAD- Student Teams-Achievement Division

UNESCO-United Nations Educational and Scientific and Cultural Organization

CHAPTER ONE
INTRODUCTION

1.1 Background Information

Chemistry has introduced many changes in the society on the best ways of coping with the needs of human life like industrial production, food preservation, synthetic detergents and drugs that uplift human standards both in Kenya and in the world (Paoloni, 1992). Chemistry grew from the principle of alchemy, a medieval chemical philosophy having as its asserted claims the transmutation of base metals into gold, the discovery of the panacea, and the preparation of the elixir of longevity (The American Heritage Dictionary of the English Language, 2000). The elixir of longevity was a chemical concoction that would enable people to live longer and cure all ailments (Columbia University, 2007). Hartmann (2006) considers it a grave mistake to confuse alchemy with Chemistry. He describes modern Chemistry as an artificial science that deals only with the external forms in which the elements of matter are manifesting themselves.

At the beginning of the independence era, Kenya faced shortage of manpower in science related areas among others. (Bogonko, 1992). There was scarcity of personnel such as engineers, doctors, surveyors, agronomists, technicians, scientists and architects. In 1966, the Kenya Government lamented that shortages of skilled manpower threatened to delay its efforts to modernise and expand the economy. Consequently, science and technology were to be more emphasized than the arts and social sciences (Bogonko, 1992). Wachanga (2002) outlines the history of the Kenya Chemistry curriculum from 1963 up to its current situation. He notes that the secondary education chemistry curriculum, which was developed soon after independence was inappropriate because it was teacher and book centred. It neglected the abilities, interests and potentials of students. By the early 1970's, scholars were already urging changes into the school curriculum. The method of instruction needed to move away from 'mechanical absorption of information' towards greater learning by doing and problem solving (Makau, 1988).

In the mid 1970's, a committee set up by the government to chart new directions in education recommended that schools should develop the ' intellectual, spiritual and physical potential' of the country's human resources for the purposes of raising the overall productivity and quality of life to include the teaching of pre-vocational craft- oriented skills (Wachanga, 2002). The Gachathi Report of 1976 and Mackay Report of 1981 recommended the emphasis of science, technology and mathematics more than the arts and social sciences (Bogonko,1992). In 1985, the Kenyan Government started implementing the 8-4-4 system of education which also aimed at enhancing the teaching of science, technology and mathematics (Bogonko, 1992, Makau, 1988). In this practical and vocationally- oriented curriculum, Chemistry was made a compulsory subject in the first two years but many schools offer it throughout the four- year secondary school cycle (Wachanga, 2002). The Chemistry syllabus offered by KIE encourages teaching through experimentation, small group teaching and use of Chemistry projects in the learning process which are learner-centred approaches. However, the teaching of the subject in Kenya's secondary schools has continued to be predominantly expository which has contributed to the poor performance (Wachanga, 2002).

Throughout the independence era, the trend was that of mobilising formal secondary schools and universities to emphasise the teaching of science and mathematics. Leaders in the government from the very beginning reminded curriculum designers not only to offer agriculture in schools but also to ensure that a higher proportion of pupils should study pure and applied sciences (Bogonko, 1992).

Aikenhead and Jegede (2002) point that any nation that ignores the development of science for all curriculum, does so at its own peril in the world and especially in Kenya (Aikenhead and Jegede, 2002). The Kenya Government required that its Chemistry curriculum be strongly emphasized. In doing so, it was hoped that the teaching and learning of Chemistry in Kenyan Secondary schools would improve but poor performance continued (Wachanga, 2002). This would benefit from the use of cooperative learning which has been found appropriate for teaching of difficult topics in physics, biology and accounting (Kiboss, 2000, Kiboss, Nassiuma and Tanui, 2004).

Table 1 shows student performance in secondary schools between 1994 and 1998.

Table 1: Performance in KCSE Chemistry According to Students' Gender

Year	No. of Boys	No. of Girls	% of students who obtained grade B- and above	
			Boys %	Girls %
1994	35,538	23,879	10.9	8.4
1995	36,837	24,632	9.2	7.1
1996	42,793	29,291	7.1	5.6
1997	46,437	32,370	8.5	6.5
1998	52,096	36,753	8.0	6.1

Source: DEO's office

In 1998, less than 10% of the total student population scored the grade B- and above. Only 8% boys and 6.1 % girls managed to get the grade. 'B-' is the minimum grade that is required for a candidate to enter into university science courses like medicine and agriculture. Most school leavers, especially from Nakuru North District where majority of student had less than a B-, would therefore not likely get into a science-based course at the university if desired. Also, the percentages of girls who acquired the grade and above were much lower than those of boys in all the years making the problem worse for the girls (Wachanga, 2002).

Poor performance in the past chemistry examinations has been attributed to the inappropriate teaching approach and lack of learning resources (Wachanga, 2002). A way out to this must be found in order to improve students' poor performance of the subject in secondary schools in Kenya and especially in Nakuru North District. Perhaps Computer Supported Cooperative Learning (CSCL) may help in alleviating the problem facing Chemistry. CSCL is a new teaching method that combines Computer Assisted Learning

(CAL) with the Co-operative Class Experiment. CAL is a learning approach that has helped teachers to teach lessons, allow practice of new skills and provide reviews and remediation for difficult subjects or topics through the computer (Bilter,1989). Examples of cooperative learning techniques include the Cooperative Class Experiment (CCE teaching method) that engages the students in performing experiments and related learning experiences in small groups (Wachanga, 2002). CCE teaching method is the cooperative technique upon which the new method, Computer Supported Cooperative Learning is based.

Wassanga (2006) also carried out a study on attitudes and science among primary and secondary school students in Kenya according to gender. Male students were found to have a more positive attitudes towards all aspects of science apart from the perception of science as a male domain where female students were found to stereotype science less frequently as a male domain. Wassanga (2006) documents underepresentation of women in KCSE subject enrolment in science subjects as compared to other subjects as shown in Table 2:

Table 2: 1993 KCSE Subject Enrolment

Year	Biology	Physics	Chemistry	Physical Sciences	Biological Sciences
Females	19,890	9,0058	20,252	39,254	39,263
Males	28,742	20,486	31703	48,354	48,893

Source: KNEC Office

1994

From Table 2, only 20,252 females opted for Chemistry as an examination subject as compared to 31,703 of the male counterparts. Most of the females interviewed in the study held stereotypical attitudes towards subjects and careers. Most of the students felt that boys were more likely to do better in science than girls (Wassanga, 2006).

Bilter (1989) identifies the following reasons as to why computers are used by teachers in the chemistry laboratory. First and foremost, they can be used to perform experiments that

are otherwise dangerous or uncomfortable. Secondly, computers work so quickly to gather data that it can make hundreds of thousands of measurements per second. Also students have time to replicate the experiment and confirm results in a single class period (Bilter, 1989). Thirdly, in calculating data the computer has gathered, the formula given is usually followed. It will not deviate from its instruction or make mathematical errors thus guaranteeing more accurate results. The final and most important reason is that students are given hands on experience in working with computers for research.

CAL has the potential of incorporating cooperative learning with the use of computers (Watson, 1990). Computer Supported Cooperative learning was used in the study with an aim of finding out its effects on achievement and attitudes of students in Nakuru North District.

1.2 Statement of the Problem

Students' performance in chemistry in Kenyan Secondary schools is below a B- which is the entry grade required for most university courses. During the period 1994-1998, Kenya's secondary school students' performance in Chemistry was low with majority of students scoring less than B-. Less than 10% of the total student population managed to get the grade B- and above. This score does not allow students concerned to join science oriented courses in the university like chemistry or medicine. This is a difficulty that has not been found out in Kenya and especially in Nakuru North District.

Computer Supported Cooperative Leaning (CSCL) is a new method that has not been studied in Nakuru North District. The effects of using CSCL on students' achievement and attitudes in Kenya, and especially in Nakuru North District is not clear and hence the need for this study.

1.3 Purpose of the Study

The purpose of this study was to find out the effects of Computer-Supported Cooperative Learning on secondary school students' achievement and attitudes in chemistry in Nakuru North District. Specifically, the study sought to achieve the following objectives:

i) To find out the effect of CSCL teaching method on secondary school students' achievement in chemistry as compared to regular teaching methods in Nakuru North District.

ii) To compare the attitudes of secondary school students' taught through CSCL teaching method and those taught through regular teaching methods in Nakuru North District.

iii) To find out whether gender influences the achievement of students who are taught through CSCL in Nakuru North District.

iv) To find out whether gender influences the attitudes of students who are taught through CSCL in Nakuru North District.

1.4 Hypotheses of the Study

The following four null hypotheses were tested in the study using a probability value of 0.05:

$H_0$1: There is no statistically significant difference in secondary school students' achievement scores in chemistry when they are taught using CSCL teaching method compared to those taught through regular teaching methods in Nakuru North District.

$H_0$2: There is no statistically significant difference in secondary school students' attitudes in chemistry when they are taught using CSCL teaching method compared to those who are taught through regular teaching methods in Nakuru North District.

$H_0$3: There is no statistically significant difference in achievement of secondary school boys and girls who are taught through CSCL teaching method in Nakuru North District.

$H_0$4: There is no statistically significant difference in attitudes of secondary school boys and girls who are taught through CSCL teaching method in Nakuru North District.

1.5 Significance of the Study

The findings of this study may be used to improve secondary school students' achievement and attitudes towards learning chemistry. The use of computers in instruction will not only

go a long way in improving student learning but also enable teachers to develop good learning resources that help pupils understand difficult topics (Kiboss, Nassiuma, et al, 2004). The study may also help to improve student literacy of computer use.

The use of CSCL may lead to decrease in the cost of buying chemicals in schools because computers have the capability of simulating experiments and enable teachers to develop appropriate learning resources to enable students to learn difficult concepts in Chemistry in Secondary Schools.

Use of computers in the classroom would also contribute to the preparation of teachers and pupils to live in a world in which computers are naturally incorporated because they live in a computer generation (Kiboss, Nassiuma, et al, 2004). The entry of computers into the education systems of developing countries mirror development in the north in two important ways. First pressure for computerization is being exerted from without the education system. Secondly, computerisation of schools is being advocated at a time when fundamental thinking about curricula and the role of formal education is taking place (Makau, 1988). Like in the industrialised north, developing countries regard the computerisation of schools as an essential element in the wider effort to gear modern technology to national development, thereby increasing a country's competitiveness in the international marketplace (Makau, 1988).

1.6 Scope of the Study

The concept 'Acids, Bases and Indicators' was chosen because it is a difficult topic in this form. The study took five weeks towards the end of the first school term of 2007. The study focused on form one students from two selected secondary schools in Nakuru North District and results generalized to form one students in this district.

1.7 Assumptions of the Study

The study assumed that all students had equal capabilities of learning chemistry. It also assumed that students would portray their true feelings on the student attitude questionnaire towards chemistry.

1.8 Limitations of the Study

The first limitation was poor keyboard skills by the students. The ability to select desired characters on the computer keyboard is an essential first- step to anyone who wishes to use technology (Makau, 1988). The Form one students had just started learning keyboard skills and more so, not all the streams in the intervention school were using computer. This limitation was overcome by carrying out the treatment towards the end of the first term when they had some practice with the keyboard and also working only with the class that took computer classes.

Another limitation was that some computers were not IBM compatible which was a necessity for downloading the CHEMLAB software (Model Science Software, 2005). This made it necessary to form bigger groups around the available IBM-compatible computers. Last but not least, the age of the computers was important as some were too slow. This limitation was overcome by choosing schools whose computer networks were recently installed or updated.

1.9 Definition of Terms

The following were the operational definition of terms:

Achievement- In this study, achievement was taken to mean the actual scores obtained in the Chemistry Achievement Test (CHAT). These scores are a measure of the amount of gain of knowledge that students have received from learning the content matter. Once this knowledge has been gained, it is in itself a moral worth of those who hold it (Salaman, 1979).

Attitudes- In this study, attitudes was taken to mean the way that you think and feel about somebody or something; the ways you behave towards somebody that shows the way you feel in the light of a public reference.

Computer Assisted Learning-In this study, Computer assisted learning was taken to mean the learning that takes place when students are aided by the computer.

Computer supported cooperative learning – In this study computer supported cooperative learning was described as a situation in which students learn together in small groups around the computer centred on a common aim.

Cooperative Class Experiment- A method in which students are taught by performing in small groups by themselves. Such groups should exhibit positive interdependence, direct interaction and individual accountability (Wachanga, 2002).

Effect- In this study, an effect was taken to mean an outcome or a consequence that result from the use of an intervention like Computer Supported Cooperative Learning.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter looked into the historical perspectives of chemistry, computer supported cooperative learning, cooperative learning techniques, examples of regular teaching methods, student achievement and attitudes and the theoretical framework guiding the study. Also it builds a conceptual framework that diagrammatically linked all the variables in the study.

2.2 Historical Perspectives

Chemistry is known to date as far as the pre-historic times and its timeline split into four general chronological categories: prehistoric times to the beginning of the Christian era (Black magic), beginning of the Christian era to the end of the 17th century (alchemy), end of the 17th century to the mid 19th century (traditional chemistry) and the mid 19th century to the present (modern Chemistry) (Columbia University, 2007). In the pre-historic times, known metals were recorded and listed in conjunction with heavenly bodies. Democritus also proclaimed the atom to be the simplest unit of matter and Aristotle declared the existence of only four elements: Fire, air water and earth. In the beginning of the Christian era to the end of the 19th century, chemists attempted to transmute cheap metals to gold, influenced greatly by Aristotle's ideas. Despite the alchemists' efforts, the transmutation of cheap metals to gold never happened within this time period. They also wanted to find a chemical concoction that would enable people to live longer and cure all ailments. This elixir of life never happened either. The disproving of Aristotle's four elements and the publishing of the book, 'The Sceptical Chemist' by Robert Boyle combined to destroy this early form of Chemistry. During the end of the 17th century to the mid 19th century, Johann J Beecher believed in a substance called phlogiston. When a substance is burned, phlogiston was supposedly added from the air to the flame of the burning object producing a product in some cases. It was disproved by Antoine Lavoisier who discovered that oxygen was part of air that combines with most substances as they burn. Because of Lavoisier's work, he is now called the 'Father of Modern Chemistry.' Charles Coulomb also discovered Coulomb's law

during this period. John Dalton also published his atomic theory, which states that all matter is composed of atoms, which are small and indivisible. From the mid 19th century to present, includes works by Heinrich Geissler who created the first vacuum tube, William Crookes who discovered cathode rays, Eugene Goldstein who discovered the proton, William Roentgen who discovered the x-rays, Henri Becquerel who discovered that pitch blend gave a fluorescent light with or without sunlight, J.J Thompson who discovered the electron and studied its properties and Marie Curie's work on radio-active elements, among others (Columbia University, 2007).

The 19th Century problems led to great and innovative discoveries in the science world that helped people solve their real life problems (Paoloni, 1992). For example, the production of chemicals such as chloride of lime, phenol (carbolic acid) and methanal (formaldehyde) made it possible for the first time not only to disinfect wounds and surgical tools, but also large effluents (Paoloni, 1992). There are still some new problems in the society that need the intervention of Chemistry and science as a whole. Such problems include the diffusion of chlorinated pesticides such as DDT that has led to the damage of the ozone layer. Paoloni (1992) observes that it is up to the secondary school teacher to ensure that any school leaver can appreciate as a citizen the role of Chemistry in the society.

