INFLUENCE OF COMPUTER AIDED INSTRUCTION ON STUDENTS’ ACHIEVEMENT, SELF-EFFICACY AND COLLABORATIVE SKILLS IN CHEMISTRY IN SECONDARY SCHOOLS OF THARAKA-NITHI COUNTY, KENYA.

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Thesis Submitted in Fulfilment of the Requirement for the award of degree of Doctor of Philosophy in the School of Education, Kenyatta University

JANUARY, 2018
DECLARATION

Declaration

This thesis is my original work and has not been presented in any other university or institution for consideration or certification. This research thesis has been complemented by referenced sources duly acknowledged. Where text, data (including spoken words) graphics, pictures or tables have been borrowed from other sources, including the internet, these are specifically accredited and references cited using current APA system and in accordance with anti-plagiarism regulations of Kenyatta University.

Signature _______________________________ Date____________________
Judith Kinya Julius
Reg. E83/25658/2013

Supervisors’ declaration

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Signature______________________________ Date____________________
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Kenyatta University
DEDICATION

This doctoral thesis is dedicated to my husband Silas, my daughter Emily and son Vincent.

Your support and love have borne this thesis.
ACKNOWLEDGEMENTS

I thank the Almighty God for the sustenance throughout my doctoral journey. This thesis was prepared under the supervision of Professor Nicholas Twoli and Professor John Maundu. I would like to thank them sincerely for their encouragement, counsel and generous guidance without which, this work would not have been possible. Your mentorship has been invaluable in my academic advancement. I am greatly indebted to all members of the Department of Educational Communication and Technology who assisted me with invaluable advice in the course of this study.

I am grateful to the County Director of Education for Tharaka Nithi for giving an introductory letter and allowing me to conduct research in the Maara sub-county. I thank the principals of participating secondary schools for allowing me to conduct research in their schools. I thank the assisting teachers and the students in the participating schools for patiently participating in my research with honesty. Above all, my greatest debt is to my family for their encouragement, support and understanding during the long period of study. You inspired me in many ways and I am thankful. For those not mentioned herein by name, your support and contributions are highly appreciated and acknowledged.
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ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>ANCOVA</td>
<td>Analysis of Covariance</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
</tr>
<tr>
<td>ASEI-PDSI</td>
<td>Activity, Student, Experiment and Improvisation-Plan, Do, See and Improve</td>
</tr>
<tr>
<td>CAI</td>
<td>Computer Aided Instruction</td>
</tr>
<tr>
<td>CAT</td>
<td>Chemistry Assessment Test</td>
</tr>
<tr>
<td>CIM</td>
<td>Conventional Instruction Methods</td>
</tr>
<tr>
<td>CEMASTEIA</td>
<td>Center for Mathematics, Science and Technology Education in Africa</td>
</tr>
<tr>
<td>COS</td>
<td>Classroom Observation Schedule</td>
</tr>
<tr>
<td>DEO</td>
<td>District Education Office</td>
</tr>
<tr>
<td>KCPE</td>
<td>Kenya Certificate of Primary Education</td>
</tr>
<tr>
<td>KCSE</td>
<td>Kenya Certificate of Secondary Education</td>
</tr>
<tr>
<td>KICD</td>
<td>Kenya Institute of Curriculum Development</td>
</tr>
<tr>
<td>KNEC</td>
<td>Kenya National Examinations Council</td>
</tr>
<tr>
<td>ICT</td>
<td>Information Communication and Technology</td>
</tr>
<tr>
<td>INSET</td>
<td>In-Service Education and Training</td>
</tr>
<tr>
<td>MOEST</td>
<td>Ministry of Education Science and Technology</td>
</tr>
<tr>
<td>NI3C</td>
<td>National ICT Innovation and Integration Center</td>
</tr>
<tr>
<td>SMASSE</td>
<td>Strengthening of Mathematics and Science in Secondary Education</td>
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<tr>
<td>SSES</td>
<td>Students Self-Efficacy Scale</td>
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ABSTRACT

The study investigated how the use of Computer Aided Instruction (CAI) affects students’ achievement, self-efficacy and collaborative skills in learning Chemistry when compared with the use of Conventional Instructional Methods (CIM). The objectives of the study were: To investigate the effect of CAI on students’ achievement in Chemistry when compared with CIM, to establish gender difference in Chemistry achievement when students are taught using CAI, to assess students’ self-efficacy in the learning of Chemistry when taught using CAI and CIM, to establish gender difference in students’ self-efficacy in Chemistry when students are taught with CAI, to determine students’ development of collaborative skills in Chemistry when taught using CAI and CIM, and to establish the challenges of employing CAI in Chemistry. The study adopted quasi experimental design, based on Solomon Four- Group, Non-equivalent Control Group Design. There were 15 secondary schools with computer laboratory in Maara District, Tharaka Nithi County. Four Extra-County secondary schools with computer laboratory were purposively sampled which included two girls’ only and two boys’ only schools. The four schools were then randomly assigned to either experimental or control groups. The study sample comprised of 174 Form Two Chemistry students from the four sampled schools. The study involved two Experimental groups which were taught through CAI method (use of tutorials, simulations and drill and practice applications) and two Control groups which were taught through CIM (non-computer aided methods) on the topics “Atomic structure, Periodic Table and Chemical families” for six weeks. Data was collected using three instruments namely; Chemistry Achievement Test (CAT), Students’ Self-efficacy Scale (SSES) and Classroom Observation Schedule (COS). Each of the instruments was administered before and after exposure of treatment (CAI) to both experimental and control group. Pilot testing of the treatment instrument, CAT, SSES and COS was done in two secondary schools in Maara Sub-county having the same characteristics as the sample schools. The reliability coefficients of the CAT and SSES were estimated using Cronbach’s Alpha Coefficient and an alpha coefficient of 0.720 and 0.884 was obtained respectively. The researcher administered the CAT and SSES instruments with the assistance of Chemistry teachers in the sampled schools while the COS was utilized by the researcher. Data was analyzed using both descriptive and inferential statistics. The differences between the group means was analyzed using t-test, Analysis of Variance and Analysis of Covariance. The statistical significance was tested at $\alpha = 0.05$. The study revealed that, the students who were taught chemistry with CAI obtained higher chemistry achievement scores, higher self-efficacy scores and higher collaborative skills scores than the students who were taught with CIM. The study further revealed that girls obtained higher chemistry achievement scores and also higher self-efficacy scores than boys when taught with CAI. The study further revealed that chemistry teachers faced some challenges including inadequate ICT resources when employing CAI in classroom instruction. The findings of this study would be beneficial to chemistry teachers in adopting instructional strategies that would help improve students’ achievement, self-efficacy and collaborative skills in chemistry. In addition, the findings would be valuable to all stakeholders concerned with the enhancement of learning chemistry.
CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Preamble

This chapter presents the fundamental elements of the study on the use of computer aided instruction in Chemistry and its effect on students’ achievement, self-efficacy and collaborative skills. It begins with the background to the study which formed the basis of the study. It was from this background that the problem, purpose and objectives of the study were formulated. Other key elements in this chapter include the research questions, hypotheses, the significance, limitations and delimitations, assumptions, theoretical and conceptual frameworks of the study as well as operational definition of key terms.

1.2 Background to the study

Computer Aided Instruction (CAI) is a very powerful instructional technique in the teaching and learning process because CAI provides an interaction between an individual learner and the computer just as it happens in the tutorial system between the teacher and the individual learner, and is able to display the instructional material to the individual student (Olagunju, 2013). CAI is based on the principle of programmed instruction and it makes use of a combination of tutorial, computer simulation activities and drill and practice programs (Stennet, 1985). It an important instructional strategy for teachers as it facilitates the learner by providing individualized instruction, effective interaction with the learner and immediate feedback (Tyagi, 2014). More importantly, it provides text, graphics, audio, visual, pictures, animation and simulation in the same media to students (Olagunju, 2013). CAI programs are therefore multi-media programs.
CAI scaffolding is computer instructional support, which helps learners to achieve goals or finish tasks that they cannot accomplish on their own but can do with the help from computer tools (Driscoll, 2000). It can support learners both cognitively and affectively. Cognitively, CAI scaffolding focuses on learners’ attention on information relevant to learning or task at hand (Jarvela, 1995), reduce learners’ cognitive load (Oliver, 1999) and prevent them from feeling frustrated by difficult tasks (Rosenshine & Meister, 1992). Affectively, CAI scaffolding offers students emotional support through engaged environments which can lead to successful learning, hence they gain confidence or attach positive feeling to learning (Driscoll, 2000).

Schank (2001) summarized the benefits of CAI in classroom practice. Firstly, it gives opportunities to both students and teachers to be quicker in instruction, promote student-engaged learning, increase learners’ motivation, provide learners with abundant sources of information and support collaborative learning. Secondly, it can change the role of the teachers from knowledge transmitters to facilitators, from primary source of information to knowledge navigator and co-learner, from controlling and directing all aspects of learning to giving learners more options and responsibilities for their own learning. Lastly, it can change the role of the learners from passive consumers of information to active participants in the learning, from reproducing knowledge to producing knowledge, and from learning as a solitary activity to learning collaboratively with others. When teaching Chemistry either practical or theory work, the teacher may require boosting from CAI computer-aided instruction. This is because CAI helps in fostering learners’ understanding, building their confidence and promoting their interactions with one another during the learning process (Jesse, 2012).
Some topics in secondary school chemistry syllabus, such as the constituents of matter (atom, element and molecules), atomic structure and periodic table, structure and bonding, forms of carbon, structures of organic compounds and metals can easily be taught using CAI. Similarly, practical topics which involve preparation of poisonous gases such as chlorine and carbon (II) oxide may be taught effectively through CAI simulations. Unlike experiments, in which the teacher must be present for practical activities to be performed, CAI programmed experiments can be simulated and learners can replay the simulated program even in the absence of the teacher. For this reason, use of CAI in schools is gaining prominence all over the world, including Kenya.

In United States of America, Computer Aided Instruction has been used for more than five decades for educational purposes. CAI started in the 1950s and 1960s in America pioneered by Kemeny and Kurtz (1964) who used a computer as part of the learning process. Kinnaman (1990) observes that in the U.S.A, the number of schools owning computers increased from approximately 25 percent in 1981 to virtually a 100 percent by the end of the decade. More significantly, CAI has been used as a method for addressing improvement in students’ learning outcomes as it offers manifold advantages over the conventional instruction methods. Fraser, Walberg, Welch and Hattie (1987) noted that the use of CAI for instruction resulted in increased student interest, cooperation and achievement in science.

In Europe, studies affirms CAI as an effective teaching approach for enhancing student’s achievement in learning Science. For example, Serin (2011) found that fourth year students in the science and technology in Turkey who received computer aided instruction obtained a higher achievement than those who were exposed to traditional method.
Similar results were reported by Ranade, (2006) whose conclusion was that CAI has a positive effect on the academic achievement of students.