Bogonko (1992) outlines Kenya's history of science education by discussing the role of secondary schools. Soon after independence, Kenya leaned toward emphasising the teaching of sciences in the regular academic secondary school syllabuses (Bogonko, 1992). From the outset, Kenya planned to promote science and technical educations in secondary schools. At high school level, Kenya reserved 55 percent of enrolment for science streams. Although increases in the enrolment in these forms slowed down from the beginning of the later half of the 1990s, the ratio of science to arts of 11:9 did not markedly change (Bogonko 1992) It was difficult at the beginning of the 1970's to fill the science places because of lack of candidates with passes in maths and sciences The problem continued dogging the Kenya system throughout. The Ministry of Education was forced to resort to division 3 EACE/KCE candidates who had a combination in three science subjects for admission into Form five. This resulted in poor performance of the EACE/KCE mathematics and science subjects with

the consequence that the production of high level scientific manpower was threatened (Bogonko, 1992).

Prior to 1984, formal general education was organised into four distinct sectors. Primary school, 7 years, lower secondary school, 4 years, upper secondary school, 2 years and the university education was at least three years. In 1984, the primary school was extended to eight years, the two secondary sectors were consolidated into a four year course and the minimum duration of a university education was made four years (Makau, 1988). Because places in the secondary and university sectors were limited, progressively smaller proportions of students were are admitted into the two sectors. Currently over 90% of the eligible age group is admitted into primary schools. Of those who complete primary schools, about 40% are admitted into secondary schools. Only about 7% of secondary school graduands are likely to get a place in the national universities and more so in science related courses (Makau, 1988).

2.3 Regular Teaching Methods in Chemistry

Regular teaching methods are methods of instruction commonly used in the instruction process. Teacher Demonstration is the most common method of instruction in the secondary and tertiary levels of education (Wachanga, 2003). The purpose of demonstration is to provide a means by which the teacher can explain or clarify certain parts of the content quickly and economically (SMASSE, 2004). Whenever possible the teacher should also give the students an opportunity to set up the apparatus required for carrying out a certain procedure. The students should also be involved in recording and discussing the results. The class should be organized in such a way that every student is able to observe the demonstration (SMASSE, 2004). Demonstrations can be used to explain an experimental setup before the students begin to set up apparatus for individual or group activities. Wachanga (2003) notes that its popularity is perhaps due to the fact that students are able to perform experiments as they are performed by the teacher. It is also less demanding in terms of both materials required and teacher preparation. The method can also be used when the materials are too dangerous or equipments too delicate to be entrusted to the students (SMASSE, 2004). Although the teacher demonstration method of teaching is popular

because it places less demand on the provision of chemicals and equipment, it is considered inferior to other methods where the learners 'discover' knowledge by directly manipulating the learning materials (Wachanga, 2003).

The lecture method is another regular method which involves giving factual information with very little or no participation by learners (SMASSE, 2004). The method has proved the most common teaching method used in secondary schools where teachers talk and students listen. Wachanga (2002) compared the lecture method with Cooperative Class Experiment (CCE) and concluded that CCE facilitates student learning in Chemistry better than lecture and demonstration. Also, students receive higher motivation level through the cooperative class experiment as they help one another (Kiboss, Tanui, et al, 2004). SMASSE (2004) notes that this method is outmoded because it does not offer training for the attainment of scientific skills (SMASSE, 2004). Secondly, the content taught in a lecture is quickly forgotten. Thirdly, lectures can be boring especially if they are lengthy and if the teacher lacks appropriate communication skills. However, this method is the most effective for transmission of large amount of subject matter. (SMASSE, 2004).

Inquiry learning is a learner-centred process where students learn strategies to manipulate and process information, test hypotheses and apply their conclusions to new content or situations (Wachanga, 2003). Inquiry as a teaching method was invented by social studies teachers (McVitte, 2007). Students were given data from different countries, and asked to analyse the data to make generalizations and predictions about the people of the countries. Inquiry is a term used broadly to refer to everything from pseudo-experiments where the teacher has the students reify already taught concepts to one in which students have virtually total control (Mcvitte, 2007). Wachanga (2003) notes that if chemistry teachers use the inquiry approach, they are likely to achieve the following chemistry teaching objectives: Firstly, the student is expected to make accurate observations and draw conclusions during experimental work. Secondly, to select and use appropriate apparatus for experimental investigations. Thirdly, to follow correct experimental practices and recall safety procedures. The fourth objective to write chemical equations for simple reactions. The fifth objective is to identify in the physical and chemical behaviour of substances. The final

objective is to use ideas, concepts and skills acquired in learning chemistry to solve problems in everyday life.

With reference to practical work, it involves teaching/learning activities conducted by the students under the guidance/supervision of the teacher (SMASSE, 2004) The teacher provides the students, either singly or in groups, with the materials and apparatus as well as the instructions to be followed in performing the experiment (SMASSE, 2004). There are certain basic skills that are essential in order for students to carry out practical work safely and successfully. Examples of such skills include ability to read instruments and correct use of equipment and apparatus (SMASSE 2004). Hodson (1996) notes that 'practical is attributed to the socializing processes within the scientific community because experiments are widely used in science. Intending science teachers become socialized during their own science education into regarding them as essential to science education. Science teachers assume that their subject must be taught in surroundings that mimic the location in which science itself is often carried out (the laboratory) and by methods which the teachers believe scientists use (experimentation).' The advantages of practical work that Hodson (1996) cites are that students achieve three kinds of learning: First, it enhances understanding of whatever is being studied or investigated. Secondly, there is enhanced procedural knowledge that is, learning more about experiments and correlation studies and acquiring a more sophisticated understanding of observation, experiment and theory. Finally yet importantly, it provides opportunities for students to report and debate their findings and supporting them in reflecting critically in personal progress during the inquiry which is built in computer assisted learning (Hodson, 1996). The practical aspect is much used in CSCL and especially in technology.

Hodson (1996) also outlines difficulties that arise from the tendency to use practical work in pursuit of any and every goal of science education including motivating students and assisting concept acquisition and development. Further, practical work is over-used in the sense that teachers engage in practical work as a matter of course, expecting it to assist the attainment of all learning goals. In the end, students feel frustrated and therefore develop negative attitude that leads to poor performance especially in Chemistry. SMASSE (2004)

also notes that lack of laboratory facilities or equipment should not be taken as an excuse to limit practical work. The teacher and the students should collect material and improvise as much as possible. Where improvisation is not possible, small-scale experimentation should be encouraged.

Another teaching method is the project work, which is described as a means by which students can develop independence and responsibility, and practice social and democratic modes of behaviour (Knoll, 1997). Kasanda (2001) notes that the project method requires the students to be actively involved in an enquiry process. She further notes that the project is often long term and may involve activities such as experiments, field studies, and a series of experiments and/or extended literature review. During this process, the students are expected to identify a topic, collect the material, organize it in a readable form and present it, usually for grading. In this way the student is accorded the opportunity to be in control of his/her learning environment.

Some advantages of project work are that it enables the learner to actually engage in scientific investigation in an area of their own interest (SMASSE, 2004). Kasanda (2001) also notes that it places students at the centre of the teaching-learning process by making them take responsibility for their learning. It also develops and practises higher order skills of analysis, synthesis and evaluation. Thirdly, it makes the students become independent. Fourthly, organizational and logical presentation skills are developed, practiced and enhanced. Finally, social skills of working as part of a group, if group project work is assigned instead of individually are fostered and students learn to listen to each other's views (Kasanda 2001). On the other hand the following are some of the disadvantages of project work: First, it is time consuming for both learners and lecturers. Secondly, assessment of learners is usually problematic. This is due to the chance that the work might have been done by somebody else. In addition, if the project was a group activity, the contribution of each individual student may prove difficult to ascertain and also needs adequate materials for students (Kasanda, 2001).

Contrary to popular belief, project work need not consume a lot of time and resources allocated to the subject. There are many opportunities for students to learn science through individual or group project work. The problems to be investigated may arise from the students' own interest but they may also be suggested by having sufficient background information before they embark on project work. Teacher supervision and guidance are important pre-requisites for successful project work (SMASSE, 2004).

Fieldwork or excursion is another teaching method that results from a need to illustrate the natural development of technological application of certain topics dealt within the classroom. It provides students with first-hand evidence of science phenomena and how they impact on everyday life. Students learn to appreciate the science not only as subjects in the curriculum but also as part of the real world where science is applied in solutions to human problems and explaining natural phenomenon (SMASSE, 2004). Fieldwork is difficult to organize but if well planned, it can be an effective method of teaching and learning some aspects of science. It need not be conducted in a place that is far from school. The immediate environment of the school may offer unique opportunities for students to conduct field studies, which may reinforce what is learned in the classroom. To avoid a situation where students reduce a field trip to sightseeing, the teacher must plan as thoroughly as they plan other lessons (SMASSE, 2004).

Discussion is another important component of the teaching/learning situation (SMASSE, 2004). It allows students to share ideas. It can be at the beginning of a topic to ascertain students' preconceived notions of subject matter or towards the end of a topic by presenting students with a new situation and asking them to explain it in terms of what they have just learned. However discussion in groups might not have much value unless it is followed by presentation of reports (SMASSE, 2004).

It is conclusively the role of the chemistry teacher to look for new methods to make his or her teaching more effective and more relevant to the student after they finish school. It is up to the chemistry teacher to make use of knowledge that science educators are often running into in scientific journals or new trends like the use of computers in the classroom.

2.4 Computer Supported Cooperative Learning

The term Computer Assisted Learning covers a range of computer-based packages which aim to provide interactive instruction usually in a specific subject area (Dempster, 2007). CAL is run either straight from software like a floppy disk or over a local network so the constraint of the internet-slow download times for multimedia materials may not apply (Dempster, 2007). CAL packages have the potential to offer more advanced interactive multimedia experiences than it is currently reasonable to expect from the web (Dempster, 2007). This has been changing as web technologies develop but there are currently many things that can only be achieved with CAL rather than the web (Dempster 2007). Kiboss (2002) also notes that it is highly probable that the latest development of new information technology like Computer Based Instruction might bring about group oriented learning environments that can meet the pressing needs of large classrooms.

Fraser and Walberg (1995) study the potential of computers in science education and describe the essential characteristics of the new technologies. These include simulations, micro-computer-based laboratories and databases. Simulations are a representation of a part of reality. Students can gain understanding of the reality by manipulating this representation. Through simulation, it is possible to study parts of reality which could not be studied before for reason of safety, ethics, and cost, lack of apparatus or scale. Simulations can be an aid in visualizing concepts as well as a bridge between reality and the student's mental model of the system. Microcomputer- based laboratories make data collection possible. It becomes much easier to repeat experiments, measure different variables at the same time, use a very short or very long time range, analyze data, and represent graphically. Instead of spending valuable instructional time in data collection, students can use microcomputer-based laboratories for analysing and interpreting data. For micro-computer-based laboratories, supplementary hardware is necessary. Databases are used to store information from various areas of knowledge which can be retrieved readily. Having retrieved information, students then can use it in practising problem-solving skills (Fraser & Walberg, 1995).

Kiboss (2002) describes the views of a group of pupils and teacher regarding the impact of a computer-based instruction (CBI) programme that involved the collaborative learning of a physics course on measurement. Three secondary schools and a total of one hundred and eighteen pupils were studied in three classrooms, one class acting as a comparison. The same teacher taught the same physics content to all three classes using one of the two teaching methods namely the regular teaching mode and the CBI mode. Selected students and their teachers were observed and interviews. The qualitative data analysis methods of comparison and clustering were used to identify patterns and themes within their interview data. Results of the study indicated significant improvements in pupil's learning of physics as well as in the development of positive effects and/or socialisation skills. Accounts by the teacher as well as those by the students indicate a perception of the potential of CBI to enhance their learning of measurement concepts and methods.

Computer Supported Cooperative learning involves the combining of cooperative learning with Computer Assisted learning. CSCL uses CHEMLAB, which is software that incorporates an interactive simulation area and a lab notebook area. The notebook contains pages devoted to theory, step-by step procedures and students' observations and calculations (Evans, 1999). The computer becomes a virtual laboratory for carrying out the class experiments in the form of a simulation. CHEMLAB can be used to introduce new computer technology to the curriculum or bring the laboratory experience to on-line students (Model, 2005). It can also be an alternative to dangerous, expensive or environmentally hazardous laboratories (Model, 2005). Interactive simulations like CHEMLAB represent a new way of learning, a way that appeals to a whole generation of students raised with television and entertained by computer games (Model, 2005).

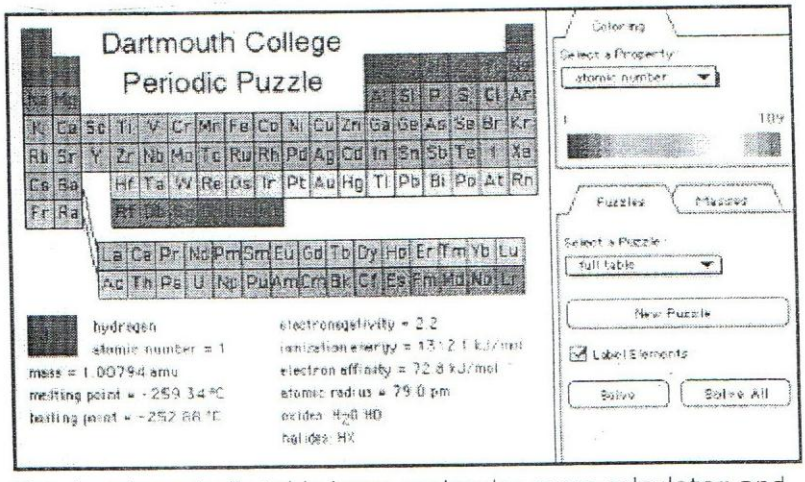
Nevertheless, interactive simulations should not be considered a substitute for hands on experience. In fact, they are a great way to prepare students to perform experiments efficiently and safely (Model, 2005). Model (2005) note that teachers know how awkward it is to explain laboratory procedures to students. Even when the instructor demonstrated the laboratory before their eyes, students ask what to do when the equipment is in their hands. The instructor inevitably ends up moving around the laboratory answering the same

questions over and over again. By having students run through the experiment using an interactive simulation before they perform the actual experiment, they are better prepared and have a better sense for what is going on. The laboratory becomes a safer environment for learning and expensive chemicals are less likely to be wasted. Evans (1999) notes that although there is no substitute for hands-on practical experience, it certainly could provide valuable pre-lab or revision sessions for those students whose experience of laboratory techniques are limited. He also notes that the package has the advantage of offering an alternative to running expensive, dangerous or lengthy experiments.

As discussed above, chemists are developing new theoretical models using computer simulations while chemistry students are learning the critical principles of experimental chemistry using interactive simulation software (Model, 2005). Interactive simulations like CHEMLAB make a virtual school possible for those , for whatever reason, do not find it convenient to attend an actual school. A student enrolled in a distance learning program may use an interactive simulation to perform laboratories at home, submitting their results to the instructor via the internet. This shows how the computational branch of chemistry is growing rapidly (Model, 2005).

Model (2005) notes some feature of CHEMLAB: It allows users to perform interactive chemistry laboratory simulations. Secondly, it emphasizes the principles and techniques of experimental chemistry. Thirdly, it is ideal for doing lab run-throughs, demonstrations, pre-lab work, and laboratories that otherwise could not be performed due to time constraints or hazards. Fourthly, it includes labs on acid-base titration among others. It also has a Lab Wizard tool which allows educators to create their own laboratory simulations.

CHEMLAB software turns the computer into a laboratory instrument for students to learn chemistry topics like measuring physical qualities like temperature and speed (Bilter, 1989). Commonly used laboratory equipment is used to simulate the steps involved in performing an experiment. Users step through the actual lab procedure while interacting with animated equipment in a way similar to a real lab experience (Model, 2005). Figure 1 show a periodic table used in Dartmouth College that uses CHEMLAB:



This handy periodic table has a molecular mass calculator and allows you to examine periodic trends by color. It is also a jigsaw puzzle! Click on the picture to link to it.