Elsewhere, researches have demonstrated that self-efficacy in learning science can be enhanced through use of computers in classroom. For example, Liu and Chen (2013) observed that grade 5 students from elementary school in Northern Taiwan demonstrated effectiveness in learning science when taught through computers. Similarly, Yien, Hung, Hwang and Lin (2011), observed that computer aided learning was more effective in enhancing the self-efficacy of students in learning nutrition course than conventional methods. It therefore, suggest that use of computer aided instruction could be a powerful instructional technique for enhancing self-efficacy of students.

Over the past three decades research on computer-supported collaborative learning has emerged for supporting distance interactions, such as email, chat, instant-messaging capability and resources for synchronous video conferencing, such as Skype (Kreijns, Paul, Kirschner & Wim Jochems, 2003). For example, Dukuzumuremyi (2014) investigated the use of computer supported collaborative learning software and applications and its associated theories of learning and pedagogical models into inclusive classroom as well as conception of knowledge of diverse pupils in collaborative learning. The data suggested that use of computer supported collaborative learning are a resourceful ways of developing collaborative skills.
Inadequacy of CAI resources has been a major challenge to many schools globally. A survey on use of ICT in education, conducted by the European Commission in 31 countries across Europe (European commission, 2013) revealed that on average, there were three to seven students per computer in European schools and at least two out of three computers were found in the computer laboratories and digital resources such as computer simulations were rarely used for lessons. Further, the survey revealed that teachers were familiar with ICT integration but used the computers to prepare their teaching. On average, only a few of the teachers used computers for instructional practices and still to a less extent allowed the students to use it during the lessons.

In Africa, studies on CAI in classroom practice tend to affirm the observations by other researchers globally. For instance in Nigeria, Kareem (2015) investigated the effects of introduction of CAI in Biology when compared to the conventional method of teaching on senior secondary school students’ achievement, revealed that improvement in students’ academic achievement in Biology resulted from use of CAI. Similarly, Olakanmi, Gambari, Gdodi and Abalaka (2016) in their study found that the Nigerian secondary school chemistry students who were taught Chemistry with computer assisted instruction had higher extrinsic and intrinsic motivation as well as achievement than those in conventional teaching methods.

In Kenya, use of CAI in the teaching and learning of Chemistry have been minimal and not widespread. This assertion is supported by Omwenga (2004) who noted that Kenyan high school teachers, chemistry teachers included have done very little to incorporate CAI teaching approach in their classroom practice. The studies conducted in Kenya on CAI also tend to affirm the observations of other researchers globally.
For instance, Jesse (2012) in a study on enhancement of science performance through computer-assisted instruction among selected secondary school learners in Kenya, noted that the improvement in Science performance by the experimental group was as a result of the application of CAI in science. In addition, Charagu (2015) in a study to assess the effects of computer based learning on Kenyan secondary school students’ achievement in Chemistry, indicated that the significant improvement in Chemistry performance for students from the experimental group was attributed to the effectiveness of computer aided learning approach they were exposed to. Research literature evidence on CAI globally, revealed the positive impact of CAI on students’ academic achievement (Olga, 2008; Serin, 2012; Ahiatrogah, Madjoub & Bervell, 2013; Jesse, 2012, Kereem, 2013; Charagu, 2015). Therefore, CAI could have helped in addressing the low performance, self-efficacy and collaborative skills of chemistry students in Kenya as illustrated in sections thereunder.

1.1.1 Academic Performance in Chemistry

The low academic performance in Chemistry education exists in countries across the world. In USA, science performance of majority of US students has been below average. For instance, a report by National Assessment of Educational progress, NAEP, (2015), a project of the federal education department, observed that only 29% of Americans country’s K-12 education in science, technology, engineering and mathematics (STEM) were rated as above in the world and that 40% of 12th–graders were rated below basic in science. Regarding gender achievement, Martin, Mullis and Chrostowski (2004) observed that boys worldwide showed significantly greater achievement in science. In United States for instance, female students’ average scores were lower than those of male students in science tests at secondary and post-secondary level (Lorenzo, Crouch & Mazur, 2006).
In Europe, a report by the European Commission (2010), indicated that more than 20% of young European students were not reaching a minimum level of basic skills in numeracy and literacy in mathematics and science. In addition, European Commission (2010) report indicated that students’ performance in science in several European countries was lower than the European Union (EU) average (501.3), on a score scale between 400 and 600 points. However, the EACEA/Eurydice (2011) report indicated that the gender differences in science achievement were insignificant. Although in the European countries the gender gap in science achievement appeared small overall, gender differences in science were substantial within schools or programmes (EACEA/Eurydice, 2010).

In Kenyan context, students’ performance in Chemistry has been low as witnessed in other countries discussed above (KNEC, 2007-2015). This situation is illustrated in Table 1.1 of the students’ performance in Chemistry in percentage at the KCSE examinations

**Table 1.1: Students’ Performance in Chemistry at KCSE: 2009 to 2015 in (%) at National Level**

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of candidates</th>
<th>Overall-Mean scores</th>
<th>Boys-Mean scores</th>
<th>Girls-Mean scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>328922</td>
<td>19.13</td>
<td>20.43</td>
<td>17.56</td>
</tr>
<tr>
<td>2010</td>
<td>347378</td>
<td>24.91</td>
<td>26.62</td>
<td>22.80</td>
</tr>
<tr>
<td>2011</td>
<td>403107</td>
<td>23.66</td>
<td>25.42</td>
<td>21.47</td>
</tr>
<tr>
<td>2012</td>
<td>427303</td>
<td>27.93</td>
<td>29.54</td>
<td>25.95</td>
</tr>
<tr>
<td>2013</td>
<td>439847</td>
<td>24.83</td>
<td>26.30</td>
<td>23.08</td>
</tr>
<tr>
<td>2014</td>
<td>476582</td>
<td>32.16</td>
<td>33.88</td>
<td>30.18</td>
</tr>
<tr>
<td>2015</td>
<td>515888</td>
<td>34.36</td>
<td>35.86</td>
<td>32.64</td>
</tr>
</tbody>
</table>

Table 1.1 indicates that there is low academic performance in Chemistry. The students’ mean scores in Chemistry are equivalent to grade D- to D+, which are far below grade C+, a requirement to qualify for courses that are science related at the Kenyan university. This is an issue that ought to raise genuine concern. The data also indicates that the performance of girls is poorer than that of boys. For instance, the performance of girls in the 2009 was 17.56% while that boys was 20.43%. Eshiwani (1982) observes that girls under achieve in science and mathematics at secondary level. Similarly, Forum for African Women Educationists, FAWE, (1999) observed that science achievement for girls is lower than that of boys partly due negative attitudes towards science. This under achievement of girls than boys in Chemistry is a matter of great concern. The students’ performance in Chemistry in Maara sub-county is not significantly different from the Kenyan national results as evident in Table 1.2.

Table 1.2: Students’ Performance in Chemistry at KCSE in Maara Sub-County in the years 2009 to 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean score (%)</td>
<td>28.07</td>
<td>26.52</td>
<td>30.70</td>
<td>30.95</td>
<td>38.16</td>
<td>38.50</td>
<td>39.42</td>
</tr>
</tbody>
</table>


The data in Table 1.2 show that the students’ performance in chemistry in Maara Sub-County is low. The mean scores are below the average, which is 50% and therefore their grade is far below C+. This implies that majority of students from Maara Sub-county and Kenya at large are disadvantaged when it comes to the choice of science-oriented courses at the university.
The Kenya National Examinations Council, KNEC (2009, 2012 & 2015) reports, highlighted some areas of students’ weaknesses in Chemistry national examinations as low ability to write symbols and formulae correctly as well as to write and balance chemical equations. The basis that enable the learners to write correct symbols, formulae and equations is the study of the structure of the atom, elements in the periodic table and chemical families.

Generally, students’ low performance in chemistry is associated to a number of factors. Ogembo (2012) attributes the students’ low achievement in Chemistry to student’s attitude towards chemistry, teacher’s attitude towards student ability in the subject, availability and use of resources, poor learning environment, and poor methods of instruction. Other researchers have singled out, use of poor teaching methods as major cause of students’ poor performance in Chemistry (Wachanga, 2002; Changeiywo, 2002; Barchok, 2006). It was therefore, important to investigate how use of CAI as a teaching strategy influence students’ achievement in chemistry.

1.1.2 Self-efficacy in Chemistry

Self-efficacy is defined as self-judgment of one's competence to successfully execute a course of action necessary to reach desires outcomes (Bandura, 1982). In chemistry academic settings, chemistry self-efficacy refers to students’ confidence in their ability to master chemistry concepts, tasks and activities. Self-efficacy of students is an important aspect in learning secondary chemistry as it directs learners to rate their confidence for attaining a specific goal in the subject (Martin, Mullis & Foy, 2008). Bandura (1993) posits that self-efficacy beliefs affect students’ outcomes by influencing students’ determinations of interests, choices, efforts, perseverance, persistence, career paths and future achievement.
Bandura and Locke (2003) found that self-efficacy influence performance and ability of the learner. This means that self-efficacy is a key predictor of students’ successes in academic performance. Kennedy (1996) believes that self-efficacy in science may affect science learning, choice of science, amount of effort exerted, and persistence in science. Smist and Owen (1994) found aptitude, attitudes, and attributions to predict science self-efficacy in high school students Martin, Mullis and Foy (2008) reported a link between the level of self-confidence in learning science and achievement in science. Baldwin, Ebert-May and Burns (1999) also stated that self-efficacy becomes more important over the duration of a course as science concepts increase in complexity.

The low self-efficacy of students in Chemistry exists in countries across the world. In United states, for instance, the National Center for Educational Statistics, NCES (2000) report that the number of students who take additional science courses is considerably lower than number of students who take at least 1 year of science in high school. Only 60% of students take 2 years of high school science and the percentage drops to 25% who take 3 years of science. Even fewer students take advanced science courses: 16% take Advanced Placement (AP) biology, 6% AP chemistry, and 4% AP physics. One potentially powerful factor that influence the academic choices and performance is the confidence (self-efficacy) with which students approach science (Britner & Pajares, 2001). In Turkey, Guvercin (2008) reported a decrease in students’ self-efficacy beliefs from 6th grade level to 8th grade level. The study indicated that 6th grade students had higher levels of self-efficacy beliefs than 8th grade students, which suggest a decline in students’ self-efficacy across grade levels in middle school students.
In high school students, science self-efficacy correlates with science achievement and is a better predictor of achievement and engagement with science-related activities in and out of the classroom than are gender, ethnicity, and parental background (Kupermintz, 2002; Lau & Roeser, 2002).

In Kenya context, many secondary school students, both boys and girls appear to have low self-efficacy in Chemistry. For instance, Chepkorir (2013), observed that students in Kenyan secondary schools lacked self-confidence in themselves when learning chemistry which leads to giving up the possibility of passing chemistry. Lack of self-confidence by students is predetermined by low self-efficacy in their ability to carry out such academic tasks. According to Chepkorir (2013), some students could not work out problems considered difficult without assistance from the teacher.

Researchers in self-efficacy posit that students’ belief in their ability, which is the self-efficacy to succeed in science tasks, courses, or activities, or their science self-efficacy, influences their choices of science-related activities, the effort they spend on those activities, the perseverance they show when encountering difficulties, and the ultimate success they experience in science (Bandura, 1997; Britner & Pajares, 2001; Zeldin & Pajares, 2000). Daine (2003) found a significant positive relationship between self-efficacy and academic achievement and that most students had moderate levels of self-efficacy in the two-year science course. Study by Silver, Smith and Greene (2001) link self-efficacy to both general academic achievement and science achievement. Britner and Pajares (2001) showed that science self-efficacy beliefs were the only motivational variable predicting students’ science achievement.
Gender self-efficacy of students in Chemistry continues to exist in classrooms globally. For instance, in America, the American Association of University Women, AAUW (1999) report shows that females have lower self-efficacy in science when compared to males. Starting in seventh grade, girls tend to underestimate their abilities in mathematics and science despite the fact that their performance remains the same as boys (Sadker & Sadker, 1995). This self-efficacy gender gap in science (chemistry) has consistently been predominant in high school level of education where the study of chemistry is not compulsory (AAUW, 1999). Female students “shy” away from chemistry tasks and activities at secondary level of education mainly due to the notion that the subject is regarded a male domain (Chepkorir, 2013). Anderman and Young (1994) reported that the middle school boys were more efficacious in science compared to girls.

Researches have shown that once students are free to choose the subjects, the participation of male and female students in the study of science, more specifically chemistry is quite different. For instance, Changeiywo (2001) noted that the participation level for female in science beyond the age at which the study of science is compulsory are lower than those for male. Also, Twoli (1986) observed that there was gender differences in sciences in which boy were more interested in physical sciences while girls were more interested in biological sciences. In a college general chemistry class, a statistically significant finding was reported with males scoring higher than females in science self-efficacy for laboratory skills (Smist, 1993). Lower self-efficacy of students, more specifically female students, in chemistry is a concern that needs to be addressed because low self-efficacy has been linked to lower academic performance.
Studies have demonstrated a clear connection between the teaching strategies and self-efficacy (Bandura & Locke, 2003; Fencel & Scheel, 2005). For example, pedagogies such as collaborative learning, use of electronic applications and inquiry-based activities have been shown a positive correlation with increased self-efficacy (Fencel & Scheel, 2005). Chen and Liu (2013) observed that grade 5 students from elementary school in Northern Taiwan demonstrated effectiveness in learning science when taught through computers. Similarly, Yien, Hung, Hwang and Lin (2011) observed that computer-game-learning was more effective in enhancing the self-efficacy of students in learning nutrition course. Generally, the teaching strategies used in classroom can make a significant difference to students’ self-efficacy.

Few studies have been conducted on relationship between teaching strategies such as computer supported learning and self-efficacy in science learning (Chen & Liu, 2013; Yien, Hung, Hwang & Lin, 2011) but no research has established a firm connection between computer aided instruction and self-efficacy in learning secondary (high) school chemistry. Based on the results of existing research studies, however, there appears to be a relationship between self-efficacy and computer supported learning in higher and elementary science education (Liu & Chen, 2013; Yien, Hung, Hwang & Lin, 2011).

1.1.3 Collaborative skills in Chemistry

Collaborative skills are behaviors that help two or more people work together and function well to achieve the set goals and complete tasks (Intel Corporation, 2008). Meaning that, collaborative skills are important skills that the students need to have in and out of the classroom.
According to Trilling and Fadel (2009), collaborative skills helps the learners to work effectively and respectfully with diverse teams, exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal, and assume shared responsibility for collaborative work, and value for individual contributions made by each team member. According to MOE Kenya (2013), collaborative skills are basic competencies that enable both the youth and the old to cope with the demands of modern life after schooling. More so, collaborative skills enables the learners to participate effectively in knowledge-based economy (Republic of Kenya, 2012). For this reason, the MOEST in the sessional paper No. 14 of 2012, affirms commitment to competency based teaching and learning that promotes acquisition of collaborative skills and attitudes (Republic of Kenya, 2012). Teachers need to structure their teaching strategies in order to impact the basic collaborative skills in learners such as team working, taking roles and responsibilities, listening to others, expressing ideas and opinions, following directions, asking for help, giving and receiving complements, respecting diverse views, sharing ideas and relating (Intel Corporation, 2008).

To the contrary, the instructional methods that the Kenyan teachers use in the classrooms do not seem to engage the learners in developing their collaborative skills. For instance, a situational analysis conducted by CEMASTEA (2009), observed that majority of the science and mathematics teachers offered inadequate opportunities for learners to interact in groups in the observed lessons. According to situational analysis report, majority of the lessons observed were “whole class” instruction which accounted for 62.5% of the lessons observed while “small group” instruction accounted for 25% and instruction in “pairs” accounted for 4.2% of the lessons observed. These report revealed low practice of small
group and pair instructions. In another study on Mathematics and Science teachers, employing ASEI-PDSI practice (CEMASTEA, 2015), indicated that most of the teachers who participated in the study did not give their learners opportunities to share ideas with one another or the teacher. This implies that the teaching methods that the teachers use hardly enhance collaborative skills among the learners during the instruction. Wachanga and Mwangi (2004) argue that the way teachers structure student-student interaction patterns has a lot to say about how well students learn and how they feel about one another.

Teaching strategies that enable the learners to work productively with others may develop students’ collaborative skills as well as their academic success. Research on CAI has shown that use of computers in learning, contributed to increased interaction and reception of information, changed the communication models and the learning methods used by the teachers and gave way to new scenarios which favored collaborative learning (Noor-ul-Amin, 2013). Again, research on collaboration encourages direct and interactive communication, working with others on team projects, and performance-based learning and assessment. More importantly, Davis (1993) report that, regardless of the subject matter, learners working in small groups tend to learn more of what is taught and retain it longer than when the same content is presented in other formats. Similarly, Lai (2010) points that collaboration can have powerful effects on student learning, particularly for low-achieving students. Unlike individual learning, students engaged in collaborative learning capitalize on one another’s resources and skills. Collaborative learning have been found to be beneficial in assisting students learn effectively and efficiently than if the students were to learn independently (Smith & MacGregor, 1992).
The use of CAI in which learners are working together in small groups over a computer on a shared assignment or an exercise affords collaborative learning environment. Many studies have focused on the arrangement of students in collaborative manner for improvement of cognitive component of learning (Prince 2004; Wachanga & Mwangi, 2004; Alexander, 2009; Johnson, Johnson & Smith, 2013) but no research has determined the extent to which collaborative skills, which is the social component of learning, are being developed in learning secondary chemistry. Therefore, it was the intention of this study to determine students’ development of collaborative skills in Chemistry instruction when taught with CAI and CIM.

Given the above observations; persistent low students’ academic achievement, low self-efficacy of students in chemistry, and minimal students’ development of collaborative skills in the learning Chemistry in Kenyan secondary schools are issues that needed intervention. This study sought to investigate whether use of Computer Aided Instruction in teaching and chemistry could have helped in addressing the above issues.

1.3 Statement of the Problem

The quality of teaching and learning Chemistry in Kenyan secondary schools continues raise concern to all education stakeholders because of low students’ academic achievement, self-efficacy and collaborative skills in the subject. The low learning outcomes in Chemistry is attributed to a number of factors, one of them being poor methods of instruction (Ogembo, 2012). This indicates that the teaching of Chemistry in Kenyan secondary schools may not be as effective as required.
Most secondary school Chemistry lessons are characterized by conventional methods, which are basically teacher-centered (Motswiri, 2004) and little integration of CAI (Omwenga 2004), raises some questions on the quality of teaching Chemistry in Kenyan schools. Available research on CAI indicates that its use in the classroom instruction can promote acquisition of facts and skills, enhance understanding of concepts, make learning more varied and interesting and provide individualized instruction as well as effective interaction and immediate feedback to the learner (Tyagi, 2014). For this reason, use of CAI in Chemistry classroom may help enhance students’ learning in chemistry. Efforts have been made by the Government of Kenya and some non-government organizations to provide infrastructure, policy and resources that supports CAI integration in the Kenyan schools. For instance, the Government of Kenya (GOK) initiated the use of CAI in education through education policies such as MOEST sessional paper No.1 of 2005 (Republic of Kenya, 2005). More so, other initiatives have been put in place in order to facilitate CAI integration in the classroom such as developing teachers’ basic computer skills, improving power supply in schools, digitalization of learning content and resources. Similarly, non-governmental organizations (NGO) like Computers For Schools Kenya (CFSK) have also made numerous efforts by equipping schools with Computers (CFSK Newsletter, 2008). More importantly, chemistry teachers in Kenyan secondary schools have been trained on CAI integration in classroom instruction.

Given the attention that CAI is receiving throughout the world including Kenya, specifically, the emergence of CAI resources mainly courtesy of GOK and some NGO, it is important to investigate its impact on various domains of students’ learning outcomes in Chemistry.
Moreover, there is scanty of research literature regarding influence of CAI on students’ academic achievement, self-efficacy and collaborative skills in learning chemistry in Kenya. Instead, the available research literature on CAI in Chemistry in Kenya have mainly focused on achievement (Jesse, 2012; Charagu, 2015) leaving the issue of self-efficacy of students in learning chemistry and development of students’ collaborative skills lacking in scholarly work. There was therefore, a need for a study to investigate the impact of CAI on students’ academic achievement, self-efficacy and collaborative skills in Chemistry in order to fill the existing gap in research literature. Thus, the present study investigated the influence of CAI on students’ achievement, self-efficacy and collaborative skills in Chemistry when compared with conventional (non-computer assisted) methods.

1.4 Purpose of the study

The purpose of this study was to assess the effect of Computer Aided Instruction (CAI) on students’ academic achievement, self-efficacy and collaborative skills in Chemistry in secondary schools of Maara Sub-county, Tharaka-Nithi County, Kenya. This entailed comparing the outcomes in the use of CAI and conventional instructional methods (CIM).

1.4.1 Objectives

The study was guided by the following objectives:

(a) To determine the effect of Computer Aided Instruction on students’ academic achievement in Chemistry as compared to Conventional Instructional Methods.

(b) To establish gender difference in Chemistry achievement when students are taught using Computer Aided Instruction, as compared to Conventional Instructional Methods.
(c) To assess students’ self-efficacy in the learning of Chemistry when taught using computer aided instruction and when taught using Conventional Instructional Methods.