Source: http://www.Darthmouth.edu/~Chemlab/info/logistics/info.html

Figure 1: Dartmouth College Periodic Table

This periodic table, although similar to the normal periodic table has pull down menus that enable the students to access information specific to each element. CHEMLAB comes with a range of pre-designed laboratory experiments for general chemistry at the high school level. Users can expand upon the original laboratory using CHEMLAB's lab wizard development tools, thus allowing for curriculum specific lab simulation development by educators (Model, 2005). These user designed simulations combine both text based instructions and the simulation into a single distribution file (Model, 2005).

CHEMLAB originated from academic work in computer simulation and software design at McMaster University. It has continued to be developed with extensive input from educators interested in the possible application of computer simulations for classroom and distance learning (Model, 2005).

Organizing students into groups can maximize the potential of CHEMLAB. It is through research that group communication and decision-making around the keyboard has additional benefit to the problem solving and hypothesis-testing (Bilter, 1989). Vockell and Schwartz

(1992) developed an instructional principle that states that students learn more if the classroom is managed effectively. The amount of time available for learning is largely determined by the teacher's instructional and management skills and the priorities set by the school administration. They also advocate cooperative learning at the computer which is made effective by cooperative guidelines. Kiboss (2002) also supports classroom management, where use of CBI might bring about group orientation in learning. Cooperative learning using the computer has the potential of improving performance and motivation of students. The extent to which cooperative learning using the computer may enhance student achievement and improve their attitude in chemistry in Nakuru North District is yet to be determined where performance is dismal.

2.5 Cooperative Learning Technique

Cooperative learning is working together to accomplish shared goals (Johnson & Johnson, 2006). Cooperative learning is a successful teaching strategy in which small teams, each with students of different levels of ability, use a variety of learning activities to improve their understanding of a subject. Each member of a team is responsible not only for learning what is taught but also for helping team-mates learn, thus creating an atmosphere of achievement. Students work through the assignment until all group members successfully understand and complete it (Johnson & Johnson 2006). Cooperative learning is based on a social learning theory that stipulates that knowledge is reached through discussion and consensus building (Kiboss, Nassiuma, et al 2004). In cooperative learning, the success of the group depends on each person's contribution (Vockell & Schwartz, 1992) The underlying principle is that many students learn better in a cooperative environment rather than in a highly competitive environment. Moreover, cooperative environments often lead to acceptance of outsiders into a group and to enhanced self-concept among students who would feel inferior in a more competitive environment (Vockell & Schwartz, 1992).

Johnson and Johnson (2006) note that cooperative learning is used because students' learning goals may be structured to promote cooperative, competitive or individualistic efforts. In contrast to cooperative situation, competitive situation are ones in which students work against each other to achieve a goal that only one or a few can attain. In competition

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there is a negative interdependence among goal achievements; students perceive that they can obtain their goals if and only if the other students in the class fail to obtain their goals. Norm-referenced evaluation of achievement occurs. The result is that students either work hard to do better than their classmates or they take it easy because they do not believe that they have a chance to win. In individualistic learning situations, students work alone to accomplish goals unrelated to those of classmate and are evaluated on a criterion-referenced basis. Students' goal achievements are independent; students perceive that the achievement of their learning goals is unrelated to what other students do. The result is to focus on self-interest and personal success and ignore as irrelevant the successes and failures of others (Johnson & Johnson, 2006).

According to Balkcom (1992), some typical strategies of cooperative learning in the United States of America are group investigations which are structured to emphasize higher-order thinking skills such as analysis and evaluation. Students work to produce a group project, which they may have a hand in selecting. There is also the Student Teams- Achievement Divisions which is known as STAD. This strategy, is used in the second to the twelfth grades. Students with varying academic abilities are assigned to four or five member teams in order to study what has been initially taught by the teacher and to help each reach his or her highest level of achievement. Students are then tested individually. Teams earn certificates or other recognition based on the degree to which all team members have progressed over their past records. Another strategy is the 'Jigsaw II' which is used with narrative material in the third to the twelfth grades. Each team member is responsible for learning a specific part of a topic. After meeting with members of other groups, who are "expert" in the same part, the "experts" return to their own groups and present their findings. Team members then are quizzed on all topics.

Johnson and Johnson (2006) make a note of what makes cooperative groups work. Placing students in groups and telling them to work together does not in and of itself result in cooperation. Not all groups are cooperative. Sitting in groups, for example, can result in competition at close quarters or individualistic effort with talking. To structure lessons so students do in fact work cooperatively with each other requires an understanding of the

components that make cooperation work. Mastering the essential components of cooperation allows teachers to take existing lessons, curricula and courses and structure them cooperatively. Secondly, it allows them to tailor cooperative learning lessons to meet the unique instructional circumstances and needs of the curricula, subject areas and students. It also allows then to diagnose the problems some students may have in working together and intervene to increase the effectiveness of the student learning groups (Johnson & Johnson, 2006).

Biehler, Bonk and Snowman (1997) identify seven elements of cooperative learning. The first is group heterogeneity where 'at the very least, groups should contain both males and females and students of different ability levels. If possible, different ethnic backgrounds and social classes should be represented as well.' Hertz-Lazarowitz and Miller (1992) did experiments using dyads created by randomly assigning same-sex pairs of students. Responses to post-experimental questionnaires and examination of within-cell variances clearly indicate that pairs of students who were heterogeneous on measures of verbal aptitude and cognitive style were more effective than homogeneous pairings.

The second element is positive interdependence where a specific goal, such as a grade or a certificate of recognition, is identified for the group to attain. Students are told that they will have to support one another because the group goal can be achieved only if each member learns the material being taught (in the case of a task that culminates in an exam) or makes a specific contribution to the group's effort (in the case of a task that culminates in a presentation or a project).' Johnson and Johnson (2006) note that when positive interdependence is solidly structured, it highlights that each group member's efforts are required and indispensable for group success and that each group member has a unique contribution to make to the joint effort because of his or her resources and/ or role and take responsibilities. Doing so creates a commitment to the success of the group members as well as one's own and is the heart of cooperative learning. If there is no positive interdependence, there is no cooperation.

The third element noted is promotive interaction where students are shown how to help each other overcome problems and complete whatever task has been assigned (Biehler, Bonk , et al, 1997). This may involve episodes of peer tutoring, temporary assistance, exchanges of information and material, challenging of each other's reasoning, feedback, and encouragement to keep one another highly motivated. Johnson and Johnson (2006) also note that there are important cognitive activities and interpersonal dynamics that can only occur when students promote each other's learning. This includes orally explaining how to solve problems, teaching one's knowledge to others, checking for understanding, discussing concepts being learned, and connecting present with past learning. Each of these activities can be structured into group task directions and procedures. Doing so helps ensure that cooperative learning groups are an academic support system , that is, every student has someone who is committed to him or her as person. It is through promoting each other's learning face-to- face that members become personally committed to each other as well as to their mutual goals (Johnson & Johnson, 2006).

The fourth element is individual accountability, which stipulates that each member has to make a significant contribution in achieving the group's goal such as achieving a minimal score on a test, or that the group's test score is the sum average of each student's quiz score (Biehler, Bonk, et al, 1997). Two levels of accountability must be structured into cooperative lessons. The group must be accountable for achieving its goals and each member must be accountable for contributing his or her share of the work (Johnson & Johnson, 2006). Individual accountability exists when the performance of each individual is assessed and the results are given back to the group and the individual in order to ascertain who needs more assistance support, and encouragement in learning (Johnson & Johnson 2006). The purpose of cooperative learning groups is to make each member a stronger individual in his or her right. Students learn together so that they subsequently can gain greater individual competency (Johnson & Johnson, 2006).

The fifth element is interpersonal skills, which are necessary if positive interdependence and promotive interaction are to occur. Students have to be taught such basic skills as leadership, decision-making, trust building, clear communication, and conflict management (Biehler,

Bonk, et al, 1997) Cooperative learning is inherently more complex than competitive or individualistic learning because students have to engage simultaneously in task work and team work (Johnson & Johnson, 2006). Social skills for effective cooperative work do not magically appear when cooperative lessons are employed. Instead, social skills must be taught to students just as purposefully and precisely as academic skills. Leadership, decision-making, trust-building, communication and conflict-management skills empower students to manage both teamwork and task work successfully (Johnson & Johnson, 2006). Since cooperation and conflict are inherently related, the procedures and skills for managing conflicts constructively are especially important for the long-term success of learning groups (Johnson & Johnson, 2006).

The sixth element is 'equal opportunities for success' where it is important that steps be taken to ensure that all students have an opportunity to contribute to their team.' The final element is team competition, which is rarely used appropriately. 'When competition occurs between well-matched competitors, is done in the absence of a norm-referenced grading system, and is not used too frequently, it can be an effective way to motivate students to cooperate with each other (Biehler, Bonk, et al, 1997).' When the team task is organized so that each individual's unique contributions are identifiable, as much be the case when rewards are dispersed on an individual basis, each team member can experience recognition as a unique contributor and thereby fulfil individual identity needs (Hertz-Lazarowitz & Miller, 1992). Yet, at the same time, members can identify with the accomplishment and receive reward for the success of the entire team (Hertz-Lazarowitz & Miller, 1992).

Johnson and Johnson (2006) also note the cooperative element of group processing. Group processing exists when group members discuss how well they are achieving their goals and maintaining effective working relationships. Groups need to describe what members actions are helpful and unhelpful and make decisions about what behaviour to continue or change. Continuous improvement of the processes of learning results from the careful analysis of how members are working together and determining how group effectiveness can be enhanced.

O'Malley and Scanlon (1989) and Tanui (2003) draw conclusions about cooperative learning. One is that despite a general preference for individual work, a high proportion of students find value in group activity. They also observe that cooperative learning encourages students helping one another. The division of labour among participants accomplishes much in learning. It is an activity where each person is responsible for a portion of the problem solving.

Cooperative learning is a useful tool in cooperative learning of chemistry where each student is expected to have a role during the learning process (keyboarder, recorder, checker, encourager, etc). The instructional principle assumes that students learn better in a cooperative environment, where the success of one student contributes to the success of the whole group (Vockell & Schwartz, 1993). It is equally important to organize the group around a common aim to avoid the fears of gender inequality (Watson, 1990).

A research study carried out by Banerjee (1997) compared the effects of lecture and cooperative learning strategies on achievement in chemistry in university undergraduate classes. The results indicated no significant difference in achievement among the students taught using the cooperative learning strategies and those taught using regular teaching methods. Banerjee (1997) suggested further research to look into the effectiveness of combined strategies in the lecture and cooperative learning as a follow up to the study. The study results also positively indicated the possibility of students being engaged through cooperative learning in situations where the teacher is not able to engage the class through lecture. This is why cooperative learning was chosen to enable learners to go through difficult topics like 'Acids, Bases and Indicators' in Secondary School chemistry in Nakuru North District.

2.6 Students' Achievement in Chemistry

Salaman (1979) brings out the ideology of achievement as 'knowledge which must be achieved by the incumbent. The knowledge itself is complex and mysterious, frequently involving the mastery of a new language. Gaining the knowledge is a tough, competitive and

demanding process, requiring more than average amounts of intelligence. Once it has been gained, therefore, it is in itself a moral worth of those who hold it.'

Aronson (2002) notes that there are many researchers who argue that motivation is the key ingredient not only in outstanding achievement, but also in extraordinary achievement. He also notes that their work suggests that creative genius itself grows out of the ability to sustain intense commitment for very long periods in the face of obstacles. He attributes intelligence to two views studied by social psychologists: that intelligent is both fixed and something that can be developed. Alfred Binet, the inventor of the IQ test was a radical proponent of the idea that intelligence can be developed. He believed that children's most basic capacity to learn could be transformed through education, and he devoted much of his career to designing education programs that might do that (Aronson, 2002). He invented the IQ test simply to identify candidates for his educational intervention, that is, children who were not profiting from the schooling they were currently receiving. Today more and more psychologists are taking the view that intelligence or important components of it can be developed through motivation and learning (Aronson, 2002).

There is increasing interest in the use of examination results to monitor the effectiveness of schools and to hold them responsible for their performance. The World Bank Group (2006) notes that 'much work has been carried out on producing indicators of the 'value' a school adds to the achievement of its students. No entirely satisfactory solution has yet been found but some countries are starting to publish value-added indicators. The most common approaches are measuring student achievement on entry to school, finding mathematical models relating entry level to likely exit level for the population, measuring student achievement on exit from school, applying models to predict how a particular school's cohort should have performed and finally comparing the achieved level with predicted level to estimate 'value added' by school. Some critics suggest that this strategy for reporting 'value added' is flawed because models used for predicting output from input are simplistic and ignore other significant factors. Secondly, determination of input levels is subject to error of measurement. Finally, determination of output levels is subject to error of measurement.

A study comparing achievement among students instructed using hands-on chemistry labs versus those instructed using virtual chemistry labs also known as e-Labs was carried out (Kerr, Kerr & Rynearson, 2004). The results indicated there were no significant differences in achievement for either group. These results suggest that when both teachers used traditional expository instruction, their students performed equally well on the unit. The study also showed no significant difference in teacher and student characteristics which lended to the validity of the results of achievement goal.

Rivera and Ganaden (2001) also carried out a study on classroom psychosocial environment. This study was undertaken to determine what psychosocial variations in chemistry classroom environments exist in selected secondary schools, how different psychosocial learning environments in chemistry classes relate to students' attitude toward and achievement in chemistry, and how attitude toward chemistry relates to achievement in this subject. The findings of the study reveal that the more favourable the classroom environment is, the higher the chemistry achievement, and vice-versa.

Aduda (2004) also notes that chemistry was among the poorly done subjects in the KCSE results. It had a mean grade of 26.85%. Similarly Physics had a mean grade of 26.85%, Biological Science, 24.25% and Mathematics 19.3%. This shows that performance in science and mathematics, specifically in chemistry can still be improved.

There is some controversy which exists about whether the instructional use of computers affects students' achievement (Jones & Scrimshaw, 1988). Whereas some researchers have concluded that the use of computers does raise student achievement, others have concluded that a computer is a vehicle that delivers instruction but does not itself affect student achievement (Jones & Scrimshaw, 1988). Although computer-assisted instruction is most often used within drill and practice situations aimed at memorizing basic facts and increasing the quantity of production, there is hope that an increased use of computer-assisted instruction in more complex learning situations will increase student' ability to apply their knowledge and solve problems (Jones & Scrimshaw, 1988).

2.7 Student Attitudes in Chemistry

Elser (1986) sums up attitude as a subjective experience involving an evaluation of something or somebody. That something or somebody is not only represented within the experience but also has a public reference. Kiboss (2000) links attitudes like motivation and interest to the classroom environment. He notes that the nature of learning activities is largely dependent on both the individual learner's contribution and participation in the teaching-learning process. He also notes that students' conceptions about science might be negatively affected by the way the teacher presents the subject. For instance, the use of such techniques as lecturing, giving of notes and drilling of students on past examination papers which most teachers find are useful strategies, may make pupils perceive science subjects as the mastery of some formulas and/ or as a way of receiving and storing information. This eventually makes them lose interest in the subjects (Kiboss, 2002). Therefore the manner in which the pupil's classroom learning environment is organised is critically important if pupil's' motivation and interest in science is to be sustained.