(d) To establish gender difference in self-efficacy of students in chemistry when taught using Computer Aided Instruction, as compared to Conventional Instructional Methods.

(e) To determine students’ development of collaborative skills in learning Chemistry when taught using Computer Aided Instruction and when taught using Conventional Instructional Methods.

(f) To establish the challenges of employing Computer Aided Instruction in teaching and learning Chemistry.

1.4.2 Research Questions

The study was guided by the following research questions:

(a) What is the difference in the chemistry academic achievement of students taught using Computer Aided Instruction and those taught using Conventional methods?

(b) Is there any difference in the chemistry mean scores of male and female students exposed to Computer Aided Instruction?

(c) What is the difference in the chemistry self-efficacy scores of students taught using Computer Aided Instruction and those taught using Conventional Methods?

(d) Is there any difference in the chemistry self-efficacy scores of male and female students exposed to Computer Aided Instruction?

(e) What are the differences in the collaborative skills scores of students taught chemistry using Computer Aided Instruction and Conventional Methods?
(f) What challenges do teachers face in employing Computer Aided Instruction teaching and learning Chemistry?

1.4.3 Hypotheses

The following hypotheses guided the study and were tested at 0.05 level of significance.

H01: There is no significant difference in students’ academic achievement scores in Chemistry between those taught using CAI and those taught using CIM.

H02: There is no significant gender difference in Chemistry achievement scores when students are taught using CAI.

H03: There is no significant difference in students’ self-efficacy scores in Chemistry between those taught using CAI and those taught using CIM.

H04: There is no significant gender difference in students’ self-efficacy scores in Chemistry when students are taught using CAI.

H05: There is no significant difference in students’ collaborative skills scores in Chemistry between those taught using CAI and those taught using CIM.

H06: There are no challenges faced by teachers in employing CAI in teaching and learning Chemistry.

1.5 Significance of Study

The findings of this study may be useful to a number of education stakeholders, especially at secondary school level education in a number of ways. First, the study may provide useful information on a practical CAI approach for use in teaching Chemistry for improving students’ academic achievement, self-efficacy and collaborative skills.
Secondly, the findings of this study may encourage Chemistry classroom teachers, particularly those in girls’ schools to incorporate CAI when choosing the classroom instructional methods in order to improve academic achievement and self-efficacy of girls in Chemistry that has been an outcry in many Kenyan secondary schools. Some of the topics and sub-topics in Chemistry which are abstract in nature can be easily taught using computer aided instruction approach as opposed to conventional teaching methods. Thirdly, the findings of study may be useful to school administrators for they are able to understand the challenges of employing Computer Aided Instruction in teaching and learning chemistry in their respective institutions. Fourthly, the research findings may serve to provide information to Chemistry teachers on an interactive classroom environment for learners to acquire collaborative skills and learning behaviour such as team working, taking roles and responsibilities, listening to others, expressing ideas and opinions, following directions, asking for help, giving and receiving complements, respecting diverse views, sharing ideas and relating well. These skills are crucial to the students after schooling, especially in collaboration.

Fifthly, findings of this study may be valuable to teacher training colleges and universities whose main aim is to train pre-service teachers on teaching methodologies. The teacher trainers are able to understand the instructional methods to emphasize on when training Chemistry teacher trainees, particularly on Chemistry topics such as “atomic structure”, “periodic table” and “chemical families”. When these topics are taught with CAI, students develop better understanding of Chemistry concepts than when taught with Conventional Methods. Finally, the research findings of this study provide a base for future studies to researchers in the field of CAI in education.
1.6 Scope of the Study

The scope of the study included Form Two Chemistry students from secondary schools with computer laboratories in Maara Sub-county of Tharaka Nithi County in Kenya. The study investigated the influence of CAI on students’ academic achievement, self-efficacy in Chemistry on the topics “structure of the atom, periodic table and chemical families in the Form Two Chemistry syllabus. This implied that conclusions would be limited to chemistry subject and only on the topics “structure of the atom, periodic table and chemical families”. Therefore, it was not proper to make generalizations for the other subjects.

1.7 Limitations and Delimitations of study

1.7.1 Limitations

The following limitations were associated with the study:

a) The participants were students enrolled at secondary in Maara sub-county, limiting generalizability to secondary schools in other geographic regions.

b) It was not possible to randomly select and assign study subjects to the sample groups due to nature of research design, which is quasi experimental design and therefore, involved intact classes.

c) The study was limited by time and financial constraints and was only, therefore able to involve a relatively small number of respondents.

d) The students’ opinions and perceptions were assessed through self-reported assessment.
1.7.2 Delimitations

It would have been ideal for this study cover more secondary schools especially those with computers facilities. However, due to logistical and financial constraints, the study was limited to public secondary schools with computers in Maara Sub-County. The scope of this study is relatively narrow and focuses on Form Two Chemistry students from only Extra-County secondary schools. This study is delimited to examining the effects of CAI on students’ achievement in Chemistry in the topics “structure of the atom, the periodic table and chemical families”. It would have been ideal to cover more Chemistry topics. However, due to time factor, the study was limited to only three topics. It would have been ideal to randomly select and assign study subjects (respondents). However, due to nature of the research design which was quasi experimental design based on Solomon-Four, Non – Equivalent control group, the study was limited to four (schools) intact groups whose subjects were not randomized.

1.8 Assumptions of the Study

The study was based on the following assumptions

(a) Students assigned to a CAI group were assumed to have basic computer skills to use CAI effectively.

(b) The teachers in experimental and control groups were assumed have equal or similar teaching experience, training and competence.
1.9 Theoretical Framework

The study was guided by the constructivist theory and technology acceptance model. The technology acceptance model developed by Davis (1989) which states that the user’s motivation for any technology is predetermined by three factors namely, perceived ease of use, perceived usefulness and attitude towards using the technology. According to technology acceptance model, for CAI- technology to be effective it needs to make the learners and teachers experience a feeling of the technology’s usefulness and ease of its use. The more successful is the CAI- technology in generating positive attitudes in learners towards using the CAI in learning, the better their learning experiences and outcomes. Thus, technology acceptance model proved to form an appropriate framework for use of CAI technology by learners in this study.

Moreover, Bandura (1982) noted the importance of perceived usefulness and perceived ease of use of technology, in predicting a person’s self-efficacy. According to Bandura, self-efficacy which is similar to perceived use of use consists of self-judgment of how well one can perform specific tasks required to accomplish specific goals, while the learning outcome judgment is similar to perceived usefulness. The value of learning outcomes, which are academic achievement, student’s self-efficacy and students’ collaborative skills in this study is therefore linked to perceived usefulness of CAI.

The fundamental insight of constructivist theory is that knowledge is actively constructed and not simply acquired by the learner. According to Jonassen (1996), constructivist learning is described by four principles: the principle of knowledge construction; the principle of active
learning; the principle of social interaction; and the principle of situated learning. Constructivists view learning as an active process (principle of active learning) in which learners construct new ideas or concepts based on the current or past knowledge and not simply acquiring the knowledge (principle of knowledge construction). Active learning of students may serve as a driving force to hard work that eventually translates to improved learning outcomes. Social interaction which include; learner-learner and learner-teacher interactions are important ingredients of learning (Jonassen, 1996). Social Constructivists argue that human beings construct knowledge through interaction with others (McKinley, 2015). In social constructivist classrooms collaborative learning is a process of student-student interaction mediated and structured by the teacher. Use of CAI is related to constructivist learning in that students are at the center of the learning process and that are actively involved in constructing knowledge rather than being passive recipients of instruction.

According to Gray (1997), a constructivist classroom are distinguished from a conventional classroom by a number identifiable characteristics; learners are actively involved in learning, the environment is democratic, the activities are interactive and student-centered and the teacher facilitates a process of learning in which students are encouraged to be responsible and autonomous. This is in contrast with conventional teaching methods in which teachers directly transfer information to the passive learners. Duit and Tregust (2003) recognizes that learning should not be seen as some sort of conceptual implanting process but as interplay between students existing ideas and knowledge or experiences they are exposed to in the classroom. The constructivist learning environments are intended to provide various paths for
learners to explore large amount of information with the teacher providing the role of a facilitator.

CAI is an appropriate medium to support active, interactive and self-directed learning. CAI allows students to work out their own learning strategies and develop different styles of learning. CAI also, facilitate constructivist practice by providing a medium of discovery and exploring larger information and giving students autonomy in using knowledge as opposed to conventional methods.

Learning with CAI provides positive interactions between student-student and student-teacher. These interaction plays a vital role during the learning process. In terms of constructivist theory; student-student and student-teacher interaction is important in the class environment. CAI resources requires creation of constructivist programs like tutorials, simulations, animations and practice exercises which students can access and use on their own. These CAI programs allows students to control, pace and sequence their learning.

When creating constructivist learning in CAI environments, teaching experience and training of the teacher is important in determining how effectively the teacher makes proper use of CAI resources. According Comber and Keeves (1993), teaching experience cause higher learning outcomes in science as knowledgeable teachers are more confident in imparting information and are able to present a wider range of examples which helps the students to understand concepts more easily. According to Bruner (1961), learning that is meaningful to students is developed through discoveries that occurs during exploration motivated by curiosity. Basically, CAI is an effective constructivist pedagogy that incorporate various
technological techniques such computer tutorials, simulations and drill and practice programs in the teaching and learning to actively support the learning process.

In this study therefore, the constructivist theory provides an appropriate framework for viewing the computer aided instruction (CAI) as an approach for teaching chemistry in attempting to improving the students’ achievement, self-efficacy and collaborative skills of students in Chemistry. Teachers applying this theory would use instructional methods that supports active, interactive and self-directed learning.

1.10 Conceptual Framework

The CAI approach encompasses a variety of techniques, tools, content and resources aimed at improving the quality and efficiency of the teaching and learning process. This entails projecting learning material to support a lesson, to multimedia self-learning instruction, to simulations to drill and practice application. There are a variety of options available to the teacher to utilize various CAI programs for effective pedagogy. The teacher can use each CAI program independently or a combination of them. The CAI programs employed for this study used a combination of tutorials and drill and practice modes, to present topics and sub-topics.

The study hypothesized that for improved students learning outcomes to be realized, the instructional methods used by the teachers have to succeed positively in impacting on students’ achievement, their self-efficacy and collaborative skills. In Chemistry teaching, the instructional methods play a major role in determining the students’ learning outcomes. In
this study, Chemistry instructional methods were categorized in two major main groups that is, the Conventional Instructional Methods (CIM) and Computer Aided Instruction (CAI).

There are a number of factors that may influence the instructional process as well as the learning outcomes. These factors include; teachers’ experience and training, and their personal dispositions. The experience and training that the teacher has determines how effectively the teacher will use the teaching approach. Some researchers agree that teaching experience during the first few years of teaching is positively correlated with students’ achievement (Kosgei, Mise, Odere & Ayugi, 2013; Standford, 2014). Also students’ personal dispositions and gender of the students may have an influence on learning outcomes. Gender was inbuilt in this study in order to statistically control for its variation (Fraenkel & Wallen, 2000).