A study was carried out to investigate how student' positive attitudes are 'transferred' into higher learning achievement by determining an intermediate variable between computer attitudes and computer learning and achievement- time spent on learning technology (Liu, Maddux , et al, 2004). It was found that four computer variables (Enjoyment, motivation, importance and freedom from anxiety) have linear relationships with time and that time has a linear relationship with computer achievement, suggesting that attitudes influence computer learning mediated by time, that is, time is an intermediate variable as proposed in the study.

Banya (2004) carried out a study to investigate the factors affecting attitudes of young female students toward chemistry at the high school level. This study investigated whether self-confidence toward chemistry, the influence of role models and knowledge about the usefulness of chemistry were affecting the attitudes toward chemistry of young females in183 high school across the United States. The young female students surveyed, had studied chemistry for at least one year prior to participating in the study during the fall

semester of 2003. The three young female students interviewed, gave detailed responses about their opinions regarding self-confidence toward chemistry, the influence of role models, and knowledge about the usefulness of chemistry on their attitudes toward the study of chemistry. Significant differences were found in the Likert-type scale scores, providing evidences supporting literature that suggests, self-confidence toward 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.

Another study carried out by Wilson (2004) gave a general education course to interest unenthusiastic students on chemistry and the environment. The author cites that at the beginning of the course students who signed up were quite open about their preferences for more "environment" and less chemistry. This problem was largely due to their perception that global warming, the ozone hole, energy efficiency; gasohol and recycling do not have anything to do with chemistry as a subject. These negative attitudes were also generated by beliefs that chemistry is the cause of water and air pollution. As the students realized that chemistry offers explanations and even solutions to real problems, they became much more interested in the subject. Wilson concludes that most subjects in chemistry can be illustrated by related environmental issues, so environmental chemistry provides an effective theme for the introduction of appropriate basic concepts in chemistry. This idea can be introduced to the Kenyan classroom to change students' perception towards how they view chemistry, which will also change their attitude.

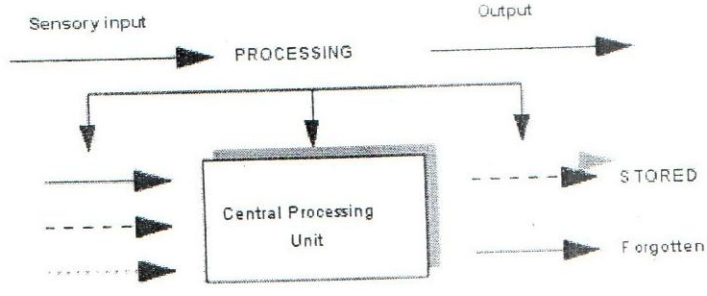
Aronson (2002) defines intrinsic motivation as doing an activity out of interest and personal engagement on it, whereas extrinsic motivation means doing an activity to receive a reward or some other kind of recognition. Regarding the motivation constructs he studies; there are many gender differences in children's competence beliefs or activities in different domains. These differences are intriguing in light of evidence that actual achievement and test-scores differences between boys and girls are decreasing (Aronson, 2002). Aronson (2002) also notes that despite evidence that male and female performance in Maths and English is becoming more similar, gender differences in competence beliefs and values regarding their subjects remain. At early adolescence, girls appear to have lower self esteem than boys do.

The present study focuses on the effect of CSCL teaching method on attitudes towards chemistry of secondary school students in Nakuru North District. It is important to take the girls' self esteem into consideration in order to improve on their performance.

2.8 Theoretical Framework

The theoretical framework underlying the study of achievement and attitudes in this study is the information-processing model, the systems theory and Maslow's Hierarchy of Human Needs.

The information processing theory was developed around the late 1950's at a time when technology was developing computers capable of manipulating large amounts of data more and more rapidly. The group of information processing theorists, who came out of cognitive psychology research, used the computer as a model for the way humans think (Huitt, 2000). It was designed to explain the cognitive process that occurs between stimulus and response (Solso, 1975; Tanui, 2003). This theory involved the flow of information from one's environment through the senses to the brain as shown in Figure 2:

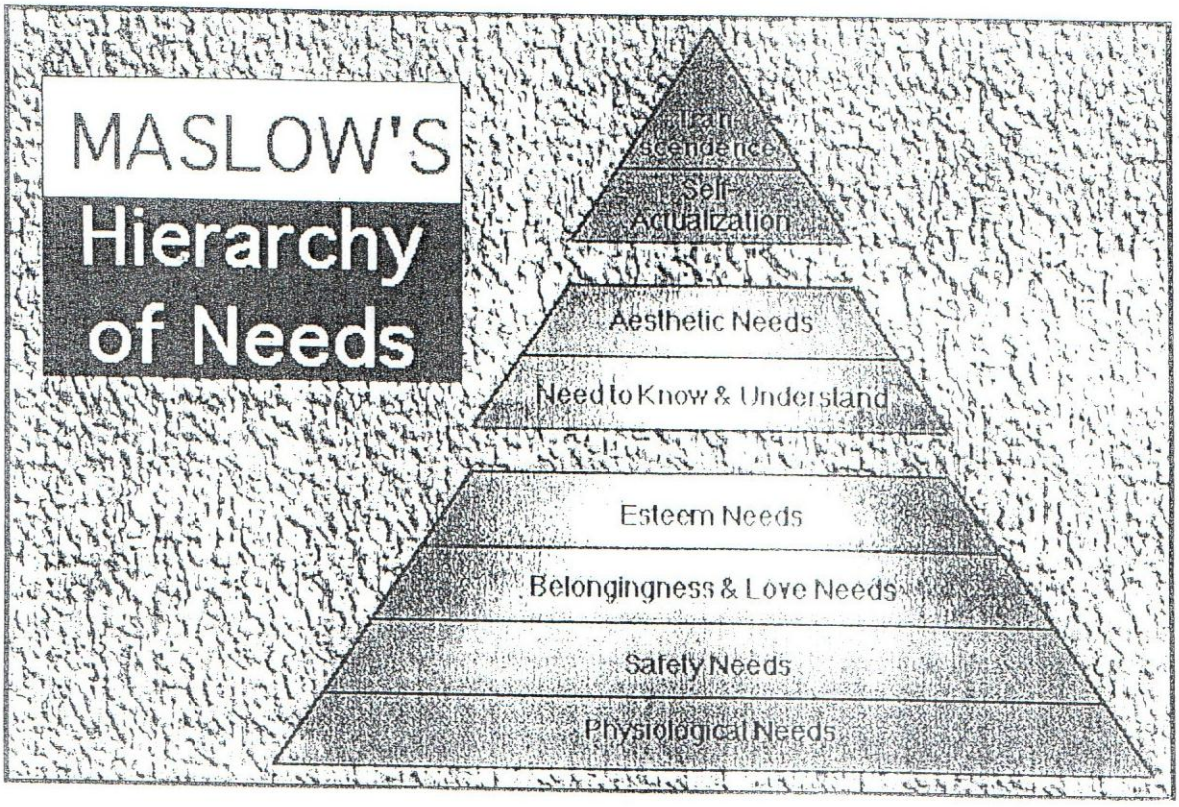


Source:http://hsc.csu.edu./au/pro-dev/teaching-online-/howwelearn/information.htm.

Figure 2: Information Processing Model

Another theory which can be used together with the information processing theory to construct meaning is the systems theory. It was developed by Gerlach and Ely (1980) and Joyce and Weil (1980) and holds that the teaching learning process is dynamic and has inputs and outputs. Heylighen and Josyln (1992) describe the systems theory as the trans-disciplinary study of the abstract organization of phenomenon, independent of their substance, type, and spatial or temporal scale of existence. It investigates both the principles common to all complex entities and the models, which can be used to describe them. Heylighen and Joslyn (1992) add that rather than reducing an entity (e.g. the human body) to the properties of its parts or elements e.g. organs or cells, systems theory focuses on the arrangement of and relations between the parts which connect them into a whole. The same concepts and principles of organization underlie the different disciplines (Physics, Chemistry, Biology, etc) providing a basis for their unification. Systems concepts include systems environment boundary, input, output, process, state, hierarchy, goal directedness and information (Heylighen & Josyln, 1992). In this study, knowledge has inputs through CSCL and outputs portrayed through achievement and attitudes scores in the CHAT and SAQ respectively.

Maslow's Hierarchy of Human Needs is another theory underlying this study especially on attitudes and more specifically motivation of students to learn chemistry. His theory contends that as humans meet 'basic needs', they seek to satisfy successively 'higher needs' that occupy a set hierarchy (Wikipedia, 2007). Maslow's Hierarchy is often depicted as a pyramid consisting of five levels: the four lower levels are grouped together as deficiency need associated with psychological needs, while the top level is termed growth needs associated with psychological needs. The basic concept is that the higher needs in this hierarchy only come into focus once all the needs that are lower down in the pyramid are mainly or entirely satisfied (Wikipedia, 2007). Maslow's theory is represented in Figure 3 below:



Source:http://Chiron.valdosta.edu/whuitt/coll/regsys/maslow.htm

Figure3: Maslow's Hierarchy of Human Needs

Huitt (2004) identifies four deficiency needs as psychological which include hunger, thirst and bodily comforts, safety/ security, belongingness and love and finally esteem. He also notes that Maslow's initial conceptualization included only one growth need- self-actualization. Self actualized people are characterized by being problem focused, incorporating an on-going freshness of appreciation of life, have a concern about personal growth and have the ability to have peak experiences. Maslow differentiated the growth need of self actualization to include cognitive needs which is to know, understand and explore, aesthetic needs which depicts symmetry, order and beauty, self actualization which is finding self fulfilment and realizing one's potential and finally transcendence which is connecting to something beyond the ego or to help others find self- fulfilment and realize their potential.

Ames and Ames (1989) identify three interrelated aspects of behaviour accounted for by theories about motivation. One aspect concerns with particular behaviour a person will perform in a given situation when other potential behaviours would have been performed. The second aspect is temperament which is a feature of behaviour that modulates and colour how the behaviour is enacted. The third aspect is persistence. Under conditions that allow a person to continue behaving in a particular way, persistence is gauged by the time allocated to or taken up by a particular behaviour (Ames & Ames, 1989). All three aspects are reflected in Maslow's theory of human needs.

For CSCL to work effectively on students, attitudes, one not only has to have students ultimate career goals in mind, that is, self actualisation needs, but also has to first think of the basic and psychological needs. Its hierarchical nature is important as it enables the teacher to be familiar with the students' background, which can lead to higher attitude scores using CSCL teaching method.

2.9 Conceptual Framework

From the discussion above, the following conceptual framework was developed. This framework delineates some important variables that are likely to influence effective cooperative learning around the computer using CSCL teaching method. The framework also guides the analysis of the separate and interactive effects of these variables (Hertz-Lazarowitz & Miller, 1992). The independent variables were CSCL teaching method. In CSCL teaching method, students were randomly assigned to computers in groups of five or six students. The groups were stratified for gender and ability and were instructed to work as a group in completing the experiments. Group members were assigned specific roles (recorder, typist, etc) which were rotated amongst the group members. The roles focused on tasks (Learning the material, recording information from the computer, making conclusions about the experiments. and completing the work and checking members' understanding). The teacher's role was to structure each day's work and monitor the learning groups to ensure appropriate cooperative and role behaviours were taking place.

The dependent variables were the student achievement scores and student attitudes scores in chemistry. Students were asked to answer 10 short answer questions on 'Acids, Bases and Indicators' at the beginning and at the end of the treatment period. The results were used to analyse the effectiveness of CSCL teaching method. They were also asked to fill a Student Attitudes Questionnaire to get their perception of how well they worked together around the computer. The scores on the SAQ were also used to determine the effectiveness of the CSCL teaching method on attitudes of students.

The extraneous variable in this study was the type of school, gender and the teacher characteristics. The extraneous variables were controlled as follows: To control for the type of school, only computer equipped schools were considered for the study. The training and experience of the teacher was primarily controlled by having the researcher do the teaching in the CSCL classroom. The pupils' age was controlled by involving students of the same age group, that is, form one students. The gender of the students was control by studying its effects on students' achievement and attitudes.

The types of variables described above are expected to influence the group interactions in the CSCL teaching method, resulting in a variety of outcomes. Important influences on such interactions include the goals and incentives of the group, the nature of the task, the individual differences of the group members and the script organisation of the group performing the task (Hertz-Lazarowitz & Miller 1992).

The binding feature of this framework is the group interactions that occurred during the use of CSCL teaching method. Group interactions involve complex combinations of the cognitive, affective, metacognitive and social activities of the learners involved. Cognitive activities include comprehension, recall and skilled performance. Affective activities include attitudes like motivation. Metacognitive activities include comprehension and performance monitoring of the students (Hertz-Lazarowitz & Miller 1992). The effectiveness of the CSCL teaching method will depend on the synergy of all these activities which is reflective of the systems theory. An over-emphasis on any one of the activities mentioned can disrupt this synergetic balance and inhibit performance of the task. If for instance, a participant

places too much emphasis on the metacognitive system, the participants' ability to generate information may be impaired (Hertz-Lazarowitz & Miller 1992). The outcomes as shown in the conceptual framework (Figure 4) are the scores that students obtained in the Chemistry Achievement Test and the Students Attitudes Questionnaire.

The independent variables are directly linked to the dependent variables as they are the means through which data can be obtained from students in order to test the hypotheses. The independent variables have also been directly linked to the extraneous variables which provide useful characteristics that enable teaching and learning to take place in the institution. Finally the extraneous variables are directly linked to the dependent variables as they enable student achievement and attitudes to be measured. All three variables are interlinked as it is the means through which the hypotheses can be effectively studied. These relationships are shown in Figure 4:

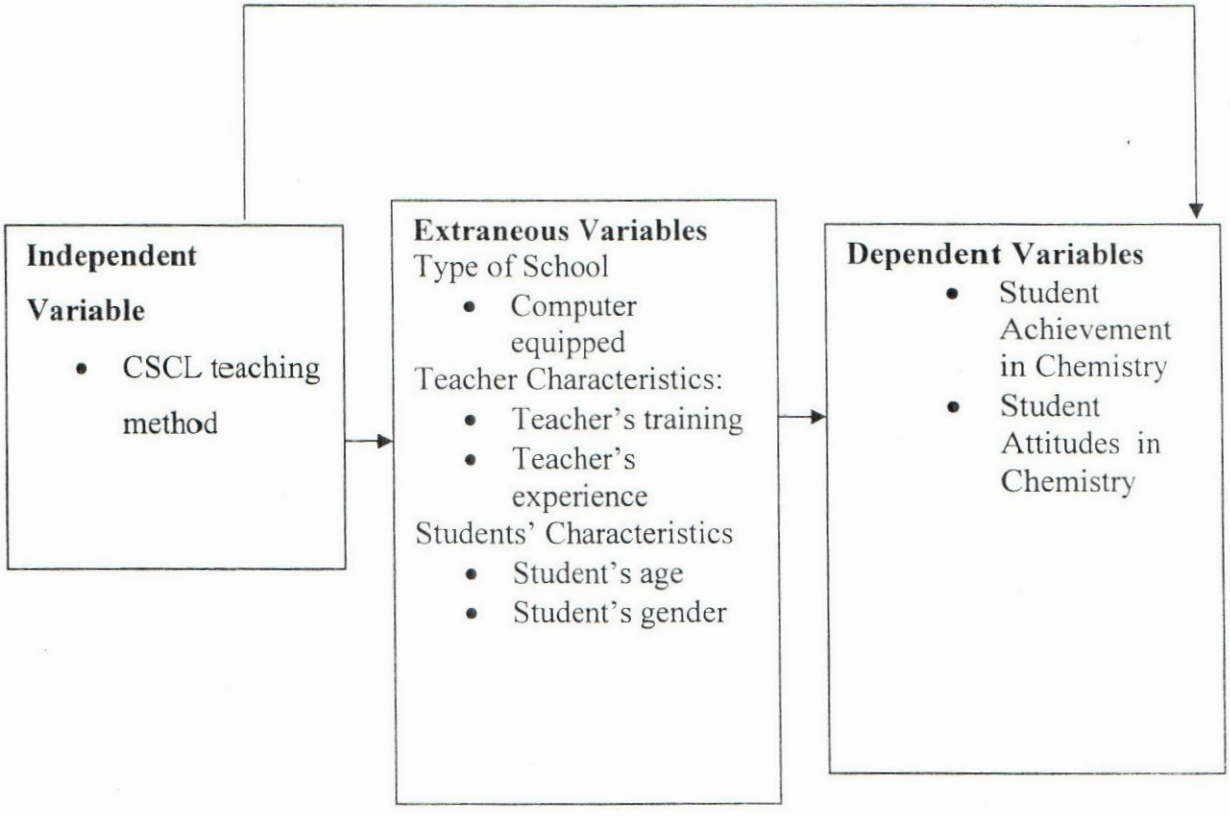


Figure 4: Conceptual Framework Showing Relationship between Variables

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter gives the research design that was used in order to provide a solution to the problem. The first section gives a detailed description of the research design. Sections that follow will consecutively look at the population, sampling procedure and sample size. The chapter then looks at the instruments that were used, their validation and analysis. The final sections will focus on data analysis.

3.2 Research Design

The study used was quasi-experimental research. The pre-test-post-test control group design was used in this study because it is effective in terms of demonstrating cause and effect of situations (Heffner, 2004). The design utilizes a control group, using random assignment to equalize the comparison group, which eliminates all the threats to internal validity except mortality. (Borg & Gall, 1989). Because of this, one can have considerable confidence that any differences between treatment and control group are due to the treatment (Borg & Gall, 1989).

The Pre-test-post-test non equivalent control group design was used in the study as shown in Table 3:

Table 3: Pre-test-Post-test Group Design

	Pre-test		**Post-test**
Experimental Group:	O1	X	O2
Control Group:	O3	___	O4

Source: (Heffner, 2004)

O1 and O3 were pre-tests that were given to the control and the experimental group while O2 and O4 were the post tests. X was the treatment that was given to only the experimental group.

3.3 Population of Study

The target population for this study were all form one students in Nakuru North District in Rift Valley Province in Kenya consisting 159 schools. Nakuru North District was chosen because of its close proximity and adequate catchments for schools possessing IBM compatible computers that could be used for instructional purposes.

3.4 Sampling Procedure

The unit of sampling was the secondary school rather than the individual learners because secondary school learners operate as intact groups and these groups cannot be broken down for research purposes as outlined by the School Administration Board (Borg & Gall, 1989, Mbugua, 2002). The District Education Office (DEO) provided a list of secondary schools while school records provided information on class composition and learner characteristics. Purposive sampling was then used to select one mixed provincial school in Nakuru North District with IBM- compatible computers and another mixed provincial school with comparable performance to be a control group. Two different schools were selected to decrease contamination of the results. The percentage of contamination of the results by interaction of students was less than if streams on the same school were to be taken for a control and an experimental group.

3.5 Sample size

The experimental group was made up of one class of 44 students while the control group consisted of a class of 37 students. This sample size was determined by the number of IBM-compatible computers that were available. Purposive sampling was used to select two mixed form one classes in Nakuru North District and involved a total of 81 students. 46 of the students were male while 35 were female. However due to absenteeism or errant students, the number of students that were reported in the data analysis were not always constant.

Mixed schools were selected for the study in order to incorporate the gender aspect into the study. All students were exposed to the same content on 'Acids, Bases and Indicators.'

3.6 Threats to Internal Validity

According to Kathuri and Pals (1993), threats to internal validity result from several factors. The first is history of the students. Between the pre-test and post- test, some events might have occurred resulting in effects that might be attributed to the treatment. This effect was not of significance because the amount of time between the pre-test and post-test was only five weeks. The second factor is maturation- students change in a variety of ways and produce differences that are independent of the experimental treatment. However, both groups experienced the same developmental processes, as both groups were form one students.

Thirdly, internal validity might be affected by the unreliability of the measuring instruments and due to extraneous factors, unique to each experimental group. To reduce this effect, the reliability of the instruments was calculated. Pre-testing is another factor that sensitizes the subject and therefore tend to perform better in the post-test not because of the treatment alone. Giving the post-test after five weeks reduced this threat to internal validity (Kathuri & Pals, 1993). Kathuri and Pals (1993) further identifies social desirability- these are responses that are not consistent with the true feelings of the person but consistent with what the person believes to be the expected or accepted response. The Student Attitude Questionnaire minimized this effect by enabling students to remain anonymous. The final factor is acquiescence, which is the tendency to agree with sentences when one is unsure or ambivalent. Students were allowed to clarify any uncertainty with the teacher to reduce this effect.

3.7 Instrumentation

Two instruments were used in the study. A Chemistry Achievement Test (CHAT) was developed to measure the students' cognitive achievement while the Student Attitude Questionnaire (SAQ) measured students' attitudes in chemistry.

i) Chemistry Achievement Test (CHAT):

Ten short answer items on 'Acids, Bases and Indicators' were used to test knowledge, comprehension and application of learned materials and marked out of 30. The CHAT was used to assess the students' achievement based on their scores. It was based on the KIE chemistry Syllabus for form one level. The CHAT was given to both the control and experimental group as a pre- test . The same test was given as a post-test.

ii) Student Attitude Questionnaire (SAQ):

Student Attitude Questionnaire (SAQ) was used to assess the students' attitude towards the chemistry course. The SAQ contained 20 items on favourable and unfavourable statements of the students' attitude towards chemistry. It was adapted from O'Malley and Scanlon's (1990) student questionnaire as well as Tanui's (2003) set of instructions to the students and reformatted to fit the objectives of the study. The SAQ was constructed on a 5 point Lickert Scale.

SAQ was given to both the control and experimental groups at the start of the treatment period and after the treatment. The items were re-organized and given as a post-test. This allowed for comparison of result in between the control and experimental groups.

3.8 Piloting

The Chemistry Achievement Test and Student Attitude Questionnaire were given to two university lecturers to ascertain its validity. They were also given to three experienced secondary school teachers to ascertain their validity. Thereafter, the test was administered to schools that were not involved in the study. In addition, two KNEC examiners were asked to comment. One school in Nakuru North District was selected for the piloting of the CHAT and SAQ in order to ascertain their reliability. The reliability of these instruments was also calculated using the Cronbach alpha formula, as each item in the questionnaire would have a range of marks. According to Kiboss, Nassiuma, et al (2004), a reliability index of at least 0.70 is acceptable. A reliability index of 0.8149 was reported for the CHAT while a reliability index of 0.7405 which was reliable. The feedback obtained was useful in improving the credibility of the items appearing in the instruments.

3.9 Module Design

CHEMLAB, a computer package used for teaching, consisted of laboratory manual and inbuilt step-by-step experimental procedures. Students were required to enter their input directly into the computer and any output in the form of observations, tables and graphs would have to be printed. The manual consisted of six experiments that showed step-by-step procedures on how to carry out experiments based on the chemistry topic 'Acids, Bases and Indicators'. It also had tables and spaces meant for students to record their observations and discussion questions to guide students on what they had already learnt. This laboratory-teaching manual was also available on the computer screens, which enabled students to type and print their results.

3.10 Data Collection Procedure

The researcher visited the schools involved in the study after obtaining a research permit from the District Education Office. The researcher trained the Chemistry teacher for two days on the CHEMLAB software and installed it. The students were also trained on cooperative learning technique and the roles that they were supposed to play in the groups assigned to each individual. Each group consisted of five to six students. A total of eight groups were formed around the computer.

The steps involved in the design were to first assign subjects to the treatment and control group. Both the CHAT and SAQ were administered as a pre-test to both groups. The pre-test was given in order to obtain information about students' achievement and attitude without the treatment. Next, the treatment, CSCL teaching method, was given to the experimental group only. The treatment was given for a period of four weeks. At the completion of the chemistry topic on 'Acids, Bases and Indicators,' both the CHAT and SAQ were given as a post-test. The amount of change on the value of the dependent variable from the pre-test to the post-test for each group was finally assessed separately (Borg & Gall 1989).

3.11 Data Analysis

The results obtained using the above instruments were analysed in the following ways: ANCOVA was used to test the research hypotheses with the help of a statistical package for social sciences (SPSS). Analysis of co-variance (ANCOVA) was used to determine whether initial differences in the control and experimental group existed prior to the pre-test conditions. ANCOVA reduced experimental error by statistical means rather than by experimental procedure (Borg & Gall, 1989). The post-test scores were corrected using the pre-test as a covariate to equate the two groups if there were any initial differences in the mean scores of the two groups. Two-tailed t-tests were also used to analyse whether the gender variable is related to the use of CSCL (Lowry, 2006). T-tests were also used to find out if there were any statistical differences in the pre-test and post-test mean scores of the student so as to make logical conclusions about the outcome of the study. A summary of the data analysis process is shown in Table 4:

Table 2: Summary of Data Analysis

Hypothesis	*Independent Variable*	*Dependent Variable*	*Statistical Test*
$H_0$1- There is no statistically significant difference on student achievement scores when taught using CSCL as compared to regular teaching methods.	CSCL approach	Achievement	ANCOVA
$H_0$2 - There is no statistically significant difference on student attitude when taught using CSCL approach as compared to regular teaching methods.	CSCL approach	Attitude	ANCOVA
$H_0$3- There is no statistically significant difference in achievement scores of students when taught using CSCL approach according to gender as compared to regular teaching methods.	Gender	Achievement	t-test
$H_0$4-There is no statistically significant difference in attitude scores when using CSCL according to gender as compared to regular teaching methods.	Gender	Attitude	t-test

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

The purpose of this chapter is to report the results of the research that was carried out and test whether the null hypotheses were acceptable or not. Specifically the hypotheses sought to find out if CSCL teaching method had any statistical difference on:

i) student achievement in chemistry

ii) student attitude in chemistry

iii) Achievement of boys and girls who are exposed to CSCL

iv)Attitude of boys and girls who are exposed to CSCL

This study used the pre-test post-test design. The students were put in two groups:

i) Group 1 was the experimental group taking the pre-test and treatment. The treatment was the CSCL teaching method which was given to determine its effects on students' achievement and attitudes

ii) Group 2 was the control group, which took the pre-test with no treatment. This would enable the researcher to determine whether any changes between the pre-test and the post-test were as a result of the treatment or not.

This arrangement enabled the researcher to:

i) Control the timing of the independent variable (treatment) and which group is exposed to it. In this study CSCL was given to the experimental group after doing a pre-test and the post-test given five weeks later.

ii) Control all other conditions in which the experiment took place. Nothing but the intervention of the treatment variable was assumed to produce the observed change in the values of the dependent variables (California State University, 2006).

The difference in the experimental group's score from the pre-test score indicates that the change in the value of the dependent variable that could be expected to occur with exposure to the treatment variable. Additionally, the difference between the change in the scores of

the experimental group and the change in the control group is the amount of change in the value of the dependent variable that can be attributed solely to the treatment (California State University, 2006). Both the t-test and the analysis of covariance can be used to solve the problem of any difference in the post-test measurements being due to failure in the randomization. Both tests compare groups in differences between post-test and pre-test (Dallall, 2006).

4.2 Results of the pre-test of the CHAT

The results of the pre-test on the instruments made it possible to:

i) Assess the similarity of the groups before administration of the treatment

ii) assess if extraneous variables have brought about changes in the pre-test and post tests as reflected in the scores of the control group.

iii) Control threats to internal validity.

Table 5 shows the mean scores on the CHAT:

Table 5: Mean Scores on the CHAT

Group	N	Mean	Std. Deviation	Std Error Mean
1 (Experimental Group)	44	3.285	2.408	.407
2 (Control Group)	37	5.727	3.581	.624

The students' CHAT mean scores shows that the control group with a mean score of 5.727 performed better than the experimental group with a mean score of 2.408. The deviation from the means for the two groups were slightly different but helpful in calculating the t-values. Hence, a t-test was carried out to find out if the students had any statistical differences in achievement in chemistry. The t-test was appropriate for the study of these mean scores as it is concerned with the inferences to be made from pre-test mean scores of the CHAT to the population of Nakuru North District. It was used to determine how probable that the differences found in the samples for the control and experimental group would also be found in the population of Nakuru North District. It was also found

appropriate for the study since the samples in this study were drawn randomly from a specified population making the sample representative of the study (Borg & Gall, 1989). The results of the pre-test are shown in table 6:

Table 6: Independent Samples t- Test on Students' Pre-test Scores on CHAT

T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
-3.316	66	.001	-2.442	.736	-3.912	-.972

CHAT maximum score-30 marks

As shown in Table 6 above, the difference between the mean scores of the two groups in the CHAT was significant at t (66) = 2.554, $p<0.05$. The negative t-value shows that the mean scores for the control group was larger than for the experimental group. Since the probability value of 0.001 is less than the alpha value of 0.05, the differences between the means were statistically significant. To statistically equate the control and the experimental group and to increase the precision of the analysis by decreasing the error variance in the pre-test it was necessary to carry out an ANCOVA on the CHAT ANCOVA would correct for the initial differences in the study (Pohlmann, 2006).

4.3 Effect of CSCL on Student Achievement in Chemistry

In order to determine the relative effects of CSCL teaching method on student achievement in chemistry, an analysis of the students' post-test CHAT scores was carried out where students did an examination after five weeks. Hypothesis $H_0 1$ of the study states that there is no statistically significant difference in student achievement in chemistry when they are taught using CSCL compared to those taught through regular teaching methods. Having established there was a significant difference in the means for the pre-test; it was then necessary to use ANCOVA to correct for initial differences as a means of equating the two groups.

Tables 7 shows the CHAT post-test scores obtained by student in the groups:

Table 7: CHAT Post- Test Scores obtained by students in the Groups

Dependent Variable: Post-test

Group	Mean	Std. Deviation	N
1(Experimental)	11.454	4.168	44
2 (Control)	15.029	4.369	35
Total	13.038	4.592	81

Table 7 above shows that the control group with a mean of 15.029 and a standard deviation of 4.369 performed better than the experimental group with a mean of 11.454 and a standard deviation of 4.168. To statistically equate the control and the experimental group and to increase the precision of the analysis by decreasing the error variance in the pre-test it was necessary to carry out an ANCOVA. The pre-test scores were used as a co-variate and the adjusted CHAT post-test scores are shown in Table 8:

Table 8: Adjusted CHAT Post-test score with pre-test as co-variate

Dependent Variable: Post-test

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1 (Experimental)	11.382(a)	.654	10.079	12.684
2 (Control)	15.120(a)	.736	13.654	16.586

a : Covariates appearing in the model are evaluated at the following values: CHAT = 4.494.

The adjusted scores above show that at the 95% of students had corrected scores ranging from 10.079 to 12.684 in the experimental group. The control group had 95% of the students with corrected scores between and 13.654 and 16.586 in the control group. The overall mean

of 15.12 with a standard error of 0.654 in the calculated scores for the control group was still higher than that of the experimental group which was 11.382 with a standard error of 0.736. However, the above scores statistically equated the pre-test scores for the two groups. The corrected values were used to carry out an ANCOVA on the CHAT post-test scores to find out if the means between the control and experimental groups were statistically significant. The results are displayed in Table 9:

Table 9: ANCOVA on Students Post-test Mean Scores on CHAT

Dependent Variable: Post-test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	256.762(a)	2	128.381	7.029	.002
Intercept	4444.108	1	4444.108	243.316	.000
Pre-test	7.757	1	7.757	.425	.517
Group	255.102	1	255.102	13.967	.000
Error	1388.124	76	18.265		
Total	15074.000	79			
Corrected Total	1644.886	78			

A: R Squared = .156 (Adjusted R Squared = .134)

An examination of Table 7 reveals that the difference between group 1 and group 2 is highly significant $F(1, 76)=13.967$ $p< 0.05$. Since Group 1 was taught through CSCL teaching and Group 2 was taught through regular teaching methods, the CSCL teaching methods resulted in lower achievement than the regular method. $H_0 1$ was therefore rejected. Since the experimental group scored higher in the pre-test shows that the use of CSCL might have affected the performance of the students.