The conceptual framework shows how the independent variables interacts with both intervening variables and the dependent variables to bring about the students’ outcomes in teaching and learning of chemistry. The independent variables (instructional methods) for this study were the Computer Aided Instruction (CAI) and Conventional Instructional Methods (CIM) while the dependent variables were students’ achievement, self-efficacy and collaborative skills. The intervening variables included the teacher’s experience and teachers’ training.
Figure 1.1 conceptualizes the relationship between the elements identified as important in integration of CAI in instruction for enhancement of students’ learning outcomes in Chemistry.

Figure 1.1: Conceptual Framework for the use of CAI and CIM in learning chemistry
1.11 Operational Definition of Terms

**Achievement:** The academic outcomes that indicate the extent to which students have accomplished specific goals that were the focus of activities in classroom instruction.

**Computer:** A machine that manipulate data according to instructions of commands.

**Computer aided instruction program:** Package developed using multimedia technology that uses a combination of texts, graphics, sound and video in the learning process.

**Computer-aided Instruction:** An interactive instructional technique whereby a computer program or programs is used to present the instructional materials and students interact with instructional materials inbuilt in the computer. It makes use of a combination of tutorials, multimedia instructions, simulations and drill and practice applications.

**Constructivism:** The learner constructs their own knowledge; learning is an active process, collaborative and situated in real-world contexts.

**Conventional Instructional Methods:** Teacher centered teaching and learning approaches that are commonly adopted for curricula delivery. These are non-computer aided instructional methods such as lecture, teacher demonstration, experiments, practical activities and whole class discussions.

**Effect:** The result of the influence of Computer aided instruction on student’ achievement, self-efficacy and interpersonal skills in Chemistry.
**Gender:** Social construction of female and male identity. It is determined by the conception of tasks, functions and roles attributed to women and men in society, particularly in schools.

**Collaborative skills:** Abilities enabling a learner to interact positively and work effectively with other students.

**Collaborative learning:** Educational approaches involving joint intellectual effort by the students or students and teachers together. Usually students working in groups, mutually searching for understanding, solutions or meanings or creating a product.

**Cooperative learning:** Educational approaches which are grounded by the structured group work and concerned with promoting both social and academic outcomes. It is more directed and closely controlled by the teacher.

**Chemistry self-efficacy:** Self judgment of a learner’s ability to perform tasks and master chemistry concepts and skills in chemistry.

**Software:** A collection of computer programs that perform some tasks on a computer hardware.
CHAPTER TWO  
LITERATURE REVIEW  

2.1 Introduction  
This chapter provides literature on teaching methods in Chemistry, computer aided instructions in teaching and learning, students’ achievement in Chemistry, students’ self-efficacy towards Chemistry, influence of methods of instruction on students’ self-efficacy towards Chemistry, students’ interpersonal skills in learning of chemistry and the summary of the literature review.  

2.2 Teaching Chemistry in Secondary Schools in Kenya  
Over the past five decades, Kenyan secondary school Chemistry curriculum has undergone various education curricula changes. For instance, first Chemistry curriculum that was developed in 1963 after the attainment of independence was teacher and book centered which was inappropriate because it neglected students’ abilities, interests and potential (Kenya Government, 1976). The next curricula which included the 1967 UNESCO Chemistry Pilot Project, the 1970 School Science Project and the 1973 Kenya National Examinations Council Chemistry Syllabus attempted to ensure appropriate teaching methods but were not implemented successfully due to lack of qualified chemistry teachers. In 1985, the 8-4-4-education system was introduced and the study of Chemistry became compulsory in Form One and Form Two. This Chemistry curriculum encouraged teaching with small groups,
through experiments and projects. Although the aim these curricula was to teach through learner-centered methods, teaching remained largely expository. Teaching and learning practices in chemistry are undergoing revolutionary changes underpinned by shifts in technological and pedagogical theory.

The GOK advocate for technology-based approaches to teaching and learning chemistry not only in schools but also in teacher education. Omwenga (2004) echoes that there is need for learning institutions to move from traditional paradigm of learning to technological-based. However, no single teaching method whether technology instruction or social construction of meaning can be the method of choice for all occasions. For any subject, Chemistry included, instructional needs change as the students’ skills and knowledge develops. According to Harris and Taylor (1983); Corno and Snow (1986) and Gastel (1991), change of instructional methods and learning activities will evolve as the students’ school years, instructional units and even individual lessons progress. For this reason, effective instruction needs to focus on the zone of proximal development, which is the range of knowledge, concepts and skills that the students are not yet able to acquire on their own but can acquire with the help from their teachers and peers. Khatete (1995) suggests that the teaching and learning process should be a spiral mode of teaching which would facilitate the restructuring of students’ concepts hence better understanding of chemistry which translates to high achievement.

Twoli (2006) pointed that: “Understanding of concepts forms the basis for other learning activities in any science discipline” (p. 127). Students tend to understand Chemistry concepts when most of the time allocated for curriculum activities and classroom instructions emphasizes the maintaining of their engagement in those activities. Harris and Taylor (1983) echoes that effective teaching practices should allow for increased opportunity to learn.
Chemistry teachers need to choose different styles and strategies for helping students learn chemistry concepts and skills. Teachers can use various teaching methods to achieve instructional objectives in chemistry, which are broadly categorized as teacher-centered or conventional and student-centered methods.

According to Cangelosi (1997) conventional instructional methods of teaching refers to instructional methods in which the teacher controls the entire lessons and learner-learner interaction is minimal or entirely lacking. Conventional methods are specifically teacher-centered methods and lecture method. Twoli (2006) identified various teaching methods including the lecture, demonstration, practical or laboratory experiments, project work and field trips for teaching secondary chemistry.

Lecture method is common conventional method for higher education where lecturers tell of research findings and their significance to students. According to Twoli (2006), the lecture mode of instruction has been considered appropriate for achieving low-level objectives in the learning of chemistry. It can also be very effective, particularly for sharing information that is not easily found elsewhere, for presenting information in a quick manner and for teaching learners who learn best by listening (Intel Corporation, 2007). However, this method of instruction has very low yield on students’ outcomes and this gives a strong argument for using it sparingly and for very brief spans in secondary chemistry (Twoli, 2006). Topics such as structure of the atom and periodic table and chemical families in Form Two chemistry which are of higher-level objectives may not be appropriately taught using the lecture method. Teacher demonstration is a very common method used in teaching chemistry. When teaching chemistry through demonstration, students are set up to potentially conceptualize class material more effectively (Erik, Williamson & Ruebush, 2007). Demonstrations can
also be used to explain an experimental set up before the students begin to set up their apparatus for individual or group activities.

Demonstration is especially useful when the apparatus or materials to be used are not enough for the whole class. It is also useful when the materials are too dangerous or the equipment are too delicate to be entrusted to the students (Twoli, 2006). Experiments whose compounds and products involve emission of poisonous gases in their experiments can only be demonstrated by the teacher. Implying that the students cannot perform such experiments on their own. On the other hand, CAI simulations usually are based on interactive graphics which gives the learner the ability to visualize a process or an activity. Practical work involves teaching/learning activities conducted by the students under guidance of the teacher. The teacher provides either singly or in groups with the materials and apparatus as well as the instructions to be followed in performing the activities. Practical work gives students an opportunity to acquire process skills and manipulative skills. However, this method is expensive in terms of materials and apparatus as well as time consuming. Kim & Chin (2011) argue that practical work is not sufficient to develop students ‘habits of mind’ because they involve simply doing but do not require thinking through doing.

CAI simulations provides a computer model of an experiment (Trowbridge, Bybee & Powell, 2004), which engages students’ critical thinking, save the burden of materials and apparatus required for real experiments. Project work is viewed as very important in the learning of chemistry because students are exposed to a wider range of skills such as process, manipulative and scientific skills. It also helps the students to improve their communication skills, especially when writing the reports, one is required to use suitable technical terms.
(Twoli, 2006). However, project work consumes a lot of time and also resources allocated to the subject are a lot.

Access to appropriate learning experiences can broaden scientific skills and knowledge, which is the aim of teaching chemistry at Kenyan secondary school level (KIE syllabus, 2007). In order to achieve this main aim of teaching chemistry, teachers need to employ teaching methods that promotes acquisition of knowledge and skills in chemistry. The choice of teaching methods to be used depends largely on the information or skill that is being taught. Chemistry teachers in Kenyan secondary schools teach a fixed set of concepts prescribed by the Kenya Institute for Curriculum Development (KICD). However, the teachers are free to choose their teaching methods (KNEC, 2006) of context and particular instances to exemplify a concept.

Murphy and Whitelegg (2006) observe that while the curriculum provides the standards to be achieved, it is the responsibility of the teacher to include several teaching and learning strategies to make the curriculum context-based and more appealing to the students, especially the females. But, KCSE statistics in KNEC (2009, 2012 & 2015) reveal a clear gender gap in favour of boys in achievement in chemistry. This study therefore focused on establishing the influence of CAI on students’ academic performance as well as the gender difference in achievement.

2.3 Computer Aided Instructions in Education

Computer Aided Instruction (CAI) has been used for many decades for educational purposes and started appearing in schools as early as the 1960s. Much of the early work which
introduced CAI in education was done in the 1950s and 1960s by researchers at Stanford University in California and International Business Machines Corporation (IBM), who developed the first CAI into select elementary schools.

Initially, CAI programs were a linear presentation of information with drill and practice sessions. These early CAI systems were limited by the expense and the difficulty of obtaining, maintaining, and using the computers that were available at that time. Another early CAI system initiated at the University of Illinois in the early 1960s and developed by Control Data Corporation was Programmed Logic for Automatic Teaching Operations (PLATO) system. PLATO system was used for higher learning and supported up to 1000 terminals for use by individual students. During this era, computers were never developed for improving the quality of teaching and learning process, but researchers used them for teaching (Sansanwal, 2000). In 1960s computer aided learning emerged from behaviorist principles and programmed instruction. Most of the educational software has been influenced by the behaviorist psychologist B.F. Skinner. Many educational psychologists found the behavioral approach unsatisfying and then there was a shift from behaviorism to cognitive approaches. This shift affects how computers are used as an instructional tool. This in turn allowed the computer to monitor the student progress and to pursue the development of higher order thinking skills and this relation between computers and students became more interactive (Breunlin, 1999).

In 1980 only 5 percent of elementary schools and 20 percent of secondary schools in the United States had computers for assisting instruction. Since the advent of the personal computers in the mid-1980s, computers have rapidly become one of the key instructional technologies used in both formal and informal education. By the end of 1980s, use of CAI
had increased dramatically and nearly all schools in the United States, and in most industrialized countries, were equipped with teaching computers.