The study found that students who were taught through CSCL teaching method achieved significantly lower scores in the CHAT than those who were not taught through it. This showed a lack of enough preparation time on the part of students taught through CSCL

teaching method. This is in contrast to an earlier study conducted by Banerjee (1997) comparing the effects of lecture and cooperative leaning strategies on students' achievement in general chemistry at the university undergraduate level found no difference in achievement. In Banerjee's study, the cooperative learning class did not get enough time to adjust to the new learning strategy. It was recommended that students should be given more time at the beginning for the cooperative learning class to develop confidence in working with one another. Although the present study was carried out with this rules in mind the use of CSCL experiments resulted in students scoring lower than their counterparts who were taught through regular teaching methods.

One possible reason for this low achievement is noted by Johnson (2006) who points out that the division of labour method of doing a group project works but sometimes people concentrate only on the part of the assignment and do not learn the rest. An individual accountability strategy to check participation by checking continually with a randomly selected group member on explanation, progress issues as the group works can be arranged by the teacher. The key is that the group realizes that each group member needs to participate actively and understand completely the material, and the group is not successful until that happens. Johnson (2006) adds that each role should be rotated so that everyone learns his or her role.

The findings of this research seem to disagree with those of other researchers who have found cooperative learning techniques to be appropriate. Johnson and Johnson (1997) report that cooperative learning has a considerable body of research validating its effectiveness of cooperative, competitive and individualistic learning. They report that cooperative learning consistently improves achievement and retention, creates more positive relationships among students and promotes students' psychological health and self esteem. They affirm that they know more about it than any other aspect of teaching and learning.

Oszoy and Yildiz (2004) also carried out a study to determine the effect of the learning together technique of cooperative learning method on students' mathematics achievement. The study was an experimental research in which pre-test-post-test design with control

group was applied. In the study, experimental and control groups were used. Learning together technique of cooperative learning method was applied to the experimental group and traditional teaching methods were applied to the control group. Conclusions showed that there was a significant difference between the results of the experimental and control groups. The learning together technique of cooperative learning method was found to be more effective than the traditional methods.

Schmidt (2000) also notes that when cooperative learning is implemented in the classroom, students are more likely to acquire critical thinking skills and achieve at a higher level as opposed to listening to lectures. Along with positive effects on student achievement, Schmidt (2000) also reports that cooperative learning should result in an increased retention of information. She affirms that cooperative learning methods are just as effective as non-cooperative methods with regard to achievement and retention.

Although the findings of the present study differ from those of the other researchers, CHAT scores of students can be improved using CSCL with other teaching methods, as studies have shown that no cooperative teaching method is effective on its own.

4.4 Results of Pre-test on SAQ

Table 10 shows the mean scores on the SAQ:

Table 10: Mean Scores on SAQ

Group	Mean	Std. Deviation	N
1(Experimental)	105.974	13.716	44
2 (Control)	112.000	15.942	37

The SAQ mean scores show that the control group with a mean score of 112.000 and a standard deviation of 15.942 performed better than the experimental group with a mean score of 105.974 and a standard deviation of 13.716. The above scores and deviations were used in carrying out a t-test to find out if the students had any statistical differences in

attitudes in chemistry. The results would be useful in drawing inferences about the pre-test mean score of the SAQ and to the population of Nakuru North District. It was used to determine how probable that the differences found in the samples for the control and experimental group would also be found in the population of Nakuru North District. As noted earlier, the t-test was appropriate for the study since the experimental and control groups were drawn randomly from a specified population making the sample representative of the study (Borg & Gall, 1989). The results of the t-test on the SAQ are shown in Table 11:

Table 11: Independent Samples t- Test on Students' Pre-test Scores on SAQ

T	Df	Sig(2-tailed	Mean Difference	Std.Error Difference	95%confiddence interval of the difference	
					Lower	Upper
-1.834	81	.070	-6.026	3.285	12.563	.452

The difference between the two groups for SAQ was not significant at t (81) =1.834, p>0.05. The negative t-value shows that the mean scores for the control group were larger than for the experimental group. Since the probability value of 0.07 is more than the alpha value 0.05, the differences between the means were not statistically significant which showed comparability in attitudes for the two groups.

4.5 Effect of CSCL on Student Attitude in Chemistry

The post-test SAQ scores were analyzed in order to find answers to Hypothesis 2, which states that there is no statistically significant difference in student attitude in Chemistry when taught using CSCL as compared to regular teaching methods in Nakuru North District. The results showed that the mean for the experimental group was 115.333 while that for the control group was 84.378. Table 12 shows the SAQ post-test scores obtained by students in the two groups:

Table 12: Results on Attitudes

Group	N	Mean	Std. Deviation
1(Experimental)	42	115.333	12.452
2 (Control)	37	84.378	26.405

As indicated in Table 12, the experimental group had a higher mean of 115.333 with a standard deviation of 12.452 while the control group has a mean of 84.378 with a standard deviation of 26.405. The above mean scores and standard deviations were useful in calculating the t-test values. The results obtained from the t-values would be used to draw inferences about the experimental and control group used in the SAQ to the population of Nakuru North District. As noted earlier, the t-test was appropriate for analysing the results on attitudes since the experimental and control groups were drawn randomly from a specified population making the sample representative of the study. The results of the t- test scores on attitudes post-test is shown in Table 13 below:

Table 13: T-Test Scores on Attitudes Post-test scores

t-Test for Equality of Means						
t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
6.792	77	.000	30.955	4.557	21.880	40.029

Table 13 above shows that the difference in the mean scores of the experimental and the control groups are significant t (77) =6.792, $p<0.05$. The positive t-value shows that the mean scores for the experimental group were larger than for the control group. Since the probability value of 0.0000 is less than the alpha value of 0.05, the differences between the means were statistically significant. This made it necessary to statistically equate the two groups and reduce the error variance in the model. This was done using ANCOVA which

controlled the post-test scores on the SAQ using pre-test scores as a covariate. This would make it possible to determine whether mean scores of the SAQ post-test differed significantly with each other. Results of the ANCOVA on the post-test scores on the SAQ are shown in Table 14 below:

Table 14: ANCOVA on Students Post-test Scores on SAQ

Dependent Variable: post-test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	18321.589(a)	2	9160.794	22.849	.000
Intercept	5093.066	1	5093.066	12.703	.001
Pre-test	457.996	1	457.996	1.142	.289
group	14730.758	1	14730.758	36.741	.000
Error	28867.398	72	400.936		
Total	822194.000	75			
Corrected Total	47188.987	74			

a R Squared = .388 (Adjusted R Squared = .371)

An examination of table 14 reveals that the difference between the experimental group and the control group is highly significant ($F(1, 72) = 36.741$) $p<0.05$. Students who were taught through CSCL method had a more positive attitude towards chemistry than those who were taught through regular teaching methods. Hypotheses $H_0 2$ was therefore rejected.

The results of the study indicate that the CSCL teaching method resulted in improved student attitude towards chemistry probably due to the goal structure of cooperative learning methods. The CSCL teaching method resulted in better student-student interaction thus improving students' attitude. This study shows that this teaching method resulted in an improvement in the attitude of the learners.

Johnson and Johnson (2006) note that students' learning goals may be structured to promote cooperative, competitive or individualistic efforts. In contrast to co-operative situations, competitive situations are ones in which students work against each other to achieve a goal only few can attain. In competition there is a negative interdependence among goal achievements; student perceive that they can obtain their goals if and only if other students in the class fail to attain their goals. Norm-referenced evaluation of achievement occurs. The result suggests that students either work hard to do better than their classmates, or they take it easy because they do not believe they have a chance to win. In individualistic learning situations students work alone to accomplish goals unrelated to those of classmates and are evaluated on criterion-referenced basis. Students' goal achievement are independent, students perceive that the achievement of their learning goals is unrelated to what other students do. The result is to focus on self-interest and personal success and ignore as irrelevant the success and failures of others. Johnson and Johnson (2006) conclude that cooperation compared with competitive and individualistic efforts results in more caring, supportive and committed relationships and greater psychological health and self-esteem.

Schmidt (2000) also supports the effectiveness of cooperative learning techniques in improving students' attitudes in a study conducted in North Carolina Home Economics students. Two groups of students were formed; cooperative learning methods were used in the instruction of one group, while non-cooperative methods were used for the other group. The results show that cooperative learning contribute to the development of interpersonal skills and the ability to work effectively in a group.

4.6 Results of Pre-test Scores on CHAT Based on Student Gender

Table 15 shows a summary of the pre-test on CHAT based on student gender:

Table 15: Pre -test Mean Scores on CHAT Based on Student Gender

GENDER	N	Mean	Std. Deviation
1 (Male)	46	5.000	3.571
2 (Female)	22	3.364	2.128

The above scores show that boys with a mean score of 5.000 and a standard deviation of 3.571 performed better than the girls who had a mean score of 3.364 and a standard deviation of 2.128. The above mean scores and standard deviations in the CHAT were useful in calculating t-test scores which was necessary in order to find out if the difference in the means was statistically significant. The results obtained from the t-values would be used to draw inferences about the experimental and control group used in the CHAT based on gender to the population of Nakuru North District. Since the experimental and control groups were drawn randomly from a Nakuru North District, it was representative of the population of the study. The results of the t- test scores on attitudes post-test is shown in Table 16:

Table 16: T-Test Score Results on CHAT Pre-test Based on Gender

t-Test for Equality of Means						
t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
					Lower	**Upper**
1.983	66	.052	1.636	.825	.0115	3.284

An examination of Table 16 indicates that the t-test scores when based on gender were not statistically significant (t 66=0.052 , p> 0.05). The positive t-value shows that the mean scores for the experimental group were larger than for the control group. Since the probability value of 0.052 is more than the alpha value of 0.05, the differences between the means were not statistically significant. The above results indicated that the groups used in the study were comparable based on gender.

4.7 Achievement of Boys and Girls Exposed to CSCL

In order to determine the relative effects of CSCL teaching method on student achievement in chemistry according to gender, analysis of the students' post-test CHAT scores was

carried out. Hypothesis Ho3 states that there is no statistically significant difference in achievement of secondary school boys and girls who are taught through CSCL teaching method in Nakuru North District.

Table 17 shows that CHAT mean scores based on student gender:

Table 17: CHAT Post- Test Scores Based on Student Gender

Dependent Variable: post-test

Gender	Mean	Std. Deviation	N
male	12.809	4.190	21
female	9.000	3.838	12
Total	11.424	4.416	33

Maximum score: 30 marks

The above results show that boys with a mean score of 12.809 and a standard deviation of 4.190 scored higher than girls with a mean score of 9.000 and a standard deviation of 3.838 in the post-test scores. The above mean scores were useful in carrying out an ANCOVA to statistically equate the two groups and reduce the error variance in the post-test scores obtained by the students according to gender . By using the pre-test as a co-variate, the results obtained would be used to determine whether the CHAT mean scores differed significantly from each other. The adjusted chat post-test scores using the pre-test as a co-variate are shown in Table18:

Table 18: Adjusted CHAT Post-test Scores Based on Gender

Dependent Variable: post-test

GENDER	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
male	14.134(a)	.670	12.795	15.473
female	11.492(a)	.979	9.536	13.448

a: Covariates appearing in the model are evaluated at the following values: Pre-test = 4.471.

Table 18 shows that the boys with a mean score of 14.134 with a standard error of 0.67 scored higher than the girls with a mean score of 11.492 and a standard error of 0.979. It also shows that 95% of the males had corrected scores ranging from 12.795 and 15.473 while 95% of the females had scores ranging from 9.536 and 13.448. The above scores statistically equated the pre-test scores for the two groups .The corrected values were used to carry out an ANCOVA on the CHAT post-test scores to find out if the means between the control and experimental groups were statistically significant. The results are displayed in Table 19:

Table 19: ANCOVA Results on CHAT Based on Gender (Post-test)

Dependent Variable: post- test

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	328.334(a)	2	164.167	16.654	.000
Intercept	399.856	1	399.856	40.563	.000
Pre-test	217.511	1	217.511	22.065	.000
gender	21.679	1	21.679	2.199	.149
Error	295.727	30	9.858		
Total	4931.000	33			
Corrected Total	624.061	32			

a: R Squared = .526 (Adjusted R Squared = .495)

An examination of Table 19 reveals that the difference between male and female students is significant $F(1,32)=2.199$ $p>0.05$. This shows that the CSCL teaching method has no effect on student achievement in chemistry according to gender. The results indicate that the CSCL teaching method had no effect on student achievement according to gender. Hypothesis H_03 is therefore accepted.

The results of this study have shown that there is no significant difference in achievement between boys and girls who are taught through CSCL teaching method. The CSCL teaching method does not seem to assist the chemistry teacher in balancing the classroom interaction patterns between boys and girls. This suggests that by using this method, the teacher might not be able to give similar attention to boys and girls and leads to improved achievement by both boys and girls. Eck, Hale, et al (2006) note that while parents have the greatest ability to influence their children, school administrations have the potential to be a powerful starting point for gender equity. According to the results of this study, gender parity in achievement at KCSE examinations cannot be achieved using CSCL teaching method.

The above results also contradict the element of cooperative learning of group heterogeneity (Biehler, Bonk, et al, 1997) where 'at the very least, groups should contain both males and females and students of different ability levels. The gender aspect of this element of cooperative learning does not seem to work well in improving student achievement in chemistry using the CSCL teaching method.

4.8 Results of Pre-test Scores on SAQ According to Gender

Table 20 shows a summary of the pre-test on SAQ based on student gender:

Table 20: Pre -test Mean Scores on SAQ based on student gender

GENDER	N	Mean	Std. Deviation
Male	56	107.321	15.848
Female	23	112.565	8.095

The above scores show that boys with a mean score of 107.321 and a standard deviation of 15.848 performed better than the girls in the SAQ who had a mean score of 112.565 and a standard deviation of 8.095. The above mean scores and standard deviation were useful in calculating t-test scores which was necessary in order to find out if the difference in the means was statistically significant. The results obtained from the t-values would be used to

draw inferences about the experimental and control group used in the SAQ based on gender to the population of Nakuru North District. Since the experimental and control groups were drawn randomly from Nakuru North District, it was representative of the population of the study The results of the t- test scores on attitudes post-test is shown in Table 21:

Table 21: T-Test Score Results on SAQ Pre-test Based on Gender

t-Test for Equality of Means						
t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
					Lower	**Upper**
-1.504	77	.137	-5.244	3.486	-12.185	1.698

Table 21 indicates that the t-test scores were not statistically significant (t (77) = 0.137 p >0.05). The negative t-value shows that the mean scores for the control group were larger than for the experimental group. Since the probability value of 0.137 is more than the alpha value of 0.05, the differences between the means were not statistically significant. Both boys and girls had similar attitudes at the beginning of the study.

4.9 Attitude of Boys and Girls Exposed to CSCL

In order to determine the relative effects of CSCL teaching method on student attitude in chemistry according to gender, analysis of the students' post-test SAQ scores was carried out. Hypothesis Ho4 sought to find out if there was a statistically significant difference in attitudes of secondary school boys and girls who are taught through CSCL teaching method in Nakuru North District. Table 22 shows the mean scores of the SAQ post-test scores based on gender for students taught through CSCL.

Table 22: Mean Scores of the SAQ Post-test Scores Based on Gender

Gender	N	Mean	Std. Deviation
male	28	115.179	13.679
female	12	116.417	10.361

Table 22 shows that the mean scores of the girls of 116.417 and standard deviation of 10.361 on the SAQ were higher than that of the male students who had a mean score of 115.179 and a standard deviation of 13.679. The above mean scores and standard deviations were useful in calculating t-test scores on the SAQ post-test scores based on student gender which was necessary in order to find out if the difference in the means was statistically significant. The results obtained from the t-values would be used to draw inferences about the experimental and control group used in the SAQ based on gender to the population of Nakuru North District. Since the experimental and control groups were drawn randomly from Nakuru North District, it was representative of the population of the study The results of the t- test scores on attitudes post-test is shown in Table 23:

Table 23: T-Test Results on SAQ Based on Gender (Post-test)

t-test for Equality of Means						
t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
-.280	38	.781	-1.238	4.418	-10.184	7.708

Table 23 shows that the differences in the means are not statistically significant, t (38) =0.781 p>0.05. The negative t-value shows that the girls performed better than the boys in the SAQ post-test scores. The probability value of 0.781 was more than the alpha value of 0.05. Hypothesis $H_0$4 was therefore accepted.

Further research carried out by Wachanga (2002) shows that the results of the cooperative class experiment teaching method on secondary school students' motivation to learn chemistry in Nakuru District increased student motivation significantly for boys in boys school was better than for boys in co-ed schools but the type of school attended did not influence the motivation of girls who were taught through the CCE teaching method. Wachanga (2002) concludes that CCE is an effective teaching method which chemistry teachers should be encouraged to use. These results affirm the results of the present study concerning attitudes of boys and girls in mixed schools. CSCL might be one way in which gender parity in secondary schools can be achieved.

Analysis of the results was also carried out using ANCOVA as shown in Table 24:

Table 24: ANCOVA Results on SAQ Based on Student Gender (Post-test)

Dependent Variable: post-test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3915.808(a)	3	1305.269	2.142	.103
Intercept	1588.945	1	1588.945	2.607	.111
Pre-test	3734.400	1	3734.400	6.127	.016
Gender	324.977	2	162.489	.267	.767
Error	43273.179	71	609.481		
Total	822194.000	75			
Corrected Total	47188.987	74			

a: R Squared = .083 (Adjusted R Squared = .044)

An examination of Table 24 reveals that the difference in attitudes between boys and girls was not significant: $F(1, 71) = 0.267$ $p > 0.05$. This shows that there was no difference in attitudes between boys and girls. Hypothesis $H_0 4$ was therefore accepted.

The results of this study have shown that there is no statistically significant difference in attitude between boys and girls who are taught through CSCL teaching method. Eck, Hale and Tjelmeland (2006) notes that the gender gap and gender bias in technology are complicated issues. Equal accessibility for girls can only come when parents, school district, and manufacturers work together for equal accessibility. Parents need to participate both in the home and school seeking to ensure that girls are computer literate. School districts, through the administration and teachers, must actively encourage young girls' interests in computer science. Hard and software manufacturers as well as internet services also need to begin providing interesting and constructive materials for girls. When these major influences, parents, school districts and manufacturers, make encouraging female participation in computer use a priority, equality in accessibility for females will eventually be achieved. CSCL is just one way in which gender bias in schools may be alleviated.

4.10 Discussion of Results

It is through the quasi-experimental design that one is able to demonstrate the effectiveness or otherwise of CSCL teaching method on the achievements and attitudes of students in chemistry in Nakuru North District. The major outcomes from the research reported in the study were as follows:

i) The CHAT pre-test and post-test scores show that CSCL teaching method has a statistically significant effect on the achievement of students in chemistry in Nakuru North District.

ii) The SAQ pre-test and post-test score show that CSCL teaching method has a statistically significant effect on student attitudes in chemistry in Nakuru North District.

iii) The results on attitudes according to gender show that CSCL teaching method has no statistical effect on achievement according to gender in Nakuru North District.

iv) The results on achievement according to gender have no statistical effect on the attitudes of boys and girls in Nakuru North District..

Low achievement scores on the CHAT brought about by the intervention of CSCL teaching method could have been as a result of student-teacher interaction, methodology and resources used (Kiboss, Nassiuma, et al 2004). It could also have been as a result of the limited amount of time for the study. Fraser and Walberg (2002) note the relationship between time and achievement at terminal secondary school level in different countries. The results provide evidence that time spent on the study of a subject is a critical factor influencing achievement at the upper secondary school level. The limited time factor on the effect of CSCL teaching method could have influenced the achievement scores of secondary school students in chemistry in Nakuru North District.

The results of the pre-test on the CHAT mean scores showed a significant difference between the two groups where the control group did much better than the experimental group. Since the study had a categorical investigative variable. that is the post-test scores and an ordered control independent variable, that is the pre-test, it was necessary to test if the groups defined by the post-test differed on the mean scores when adjusting for the effects of the pre-test. As noted earlier, the ANCOVA was carried out to:
i) statistically equate the control and the experimental group and
ii) to increase the precision of the analysis by decreasing the error variance
in the model (Pohlmann, 2006).

The mean scores for the CHAT showed a significant difference in the means for the pre-test which made it necessary to equate the two groups using ANCOVA. The mean scores on the post-test still showed that the control group performed better than the experimental group and the differences in the scores were found to be statistically significant. Hypothesis H_01 was therefore rejected. Hertz-Lazarowitz and Miller (1992) show evidence from studies that cooperation is more effective in increasing performance when coordination of efforts is vital to effective functioning, whereas competition is at least as effective as cooperation when coordination of efforts is not so important. Because most tasks of practical importance,

including learning do not require coordination of efforts between two or more individuals, they conclude that competition is usually better than cooperation for most tasks. These findings support the present study where CSCL teaching method resulted in lower achievement of the students.

The results of the study also showed that the t-test results of the pre-test on the SAQ did not show a significant difference in the mean scores. This means that the pre-test was effective in showing that all students had similar attitudes towards chemistry at the beginning of the study. The post-test scores showed that the experimental group performed better than the control group. Both the t-test and the ANCOVA results showed a significant difference in the mean scores of the SAQ post-test. Hypotheses $H_0 2$ was therefore rejected.

The above results show that the elements of cooperative learning were effective in improving attitude scores of students in the SAQ. The observation about cooperative learning is similar to that of Wachanga (2002) that cooperative learning is largely about emphasizing social interactions. Psychology of learning is not only about accumulation of knowledge but is also part of a social context in which students live. In co-operative learning, all students are perceived as "knowing' and that each is able to contribute through discussions and consensus (Kiboss, Tanui, et al, 2004). Johnson and Johnson (1996) note that positive independence and group incentive in cooperative learning techniques like CSCL induce the student to goal directed behaviour.

Jones and Scrimshaw (1988) also support the findings of this study which show that CSCL teaching method improves attitudes of students. They acknowledge the existence of evidence on co-operative learning situations which promote more positive attitudes towards the subject area and the instructional experience than do competitive individualistic experience. The use of computers within the instructional situation, however, often produces high interest in the class, which may result in positive attitudes towards working with the computer and towards the subject area being studied (Jones & Scrimshaw, 1988).

Makau (1988) also carried out a study of student responses on the use of computers in education. Students were asked to respond to statements which elicited attitudes towards use of computers in formal education. The most important perception of the innovation by the students was the recognition that the teacher plays an important role in student learning. Thus, in order for integration of the technology into the new curriculum to succeed, teachers needed to play an active professional role in computer assisted lessons. The students' responses also seemed to imply that the new content must first be learned in the regular lesson under the active guidance of the teacher. This was the basis of CSCL teaching method where students attended regular chemistry lessons to learn the content on ' Acids, Bases and Indicators' before proceeding to the computer laboratory to perform the experiments. This may be a reason as to why student attitudes improved using CSCL teaching method.

When the CHAT mean scores were analysed according to gender, the pre-test scores showed that the mean scores between boys and girls were not statistically significant. Therefore both boys and girls had similar achievement scores at the beginning of the study. On the other hand, an examination the post-test scores revealed that the difference between male and female students was significant with boys performing better than the girls. Hypothesis $H_0 3$ was therefore accepted. However, there was a marked improvement in the mean scores of the girls from the pre-test. The current results show that improved performance by girls was due to CSCL which gave the students expanded perception on resolving differences of opinion and discussion which involved cooperation (Kiboss, Nassiuma et al, 2004). Aronson (2002) notes that many researchers studying motivation have taken the broad perspective that it is children's interpretation of their achievement outcomes that are critical mediator of subsequent achievement behaviour. Therefore students' beliefs about themselves and their achievement have been a major focus of research. CSCL teaching method motivated the girls to perform better in the post-test scores in the CHAT. There are many gender differences in children's competence beliefs for activities in different domains. These differences are intriguing in light of evidence that achievement scores and test score differences between boys and girls are decreasing (Aronson 2002). However these results contradict the findings of the present study.

Aronson (2002) also notes intrinsic and extrinsic motivation play a part in the many gender differences for activities in different domains that gender differences in verbal ability are negligible; differences in quantitative skills show that girls' computation skills are better at all ages and boys do better in mathematics conceptual "word problems" In high school, differences in science knowledge and process skills favour boys though they are decreasing and appear to reflect experiential differences between boys and girls. The findings by Aronson (2002) are in agreement with the present study where girls were motivated to improve their attitude scores in chemistry. The results however need to be studied further.

Helgeson and Kumar (2000) who studied the effect of gender on computer-based Chemistry problem solving did not find any differences between male and female high school students solving stoichiometric chemistry problems through the computer. They attribute increase in student achievement in computer-based science tasks to the availability of immediate feedback. The Hyper equation software used in their study was programmed to provide immediate feedback which might have contributed to narrowing any gender gaps. They further note that the quality of feedback has an effect on the "self- confidence" of females and consequently in the science learning tasks. They also recommended for further research to what extent feedback influenced particularly the performance of female students in the study. The immediate feedback feature was not incorporated in CSCL software used in the study. This could have been a factor that would have enhanced the CSCL teaching method used in the study.

Jones and Scrimshaw (1988) also outline a study conducted to compare the results of computer assisted cooperative, competitive and individualistic learning. The study was the first to compare the effectiveness of cooperative, competitive and individualistic goal structures in computer assisted instruction. The results indicate that when teachers wish to maximize achievement in computer assisted learning tasks, they will be well advised to structure the lesson cooperatively rather than competitively and individualistically. The study concludes that girls will be adversely affected by competitively structured computer-

assisted lessons. They therefore support the combination of co-operative learning and computer assisted instruction. However the findings are contrary to the present study.

SAQ pre-test mean scores were also analysed according to gender. The scores showed that the mean scores between boys and girls were not statistically significant. Therefore both boys and girls had similar attitude scores at the beginning of the study. An analysis on the post-test scores according to gender showed no significant difference in the attitude scores where girls performed better than the boys. Hypothesis $H_0 4$ was therefore accepted. These results are in agreement with studies by Kiboss, Nassiuma, et al (2004) and also Wachanga (2002) who apply the elements of cooperative learning in their studies.

Fraser and Walberg (1995) note that while computer applications are believed to have much potential for science education, the anticipated effects of using new technologies often are not supported by empirical evidence. It is often asserted that new technologies enhance students' performance and motivation. For science education specifically, simulations, micro-computer based laboratories and databases are said to be important for facilitating mastery of science concepts and of science process skills (Fraser & Walberg, 1995). Kiboss (2002) notes the importance of a paradigm shift within the teacher in order for Computer Based Instruction to be effective: Change is an important element in education but for genuine change to occur in the classroom milieu, the teacher must undergo a radical transformation of attitudes. Without such a transformation, new innovations may not succeed because many teachers are fond of teaching what they were taught as children rather than what they were taught to teach. Genuine change can only occur in the classroom when the teacher is willing to change. Part of the reason why the use of computer based instruction to augment regular teaching method in Kiboss' study was successful was perhaps well illustrated by a teacher's own account of the first experience in having to use computer based instruction in a real physics laboratory classroom.

Although the teacher who used CBI successfully felt change was desired, the process was a gradual process. Once he had internalised the process he seemed ready for it. Kiboss (2002) further notes that the teacher became aware of his need for a paradigm shift in his

instructional practice which entailed the realisation of his limitation and the need to improve and foster reciprocal relationships between him and his pupils. Despite his initial misgivings, the teacher was convinced that change was inevitable in order to adequately face new challenges. He seemed quite ready for a genuine change. This was quite apparent as the teacher seemed willing to abandon his previous approach and embrace the new method which he reckoned might eventually improve the classroom environment. The present study did not show improvement in the mean scores of CSCL. This could be attributed to a lack of paradigm shift within the teacher which is a factor that needs to be taken into consideration in the future. The teacher may have embraced the regular teaching methods as opposed to CSCL teaching method. It is through the qualitative approach that one is able to gain detailed context bound information necessary to understand the effectiveness or otherwise of computer based instruction as it is experienced in the classroom setting (Kiboss, 2002).

From the above discussion, CSCL teaching method is useful in improving attitude scores of students and the finding are in agreement with other researchers. However, the method seems to lower achievement scores of students even when based on gender. Other researchers seem to contradict this finding as cooperative learning techniques improve achievement in their studies. However, the results need to be verified with a larger sample size .

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on this study, the following conclusions have been reached

i) The CSCL teaching method does not facilitate students' learning in chemistry better than the regular teaching methods

ii) Students taught through the CSCL teaching method show an improvement in attitudes towards chemistry compared to those who are taught through regular teaching methods.

iii) The use of CSCL teaching method does not improve secondary school boys and girls' achievement scores in chemistry.

iv) The use of CSCL teaching method significantly improves secondary school boys and girls' attitudes towards chemistry.

5.2 Implications of the Study

Although CSCL teaching method results in lower student achievement than the regular teaching methods, it can be used together with the regular teaching methods since it improves on students' attitudes . Slavin (1990) notes that any cooperative learning model is more effective when it is used to supplement but not to replace other teaching methods. Most studies carried out on cooperative learning techniques show an improvement in achievement and attitudes. CSCL teaching method only improves on attitudes of students but negatively affects their achievement. Scrimshaw and Jones (1988) also support the use of computers in the classroom as an effective motivator in group work. This method is therefore likely to assist on changing the trend where boys' attitudes have been better than that of their female counterparts. However, more research is required concerning achievement scores in chemistry using CSCL teaching method using a larger population.

The results of this study indicate that CSCL teaching method extends a positive influence on attitudes especially when used hand in hand with regular teaching methods. This implies that the problem of poor attitudes in Chemistry may be addressed by incorporating the CSCL teaching method at the secondary school level. Results have shown that both boys and girls have comparable attitudes. It seems likely that the CSCL teaching method has the potential of maintaining these comparable attitudes throughout the secondary school course. Widespread implementation of this method would be beneficial to students.

5.3 Recommendations

Based on this study, the researcher makes the following recommendations:

i) The Ministry of Education should include the CSCL teaching method in their teacher training workshops like SMASSE with an aim of making it part of the Chemistry curriculum.

ii) More research on the CSCL teaching method with more student population should be done to ascertain the results of this study.

iii) More schools in Nakuru North District should be made computer equipped so as to enhance the CSCL teaching method.