Since 1990s, rapid advancements in computer and technology, as well as the Internet, have led to a rapidly increasing interest in and use of CAI for instructional purposes (Online Encyclopedia, 2000).

Computer Aided Instruction methods encompasses a variety of techniques, tools, content and resources aimed at improving the quality and efficiency of the teaching-learning process. The functional use of computer instruction and learning has been subdivided into teacher-centered instruction in which the teacher takes control in the design, development and delivery of instruction and student-centered learning, in which the students are involved in constructive activities that lead to learning. Computer aided instruction is one of the latest and newest instructional innovations for the learning environment from the point of view of both the teacher and the learner that can be used in teaching science (Hicks & Hunka, 1972). It is an interactive instructional approach that involves the use of a computer program or programs to present the instructional materials and monitor the learning that takes place.

Computer Aided Instruction serve one main purpose of complementing the teaching and learning of concepts and skills as well as providing practical instruction through interactive programs that teach effectively. Computer Aided Instruction uses a combination of text, graphics, sound and video and are available in various modes such as tutorials, simulations and drill and practice, to present content and provide immediate feedback for students’ responses (Patel, 2013). CAI is a common technology in today’s educational setup and that it can be utilized to help a student learn in all areas of curriculum (Patel, 2013). CAI provides
an instructional interaction between the learner and the computer in a variety of contents with or without the assistance of a teacher (Encyclopedia Britannica, 2017).

More importantly, use of CAI enables learners be active in the learning process and to construct their own knowledge (Özmen, 2008). According to Wikieducator (2008) a typical computer aided instruction consist of a number of elements which include: text or multimedia content, multiple choice questions, problems, immediate feedback, notes on incorrect responses, summarizes students’ performance, exercises for practice and worksheets and tests. The aforementioned components of a typical CAI, thus formed the major elements that guided the use of CAI in this study. According to Lin (1998), computer aided instructions are perceived as having a positive effects on students’ learning. Students are more likely to be more involved during instructional process when computer technology is involved which is a significant factor over conventional methods (Sivin-Kachala & Bialo, 2000).

2.3.1 Types of Computer Aided Instruction

The type of approaches in computer Aided instruction has undergone steady changes in the last four decades with largest proportion of research reports involving CAI as a tutor or tool and its various modes such as drill and practice, tutorials, simulations, instructional games and multimedia instruction (Douglas, 1997-2000).

2.3.1.1 Drill and practice modes

Drill and practice was one of the earliest forms of computer based learning (Trowbrrige, Bybee & Powell, 2000). Drill and practice is suited for behaviourist model with repeated practice of lower-level cognitive skills and offer structured reinforcement of previously learned concepts. The guided drill is a computer program that poses questions to students,
return feedback and selects additional questions based on the students’ responses. Drill and practice may use games to increase motivation. Through enhanced motivation and ample practice afforded by drill and practice programs, learners improve their abilities to solve the problems presented to them. Kauchak and Eggen (1993), however argue that the use of computers to review previously learned material is one of the least efficient and most inexpensive.

2.3.1.2 Tutorial mode
Tutorials are used to teach new concepts and processes. It is the most common for computer aided instruction that presents the information, guides the learner through the system, allows the learner to practice and then assesses the learner (Fraser & Walberg, 1995). Intelligent tutoring systems are capable of corrective feedback and adapt their presentations to suit the learner, based on the actions of the learner. These programs often consist of several screens of textual material, followed by exercises or questions. In this tutorial category, the information is presented in small units and then questions are provided. The student's response is analyzed by the computer and appropriate feedback is provided. Under this mode, the students can work on their own pace. Most tutorial systems can adapt instruction by using student’s prior performance in the programme to determine what material to present. Since tutorials allows the learners to practice and assess their learning, then they can serve as a powerful media of impacting new knowledge.

2.3.1.3 Instructional Games
In games mode, there is generally a competitive element. Instructional games are activities that are played with a prescribed set of rules and usually result in a winner at the completion
of the activity. The main purpose of computer games is to reinforce knowledge that the learner is assumed to have. Games make the learners practice physiological, mental and social skills that improve their fitness besides fostering cooperation among them. Games should be integrated into the day-today curriculum of the school because they can provide an excellent vehicle to impart knowledge in an enjoyable manner.

2.3.1.4 Computer simulations

Simulations provide a computer model of an experiment or a real life or imaginary situation (Trowbridge, 2004). The context of the simulation in chemistry may be a laboratory experiment or an animation of a working of a chemical plant. Simulations usually are based on interactive graphics and give the learner the ability to visualize a process and explore the effect of changing parameters on the operation of the system. Simulation is used where it is not practical or feasible to provide the learning in real-life. Students are not only motivated by simulations but also learn by interacting with them in a manner similar to the way they would react in real situations. Computer simulation is among the most powerful educational delivery method because it provides situated, authentic form of practice, feedback about the performances and motivation for learning while avoiding physical danger and constraints.

2.3.1.5 Computer Multimedia instruction

CAI is one of the multimedia instructions that as proved to enhance students’ performance, and arouse their interest in learning (Gambari, 2010). Computer multimedia presentations exploit the role of multisensory perceptions in the learning process. It not only provides text but also sound, picture, music, animation, graphics and video to make learning more lively.
and effective. Various computer media make certain types of learning easier. Media facilitate a teacher, in the transformation of a desired learning experience in the most effective manner. Therefore, computer media selection is an important part of instructional design and delivery. Various computer media have to be used in combination if needed. Computer multimedia links to navigate the universe of connected information and hence multimedia learning is highly effective. Research conducted by Lindstrom (1994) revealed that people only retain: 10% of what they read, 20% of what they see 30% of what they hear, 50% of what they see and hear 90% of what they see, hear, and do simultaneously. That is why CAI approach can be an effective tool in teaching and learning process.

2.4 Computer Aided Instruction and Conventional methods

Computer aided Instruction (CAI) makes teaching and learning far more effective than those of the conventional instructional methods as it is used for presenting information, testing and evaluation and providing feedback, it aids individualized learning, it can adapt to the abilities and preferences of the individual student and increase the amount of personalized instruction a student receives, it helps to develop creativity and problem solving skills, identity and self-reliance in learners. This serves to control lots of variables having an impact on learning, which cannot be controlled by means of conventional educational techniques (Tareef, 2014).

Research studies indicates that CAI brings several possible advantages as a teaching/learning tool over the conventional methods. For example, Bhagwan (2005) summarized some most important contributions of CAI in teaching and learning as; promote positive effect on student’s attitude, makes instruction more student-centered, shift the teaching and learning from teacher-centered to a student- centered environment, encourages collaborative learning.
and stimulates increased teacher-student interaction, promote active learning and provides evaluative learning.

The main advantage of the computer as a learning medium is its ability to process information quickly, unlike the conventional methods. This makes it possible for the computer to accept and act upon a variety of different kinds of response from the learner and to provide information in textual, graphical, and animated form (Rushby, 1989). Compared to conventional teaching methods such as lecture and discussion, computer aided instruction offers the important advantage of being able to adapt materials to the needs of each student. By this way, context can be varied to increase its meaningfulness to individual student (Ross & Anand, 1987). This adaptation is further applied as learner’s needs change over the course of a lesson. Further, CAI is visually attractive, when it presents concepts using demonstrations that are made attractive by animation, color, and sound. Besides this, computer aided instruction captures and holds the students’ attention by providing opportunities for competition where the opponent is the student’s previous performance (Mahmood, 2006). Cotton (2001) pointed that teachers can benefit from CAI since it can be programmed with concept, level and learners’ ability so that the students are not challenged outside his or her demonstrated ability range, nor are they allowed moving to a higher level until they have mastered the level on which they are working.

Further, CAI provides a self-directed learning to students, and allows learners to become empowered to take increasingly more responsibility to choose, control, and evaluate their own learning activities which can be pursued at any time, in any place, through any means, at any age (Mauro, 1994). Implying that learners can decide what they want to learn and in what order. By the way of providing learners with interactivity, connectivity and controlling of
learning environments, CAI programs enable students to actively participate in learning process.

Stennet, (1985) observed that a well designed and implemented drill and practice or tutorial CAI used as a supplement to conventional methods produces an improvement in students’ achievement. Similarly, Serin (2011) found that fourth year science and technology students who received computer aided instruction obtained a higher achievement than those who were exposed to conventional method. Wishart (2002) found that students using CAI have increased self-confidence, more successful and more motivated to learn than when taught with conventional methods. Usun (2003) pointed that one of the benefits of CAI over conventional methods is the immediate feedback received by the student. CAI is effective for improving instruction for students in all levels including those with special needs, unlike the conventional methods (Regan, Berkeley, Hughes & Kirby, 2013).

Another advantage of CAI over conventional methods in teaching is self-paced learning in which students can proceed at their own pace, unlike for the conventional instructional classrooms. Lawson (1999) indicated that a student may review particular topics on which he/she needs clarification and if familiar with the topic, may quickly progress at a faster rate to other topics. This is in contrast to conventional methods, in which learning is based on a predetermined time, where students are expected to master the topic during that time. According to Lin (1998), students perceive computers aided instructions as having a positive effect on their learning. They are more likely to be more involved and active participants during instructional process when technology is involved which is an important factor over conventional methods (Sivin-Kachala & Bialo, (2000). Many researchers recommend using
computer aided learnings over conventional methods to support higher order thinking and problem-solving skills.

Herrington (1999) depicts CAI as powerful partner that can supports learning by allowing students to use them as tools to construct knowledge, explore and assess information. Other researchers note that using computer instructions can provide students an opportunity to learn and apply real world skills which is a provision not offered by conventional methods (Ivers & Barron, 2002). Cotton (2001) indicated that computer software provides many instructional benefits and that CAI can have a much greater impact on student learning when compared to conventional methods. Moreover, students receiving CAI also retain their learning better. Cotton (2001) concluded that the use of CAI can leads to more positive student attitudes than the use of conventional methods. According to Mauro (1994), computer aided learnings provide flexibility to learners which are sometimes denied by the conventional methods. CAI provides flexibility of schedules which comes with the cost-effectiveness of using CAI over traditional methods. Since learners can study at home avoiding the need to travel to training facilities, this results in savings in costs on travel and accommodation costs (Dhanjal, 1999). Learning institutions therefore, need to shift towards the goal of transforming the conventional way of learning to technology-based learning. Thus, computer aided instructional activities should be incorporated into chemistry lessons in order to have the benefits of CAI.

2.4.1 Limitations of Computer Aided Instruction

Although the CAI has been used in the educational settings for classroom instruction, there are limitations that have restricted the effective use of CAI. For example, with self-access programs when learners are left on their own too much, they may feel overwhelmed by the
information and the resources available leading to loss of attention to the main learning objectives.