5.4 Areas for Further Research

The present study suggests that the CSCL teaching method can be effective in improving student attitudes. However, there are areas that warrant further investigation to enhance the findings of this study such as such as the following:

i) An inquiry to determine the students' perception of the classroom environment when taught through CSCL

ii) An in-depth study of the effects of collaborative versus cooperative leaning computer supported learning strategies on secondary school students' achievement and attitude in Chemistry.

iii) A study aimed at redressing the balance between students learning with CSCL teaching

method rather than about how to use the computer program and practice of computer skills

during the lesson.

iv)A study aimed at determining the students' interaction patterns during the lesson in boys only, girls only and co-ed classes including varying the number of boy and girls in the cooperating groups on students' attitude and achievement.

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APPENDICES

Appendix A

Student Attitude Questionnaire (SAQ)

STUDENT NO: (Optional) _____ CLASS_____ AGE_____.

SEX____

INSTRUCTIONS

1. This is not a test and there are no correct or wrong answers
2. It is important that you tell us your honest view
3. Read the items carefully and try to understand before choosing what truly reflects your perception of Chemistry.
4. Please circle the response that best reflects how you feel

KEY

SA: Strongly agree A: Agree D: Disagree SD: Strongly Disagree

U: Uncertain

1) I prefer to work alone than in groups SA A D SD U

2) I find working around the computer more helpful than individual work

SA A D SD U

3) I have participated in other voluntary group work during the course of the year

SA A D SD U

4) What size group do you prefer to work with?

1-2 3-5 more than 5

5) I find the value of self-help study groups helpful.

SA A D SD U

6) If given an opportunity to learn through the computer, I expect

i) pleasure SA A D SD U

ii) a source of anxiety SA A D SD U

iii) Stress and demand SA A D SD U

iv) to appreciate Chemistry SA A D SD U

v) to be more interested in Chemistry SA A D SD U

7) I expect learning through the computer to be

i) Fun	SA	A	D	SD	U
ii) Informative	SA	A	D	SD	U

8) I find learning around the computer

i) Stimulating	SA	A	D	SD	U
ii) Time wasting					
	SA	A	D	SD	U
iii) Useful	SA	A	D	SD	U
iv) interesting	SA	A	D	SD	U

9) I will become more interested in chemistry after using the computer in class

SA A D SD U

10) I will become more active in chemistry because of working in groups at the computer

SA A D SD U

11) I feel that girls will have more opportunities to use the instrument than boys will

SA A D SD U

12) I do not mind working in groups when drawing the observations

SA A D SD U

13) I expect scientific principles illustrated by the new technology's pictures and diagrams to be clear

SA A D SD U

14) Typing on the keyboard is difficult and frustrating.

SA A D SD U

15) Our teacher pays more attention to boys than girls do

SA A D SD U

16) I expect the new technology's directions to be clearer than the teacher's directions

SA A D SD U

17) I need more than class time to finish my work

SA A D SD U

18) I will do new and interesting things via the new technology

SA A D SD U

19) Gaining access to the Chemistry lessons on the computer should be easy and interesting

SA A D SD U

20) My fellow students should be friendly and work together as a team

SA A D SD U

Appendix B

Chemistry Achievement Test (CHAT)

NAME_____ ADM Number_____ 30 marks

SCHOOL _____

INSTRUCTIONS: Answer ALL questions in the spaces provided

TIME: 40 Minutes

1) Complete the following table by writing the PH values against the corresponding solutions (Use PH values 2,7,11,5 and 10)

(5mks)

Solution	**PH Value**
Sodium Hydroxide	
Ethanoic Acid	
Hydrochloric Acid	
Wood Ash	
Distilled Water	

2) A form one student went to the laboratory and found different test tubes with solutions A, B, C and D and three bottles labelled 1, 2 and 3. She proceeded to identify the solutions and indicators. The results are shown below:

Solution	**Colour Indicator**		
	1	2	3
A	Red	Colourless	Red
B	Yellow	Pink	Blue
C	Red	Colourless	Red
D	Yellow	Punk	Blue

i) Group the solutions as either acids or bases (2 makes)

A _____ B_____

C_____ D_____

i) Identify indicators:

1) _____ 2) _____ 3) _____ (3mks)

3) i) What is an acid base indicator?

_____

_____ (1mk)

ii) What is the advantage of the universal indicator over other indicators? (1mk)

_____

3) State three reactions involving acids that produce hydrogen gas (3 mks).

i)_____

ii)_____

iii)_____

5)Write word equations for the reactions between dilute hydrochloric acid and:

i) zinc

metal_____

ii) Magnesium

metal_____

iii) Copper (II)

Carbonate_____

iv) Sodium Hydrogen

Carbonate_____

(4 mks)

6) Explain why the reaction between calcium and dilute sulphuric acid slows don and eventually

stops_____

_____

_(2mks)

7)What is the purpose of tartaric acid in baking powder?_____

_____

__(2mks)

8)State whether solutions having the following PH values will be strong acids, weak acids, strong bases weak bases or neutral (5mks)

PH 10_____

PH 2_____

PH 6_____

PH 7_____

PH 8_____

9) Name the product of the reaction between a base and an acid (1mk)

_____

_____

b) What is the above reaction called? (1mk)

_____

10) Why do alkalis have a soapy feel? (1mk)

_____

_____

Appendix C

CHEMLAB LABORATORY MANUAL

ACIDS, BASES AND INDICATORS AND INDICATORS

Introduction

An indicator is a substance that displays different colours in basic and acidic solutions. Plant extracts are simple acid- base indicators. It is possible to use flower extracts to group different substances into acids and bases.

EXPT: To investigate the colour changes of indicators in different substances

REQUIREMENTS

Apparatus

Test-tube rack

7 test tubes

Chemicals

Bromothymol blue

Phenolphthalein

Litmus solution

Methyl orange

Lemon or orange juice

Dilute hydrochloric acid

Baking powder solution

Vinegar

Soap solution

Sodium hydroxide solution

Procedure

1. Place four test tube racks with seven test tubes in each rack

2. Take indicator bottles containing, bromothylmol blue, and phenolphthalein. Litmus solution and methyl orange
3. Put to one set of seven test tubes, 2- 3 cm^3
4. $^{+}$ of lemon or orange juice, hydrochloric acid, baking powder solution, vinegar, soap solution and sodium hydroxide.
5. Add 2 drops of bromothymol blue to each of the seven test tubes with the solutions and record the colour changes

To Show the Effect of Commercial Indicators on Substances

Substance	Bromothymol Blue	Phenolphthalein	Litmus solution	Methyl Orange
Lemon or orange juice (Citric acid)				
Hydrochloric acid solution				
Baking powder solution (tartaric acid)				
Vinegar (Acetic acid)				
Soap solution				
Dilute sodium hydroxide				

Repeat the experiment with the other three sets of test tubes and the other indicators (phenolphthalein, litmus solution and methyl orange (each at a time)

Discussion questions

1. Comment on the outcome after performing the experiment
2. Why do you think small amounts of indicators are recommended?

3. Do substances with the same colour have same acidity or alkalinity?

Universal indicator and the PH scale

The indicators used so far showed the same colour changes for the following: vinegar and lemon or orange juice. To know if substances have the same acidity or alkalinity, the universal indicators used. This indicator is a mixture of indicators and is used to show the extent of acidity or alkalinity of a substance. The extent of acidity or alkalinity of a substance is then read on a pH scale by matching the colour change to the corresponding numerical value on a similar colour band on the pH scale.

The pH values for acids range from zero to just below seven (7) whereas those for bases range form just above 7 to 14. All values on the scale are from 0-14. Seven (7) indicates the neutral value. The lower the pH value, the more acidic a substance is, while the higher the pH value, the more alkaline or basic it is.

EXPERIMENT: To show different colour changes of the universal indicator and the pH values in different solutions

REQUIREMENTS

Apparatus

Test-tubes

Test-tube racks

Droppers

Chemicals

Universal Indicators

Refer to solutions in the table

Other materials

PH chart/ meter

Procedure

1. Add 2 drops of the universal indicator in the solution being tested.

2. Match the colour change to the corresponding colour on the pH meter and hence deduce the approximate pH Value
3. Record the colour change and the pH value for each substance

Solution or suspension	Colour on adding 2 drops of universal indicator	pH value
1.Distilled water		
2 Lemon juice		
3. Baking powder solution		
Ammonia solution (dilute)		
Ammonium sulphate solution		
Sodium Chloride solution		
Sodium Hydroxide solution		
Carbon dioxide solution		
Sulphur dioxide solution		
Dilute sulphuric acid		

Discussion Questions

1. Which substances can be listed under strong acids?
2. Which substances can be listed under strong bases?
3. Which substances can be listed under weak acids?
4. Which substances can be listed under weak bases?
5. Which substances can be listed under neutral substances?

Reactions of Acids with Metals

Acids are substances, which dissolve in water to produce hydrogen ions as the only positive ion. A solution of hydrochloric acid for example contains hydrogen ions and chloride ions. Similarly sulphuric acid solution contains hydrogen ions and sulphate ions. When an acid reacts with a metal, the hydrogen in the acid is displaced by the metal to form hydrogen gas and a salt

Acid + Metal→ Salt + Hydrogen

Example:

a) When dilute sulphuric acid is added to zinc granules, hydrogen gas and a salt (zinc sulphate) are produced:

Zinc + Sulphuric acid→ Zinc Sulphate + Hydrogen

b) Magnesium reacts vigorously with the acid than zinc

Magnesium + Hydrochloric acid → Magnesium chloride + Hydrogen

Very reactive metals like potassium, sodium and calcium react violently with acids and should not be used in this experiment. The reaction of calcium metal with dilute sulphuric acid slows down and eventually stops due to the formation of insoluble calcium sulphate which coats the metal and prevents it from further reaction.

Acids react with carbonated and hydrogen carbonates to produce carbon dioxide gas, a salt and water

Acid + Carbonate→ Salt + Water + Carbon dioxide

Acid + Hydrogen Carbonate→ Salt + Water+ Carbon dioxide

The reaction of sulphuric acid with calcium carbonate stops immediately due to the formation of an insoluble layer of calcium sulphate, which prevents further action of the acid on the carbonate.

EXPERIMENT: To investigate how dilute acids react with carbonates and hydrogen carbonates

1. Add a spatula end- full of the solids listed below to a test-tube containing about 2 cm3 of one of the acids. Pass the gas liberated though limewater. Repeat the experiment until each solid had been added to each acid, using fresh samples of limewater in each case.
2. Record the observations
3. The solids used in this experiment are: Sodium carbonate, Calcium Carbonate, Copper (II) Carbonate and sodium hydrogen carbonate. The acids used are: Hydrochloric acid, Nitric acid and Sulphuric acid.

Discussion Questions

1. What was the gas evolved in each case?
2. Explain the observations made when dilute sulphuric acid reacts with calcium carbonate.

Metal Carbonate or Hydrogen carbonate	Hydrochloric acid	Nitric Acid	Sulphuric Acid
Sodium Carbonate			
Calcium Carbonate			
Copper Carbonate			
Sodium Hydrogen Carbonate			

Neutralisation Reaction

Sodium Hydroxide is a soluble base. When an acid and a soluble base react, the hydrogen ions (H+) from the acid and the Hydroxyl ions (OH-) from the base combine to form water. The other product is a salt in solution. This is a neutralisation reaction

Sodium Hydroxide + Hydrochloric Acid → Sodium Chloride + Water

The point at which the amount of hydrogen ions from the acid becomes equal to that of the hydroxyl ions from the base is known as the end point or the equivalence point. The end- point is detected by use of an acid –base indicator such as methyl orange

To investigate how dilute acids react with bases

a) Pipette 25.0 cm^3 of 1M SODIUM HYDROXIDE solution into a conical flask and add three drops of methyl orange indicator.
b) From a burette, add 1M hydrochloric acid to the solution until the indicator just changes colour. The solution is now neutral i.e. it does not contain any excess acid or alkali (soluble base).
c) Record the volume of the acid added from the burette.

Note: The Volumes of hydrochloric acid and sodium hydroxide, which neutralizes each other, are known; repeat the experiment this time without the indicator. Evaporate the neutral solution until it is saturated. Allow the saturated solution to cool to obtain the crystals of the salt sodium chloride.

Discussion questions

1. Why was it necessary to use an indicator in this experiment?
2. What observations are made when hydrochloric acid is added to sodium hydroxide? Write a word equation for this reaction

EXPERIMENT: To investigate how dilute acids react with insoluble bases

When an acid reacts with metal oxides, a slat and water are formed as the only products

Acid + Metal oxide → Salt + Water

These are also neutralisation reactions

Examples

Aluminium oxide + Nitric Acid Aluminium Nitrate + Water

Zinc Oxide + Hydrochloric Acid Zinc Chloride + Water

Copper Oxide + Sulphuric Acid Copper Sulphate + Water

Place a small sample of aluminium oxide into a test-tube and add to it 5 cm3 of dilute nitric acid and shake the mixture. Repeat the procedure using the following solids in different test tubes: Zinc oxide, Copper (II) oxide), Magnesium oxide and lead (II) oxide. Record your observations. Where a reaction does not seem to occur, warm the mixture gently.

Record your observations

Name of solid	Observation When Acid is added
Aluminium Oxide	
Zinc oxide	
Copper (ii) oxide	
Magnesium oxide	
Lead (II) oxide	

Bases

A base can be defined as a substance which when reacted with acids from salt and water as the only products. Ammonia solution, metal oxides and metal hydroxides are examples of bases

Bases turn moist litmus paper blue. Soluble bases are called alkalis. Alkalis have a soapy feel.

Most metal oxides and hydroxides are insoluble in water. The insoluble metal hydroxides are classified as basic hydroxides while the insoluble metal oxides are classified as basic oxides

Calcium hydroxide is sparingly soluble. It forms a white suspension in water

EXPERIMENT: To investigate whether all bases dissolve in water

Place a spatula end-full of sodium oxide in a test-tube.

Add 5 cm^3 of water and shake to dissolve.

Test the resulting product with red and blue litmus paper.

Repeat the procedure using zinc oxide, copper (II) oxide, calcium oxide and magnesium oxide.

Record the observations in table form

Discussion question

What is the effect of bases on litmus?

EXPERIMENT: To investigate what happens when metal hydroxides are heated

Place 2 cm^3 of 1 M zinc sulphate in a boiling tube and carefully add 2 or 3 drops of 2M sodium hydroxide solution. Decant and precipitate gently at first and then strongly. Record your observation in table form

Repeat the procedure using different boiling tubes containing the following salt solutions instead of Zinc sulphate: Magnesium sulphate, calcium chloride, iron (II) sulphate, iron (II) chloride, copper (II) sulphate and lead (II) nitrate

2) Classify bases according to their solubility

EGERTON UNIVERSITY LIBRARY

Appendix D

Research Authorization

MINISTRY OF SCIENCE & TECHNOLOGY

Telegrams: SCIENCE TEC", Nairobi

Fax No.
Telephone: 318581
When replying please quote

REPUBLIC OF KENYA

JOGOO HOUSE
HARAMBEE AVENUE
P. O. Box 60209-00200
NAIROBI
KENYA

MOST 13/001/37C 16/2

16th January 2007

Mary Kemunto Nyaema
Egerton University
P.O. Box 536
NJORO

Dear Madam,

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on, ***'Effects of Computer Supported Co-operative Learning on Sec. School Students Achievements and Attitudes in Chemistry in Nakuru District'***

I am pleased to inform you that you have been authorized to carry out research in Nakuru District for a period ending 30th July 2007.

You are advised to report to the District Commissioner and the District Education Officer, Nakuru District before embarking on your research project.

On completion of your research, you are expected to submit two copies of your research report to this office.

Yours faithfully

M. O. ONDIEKI
FOR: PERMANENT SECRETARY

Copy to:
The District Commissioner
Nakuru District

The District Education Officer
Nakuru District