The malfunctioning equipment cannot only result in lost time but also may fail, causing frustration to learners (Levy, 1997). Ross and Bailey (1996) found that CAI may not be suitable for all learning styles. One of the important concerns of the implementation of CAI is how to finance it. CAI software are expensive components for most of the poor school institutions. In the under developed and developing countries, this could be a big obstacle for the effective use of CAI in educational setups. A major concern for integration of CAI into education is the teacher’s negative attitude and less capability to use it. Successful teachers in technology integration regularly make considerable changes in their teaching methods and in students’ achievement (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). Roschelle et al. (2000) also added, “One of the biggest barriers to introducing effective technology applications in classrooms is the mismatch between the content of assessments and the kinds of higher-order learning supported most effectively by technology” Roschelle et al. (2000).

The major barrier to effective use of CAI is the curriculum integration. Curriculum integration is the use of computers to support and enhance learning and teaching in the mathematics lessons. Thus, computer aided instructional activities should be incorporated into chemistry curriculum in order to have the benefits of CAI.

2.5 Computer Aided Instruction and Achievement

There is large research data to show that CAI is capable of improving students’ academic achievement. For instance, Serin (2011) found a statistically significant increase in the achievements and problem solving skills in the experimental group that received the computer based science and technology instruction for the fourth year pupils. Olga (2008)
conducted a study on the effects of computer-assisted instruction on the students’ achievement, attitudes and retention of fourth grade Mathematics course.

The findings revealed significant difference between the groups on the post achievement tests and attitude scales in favor of experimental group. Similarly, Jesse, Twoli and Maundu (2014) assessed the effectiveness of computer assisted instruction (CAI) on science performance among selected secondary school learners in Kenya. The findings showed that the learners taught through CAI performed significantly better than learners taught through conventional instructional methods (CIM) in Science. In addition, Charagu (2015) in a study to assess the effects of computer based learning on secondary school students’ achievement in Chemistry, indicated a significant improvement in Chemistry performance for students from the experimental group (computer assisted learning) than those students from control group, who were not exposed to computer assisted learning.

Ahiatrogah, Madjoub and Bervell (2013) in a study on effects of Computer Aided Instruction (CAI) on the achievement of Junior High School students in Pre-Technical skills, revealed that the CAI group performed better than the traditional method of instruction group. Similarly, Kareem (2015) in a study to investigate the effects of introduction of CAI in Biology compared to the conventional method on senior secondary school students’ achievement, the results revealed that CAI improved students’ academic achievement in Biology. Olakanmi, Gambari, Gdodi and Abalaka (2016) in a study to establish the effects of computer assisted instruction in promoting intrinsic and extrinsic motivation among senior secondary students, found that the students who were taught chemistry with computer assisted instruction had higher extrinsic and intrinsic motivation as well as achievement than those in conventional teaching methods.
Ardac and Sezen (2002) indicate that the effectiveness of CAI increases when learning is supported by teacher-directed guidance and that students showed significant gain in content knowledge than when learning was unguided by the teacher. Research carried out by the International Association for Evaluation of Education Achievement (IAEEA) in nineteen countries found that use of computers in class improved achievement of students in science and also increased the amount of science curriculum that was covered. From the literature reviewed, it was clear that use of CAI raises students’ achievement scores. However the studies above have not investigated the influence of CAI on students’ achievement, self-efficacy in learning chemistry and development of collaborative skills simultaneously.

2.6 Challenges of Employing CAI in Chemistry Instruction

There are a number of factors that hinder effective use of CAI in classroom instruction. Harrison (2010) identified teachers’ skills and experience with using technology, and their personal beliefs and perceptions about CAI as some of the factors that hinder use of CAI in classroom. Similarly, Mentz & Mentz, 2003) noted low levels of teachers’ CAI knowledge and skills as major impediments to effectively introducing technology into African schools. According to Pelgrum (2002), many school leaders perceive the lack of CAI-related knowledge of teachers as one of the main impediments to the realization of their CAI integration goals. Also, Anderson (1997) identified a range of factors that affect CAI use by teachers, including teacher attitude and training in the use of ICT, access and ICT skills. There is also a general inadequacy of learning resources, course curriculum and other learning materials that incorporate ICT use (JISC, 2004). On the same note, Tella (2007)
found that computer use was predicted by intentions to use it and that perceived usefulness was also strongly linked to these intentions.

Generally, if the CAI resources are available, this will motivate the teachers to access them more than when they are not available or available but not in sufficient quantity and quality. Jones and Kozma (2003) noted that national ICT policies provide a rationale, a set of goals, and a guidance of how education systems work if ICT is introduced into teaching and learning, and they can benefit both the students and teachers. This implies that school ICT policies forms a strong foundation for ICT use in schools.

Research studies have been undertaken globally which relate to use of CAI for classroom instruction. One of such study is the European commission (2013) survey on use of ICT in education, conducted by the European commission in 31 countries across Europe. The survey findings were; digital resources such as computer simulations were rarely used for lessons, teachers were familiar with CAI integration but used the computers first to prepare their teaching, only a few of the teachers used CAI for instructional practices and still to a less extent allowed the students to use it during the lessons.

Another study whose content is related to use of CAI, is a survey of ICT use in education in Latin America and Caribbean revealed different findings from those of former study (UNESCO Institute for statistics, 2009). The study focused on ICT infrastructure, availability of different forms of ICT-based instructions and preparedness of teachers to integrate ICT in schools. The study found out that the Caribbean countries had higher integration level of ICT-based instruction and had adequate ICT infrastructure, including computer hardware,
software and internet connectivity than Latin America. The study also assessed the learner-to-computer ratio in order to aid the delivery of CAI.

The findings revealed that in Uruguay, the learner-to-computer ratio was 1:1, where the schools had formulated strong ICT policies in education. The National Council for Science and Technology (2010) carried out a survey to assess the ICT capacities and competencies in selected secondary schools in Kenya. The study found that computer studies was studied as an elective subject and that only one class was studying it and that the students in Kenya schools shared a computer in the ratio 1:40. Teachers were advancing their ICT-skills and to a less extent used ICT in teaching and instruction. The above studies have not investigated the challenges facing teachers in the use of Computer Aided Instruction. The proposed study sought to investigate the challenges faced by teachers in the use of CAI.

2.7 Gender and Chemistry Achievement

Gender refers to traits and behavior that a particular culture judges to be appropriate for men and women. In contrast sex refers to biological differences between females and males (Woolfolk, 2016). Gender role identity is the image each individual has of himself or herself as masculine or feminine in characteristics. It is a part of self-concept. Children begin to form gender schemas or organized networks of knowledge about what it means to be male or female through interaction with family, peers, teachers and the environment.

Studies on gender differences in Chemistry achievement have continued to yield inconsistent results. The results of some studies indicate that male students achieve significantly better than girls (Kador, 2001; Usman & Ubah, 2007) while some other studies reveal no significant difference in the achievement of the two genders (Nbina, 2010; Loofa, 2001). For
instance, Eshiwani (1982) noted that girl under-achieve in science and mathematics. This underperformance of girls is partly due to teachers’ bias in the teaching and learning process. Teachers tend to pay more attention to boys who appear to be more troublesome to control than girls who appear to be well disciplined. As a result, girls receive less attention, less help and fewer challenging learning activities from their teachers. Similarly, Forum for African Women Educationists, FAWE (1999), observed that science achievement for girls in Kenya has been lower than that of boys partly due to their attitude, their motivation as well as their interests towards Science. The participation of female and male students in science including chemistry is quite different once they are free to choose the subjects. For instance, Changeiywo (2001) noted that: “The participation level for female in science beyond the age at which the study of science is compulsory are lower than those for male” (p.17).

Additionally, Erwin (1993) observed that among upper primary and secondary school students, boys have greater interest in Science than girls. Moreover, Partinson (1994) asserts that there is gender imbalance in school sciences where more boys take science subjects than girls. Although there is no gender differences in general intelligence, notable differences are found on some tests of cognitive abilities. Many of the tasks that assess the ability to manipulate visual images in working memory shows an advantage for males whereas many tasks that require retrieval from long-term memory and acquisition and use of verbal information show an advantage for females. According to Trowbridge, Bybee and Powel (2004), the gender difference tend to be very large for Physics, small for Chemistry and either slight or non-existent for Biology. Also, Twoli (1986) argue that gender differences are particularly related to sciences interest in that boys were more interested in physical sciences while girls were more interested in the biological sciences. This indicates that there could be
a relationship between gender, the choice of the subject and probably the science performance, including chemistry.

Education, Audiovisual and Culture Executive Agency, EACEA (2010) observed that gender differences in science were substantial within schools or programmes in many European countries. In addition, there were gender differences regarding scientific competences and certain attitudes in which females were stronger in identifying scientific issues, while males were stronger at explaining phenomena scientifically. On contrast, Martin, Mullis and Foy (2008) observed that grade 8 science students, on average across the Trends in International Mathematics and Science Study, TIMSS 2007 countries, females had higher average achievement than males by six points. Similarly, Klainin and Fenshams (1987) noted that Thai girls perform at least as well as boys in Physics and better than boys in Chemistry. This is because their cultural norms and values reflect a society in which women traditionally have played an important economic role. This calls for need to develop teaching strategies that will enable the female students to be more motivated and more confident in learning Chemistry tasks and concept, hence perform equally or more than the male counterparts. Although the above studies have observed gender difference or no gender difference in chemistry achievement, they have not investigated how use of CAI interact with gender to affect students’ achievement in chemistry. This study therefore, sought to establish gender difference in students’ Chemistry achievement when taught using Computer Aided Instruction approach.

2.8 Self-efficacy

According to Bandura (1986), self-efficacy is a self-judgment of one's ability to perform a task and skills within a specific domain of learning. Self-efficacy judgments are related to
specific tasks in a given course of study and is goal directed (Bandura, 1997; Pajares, 2005; Zimmerman, 2000).

Moreover, self-efficacy judgments direct people to rate their confidence for attaining a specific goal. Those students who seem to be more self-efficacious are actually more confident towards a specific subject. According to Bandura (1997) and Schunk (1989), people’s self-efficacy beliefs affect several aspects of their behavior, including their choice of activities, their effort and persistence, and eventually, their learning and achievement. Bandura (1986) noted that having high self-efficacy in one subject does not necessarily guarantee high self-efficacy in another domain. Students with high self-efficacy in Chemistry tasks and activities will be more likely to select such tasks and activities. They work harder to complete those activities successfully and persevere even when faced difficulties. Alternatively, students who do not believe that they can succeed in Chemistry tasks will avoid them if they can, and will put minimal effort if they cannot (Britner & Pajares, 2006).

Experiences that are interpreted as successful raises self-efficacy while those interpreted as unsuccessful generally lower the self-efficacy. Zimmerman (2000) associated high self-efficacy with greater self-regulation which included more efficient use of problem-solving strategies and management of working time. Furthermore, efficacious individuals persist longer to complete a task, particularly in the face of challenging activities and tasks (Pajares, 2005; Zimmerman, 2000).

Further, Bandura (1997); Pintrich (2003) pointed that self-efficacy and performance is reciprocally related, whereby successful task performance enhances self-efficacy leading to the adoption of more difficult tasks. The adoption of more difficult activities and tasks
requires greater effort, which will positively affect performance. Successful performance will in-turn lead to greater self-efficacy and thus the cycle continues.

In addition, Bandura (1997) noted that self-efficacy predicts intellectual performance better than skills alone and it directly influences academic achievement through cognition. Although past performance raises academic self-efficacy, it is student interpretation of past successes or failures that may be responsible for subsequent success or failure. More so, perceived self-efficacy predicts future achievement better than past performance since they influence thought processes (Bandura, 1986). Fluctuations in achievement may be explained by fluctuations in self-efficacy. According to Schunk and Pajares (2002) self-efficacy is related positively to interest and engagement in learning.

Further, Bandura (1997) mentioned that student’s beliefs about their efficacy to manage academic task demands can also influence them emotionally by decreasing their stress, anxiety, and depression. Zimmerman and Kitsantas (1997), found self-efficacy to be highly correlated with students’ rated intrinsic interest in a motoric learning task as well as in a writing revision task. Pajares and Miller (1994) observed that learning skills acquisition enhances self-regulated learning behaviour which in turn ensures motivation and confidence as a learner engages in learning tasks.

The confidence to approach learning in an independent manner which promotes the belief in one’s ability to execute a given task may invariably lead to enhanced self-efficacy. Salomon (1984) also found that self-efficacy is positively related to self-rated mental efforts and achievement during students’ learning from text material that was perceived as difficult. It
was necessary to devise strategies such as CAI to boost which would help increase students’ academic self-confidence (self-efficacy) as well as achievement in science.

2.8.1 Self-efficacy in Chemistry

Self-efficacy is especially important in learning difficult subjects (such as chemistry and other sciences) given that students enter courses with varying levels of fear and anxiety (Baldwin, Ebert-May, & Burns, 1999). According to Baldwin et al. (1999) self-efficacy becomes more important over the duration of a course as science concepts increase in complexity. Smist and Owen (1994) found aptitude, attitudes, and attributions to predict science self-efficacy in high school students. It is thought that science self-efficacy may affect science learning, choice of science, amount of effort exerted, and persistence in science (Kennedy, 1996). Diane (2003) notes that self-efficacy indirectly influences perseverance in science learning. Also, Watt (2006) observed that Mathematics and science students with high self-efficacy enroll in more challenging courses than do students with low self-efficacy because they perceive demanding tasks as challenges rather than threats. Chepkorir (2013), observed that students in Kenyan secondary schools lacked self-confidence in themselves when learning chemistry which leads to giving up the possibility of passing chemistry.

According to Chepkorir (2013), some students could not work out problems considered difficult without assistance from the teacher. Daine (2003) found a significant positive relationship between self-efficacy and academic achievement and that most students had moderate levels of self-efficacy in the two-year science course. Study by Silver, Smith and Greene (2001) link self-efficacy to both general academic achievement and science
achievement. Baldwin, Ebert-May and Burns (1999) also stated that self-efficacy becomes more important over the duration of a course as science concepts increase in complexity.

Research studies have demonstrated that self-efficacy, which is confidence in learning chemistry can be enhanced through use of computers. For example, Liu and Chen (2013) observed that grade 5 students from elementary school in Northern Taiwan demonstrated effectiveness in learning science when taught through computers. Similarly, Yien, Hung, Hwang and Lin (2011) observed that computer-game-learning was more effective in enhancing the self-efficacy of students in learning nutrition course than conventional methods. Tsai, Chuang, Liang and Tsai (2011) noted that students’ self-efficacy plays a positive role in students attitude towards their processes and outcomes derived from Internet-based learning. Susskind (2005) examined the effects of non-interactive computer assisted instruction on students’ performance, self-efficacy, motivation and attitudes. Half the lectures were presented to two introduction to Psychology College classes. They were taught in the traditional lecture method and the other half were taught by power point multimedia. Findings showed that students had more positive attitudes about the course and greater self-efficacy with power point.

Researchers have pointed that the self-efficacy of students regarding usage of computers in learning is gender biased. Bimber (2000) argument, that computer usage has been known to be biased toward the interests and fashion of men. Furthermore, Isman and Celikli (2009) found that females are not as confident as men are to computers. Awoleye and Siyanbola (2005); Bimber (2000), indicated that computers have some gendered attributes that favor man in some way so that men are more likely to use computers and they are more confident.
Isman and Celikli (2009) found out that students with different computer skills show different self-efficacy levels. In addition this some students have advance computer knowledge and therefore they complain about the level of the computer courses offered to them.

Other studies have demonstrated a clear link between and self-efficacy and performance in learning science. For example, PISA (2006) observed that students’ belief in whether they could handle tasks effectively and overcome difficulties, which is self-efficacy in science was particularly closely related to performance. More so, Martin, Mullis and Foy (2008) also reported a link between the level of self-confidence in learning science and achievement in science. Nbina (2010) found that instruction in the metacognitive self-assessment strategy using computers improved the students’ chemistry achievement and self-efficacy among senior secondary school students in Delta North education zone of Delta state. Furthermore, Fencl and Scheel (2005) found that use of electronic application pedagogies had a positive correlation with increased self-efficacy in non-major physics students. From the literature, it is found that use of computers could be a good approach for improving students’ self-efficacy in learning chemistry.

Several past studies on self-efficacy have mainly focused on the relationship of self-efficacy and achievement or performance in general (Pasana & Teresa, 2004; Schunk, 1989; Schunk & Swartz, 1993) and others have explored on students’ self-efficacy and teaching strategies in elementary (Liu & Chen, 2013) and higher science education (Fencl & Scheel, 2005; Yien, Hung, Hwang & Lin, 2011). From the literature, it is found that self-efficacy and achievement have a positive relationship as well as the teaching strategies. The above studies have not investigated the connection between teaching strategies such as CAI and self-
efficacy of students in learning chemistry. The study, therefore sought to investigate on how use of CAI affect self-efficacy of students in learning Chemistry.

2.8.2 Self-efficacy and Gender

According to Smist and Owen (1994) and also Tippins (1991), female students have lower science self-efficacy compared to male students. From primary school level, girls tend to underestimate their abilities in Mathematics and Science (Sadker & Sadker, 1995). Girls’ capabilities are undermined by sex-role stereotypes in many cultures intimating that females are not as able as males, especially in such discipline as science (Bandura, 1986; Bandura (1987).

Another contributing factor is the lower level of expectations that parents, teachers, and counselors often hold for girls, which can discourage further study in science fields (American Association of University Women Educational Foundation, AAUW (1999). According to AAUW (1999), girls’ enrolment in Biology and Chemistry has increased and even exceeded boys, although boys are still enrolled more often in physics than girls. Confidence is strongly correlated to students continuing in mathematics and science courses (Pajares & Miller, 1994).

In a college general Chemistry class, a statistically significant finding was reported with males scoring higher than females in science self-efficacy for laboratory skills (Smist, 1993). The study also mentioned that females had lower self-efficacy scores than males for the sciences. Ochieng (2015) conducted a study on self-efficacy and academic achievement
among secondary schools in Kenya and observed that there was a significant difference in self-efficacy regarding male as compared to their female counterparts in Mathematics. Where these differences exist between males and females, it has usually been attributed to unequal exposure of males and females to experiences relevant to chemistry learning.

This is occasioned by the traditional cultural attitude towards the female gender which restricts them from activities considered masculine (Okeke, 1990). This difference in cultural attitude towards males and females in access to environmental stimulations has been reported to influence their self-efficacy in favour of the boys (Eze & Agboma, 2008). Some studies suggest that the gender differences in science, technology, engineering and mathematics self-efficacy may be closing. For example, a cross-national comparison study conducted by Chen and Zimmerman (2007), on the accuracy of self-efficacy beliefs of middle-school science and mathematics students, found no gender differences in science and mathematics self-efficacy.

Additionally, Britner and Pajares (2006) study on sources of science self-efficacy beliefs of middle-school students, revealed that the middle school girls had higher science self-efficacy than boys. EACEA (2010) report indicated that on average, girls had lower levels of belief in their scientific abilities than boys in all European countries. Boys also had higher level of self-efficacy in tackling specific scientific tasks. However, both boys and girls had similar levels of interest in science and there was no overall difference in boys’ and girls’ inclination to use science in future studies or jobs. Most of the research has focused on students in ‘normal’ classroom environment and has shown that females have lower levels of self-efficacy in mathematics and science classes than their male counterparts (Smist & Owen, 1999; Tippins, 1991; Smist, 1993; Eze & Agboma, 2008). Basically, most of the earlier
researches conducted on science, technology, engineering and mathematics self-efficacy based on gender were investigated in “normal classroom environment” rather than a computer learning environment. Thus, it was important to carry out a study to investigate how use of CAI approach influence gender self-efficacy in learning Chemistry.

2.9 Collaborative learning

Collaborative learning has its roots in the work of Piaget and Vygotsky (Dillenbourg, Baker & O’Malley, 1996). According to Dillenbourg (1999) collaborative learning refers to a situation in which two or more people learn something together. Collaborative learning is based on the view that knowledge is a social construct. Britton (1990) posits that student’s learning is derived from the community of learners and recommends placing students in groups and letting them generate their own ways and procedures for learning. Britton believed in learning something by making intuitive responses to whatever efforts produce, rather than the application of explanations, instructions for action. Collaboration is sometimes distinguished from cooperative learning in that cooperation is typically accomplished through the division of labor, with each person responsible for some portion of the problem solving.

On the other hand, collaboration involves participants working together on the same task, rather than in parallel on separate portions of the task. Dillenbourg (1999) notes, collaborative situations are characterized by symmetrical structures, with symmetry of action in which each participant has access to the same range of actions. This contrasts with the typical division of labor in cooperative learning structures which the partners split up the work, solve sub-tasks individually, and then put their respective contributions together. However, cooperative and collaborative learning both stress the centrality of interdependence. In collaborative learning, interactions exist which are characterized by shared goals, symmetry of structure, and a high
degree of negotiation, interactivity, and interdependence. These interaction plays a vital role during the learning process. In terms of constructivist theory; student-student and student-teacher interaction is important in the class environment.

As Van Boxtel, et al. (2000) explain, collaborative learning activities allow students to provide explanations of their understanding, which can help students elaborate and revise their knowledge. Social interaction stimulates elaboration of conceptual knowledge as group mates attempt to make themselves understood. Lai (2010) demonstrates that providing elaborate explanations improves student comprehension of concepts. Collaborative interactions are characterized by shared goals, symmetry of structure, and a high degree of negotiation, interactivity, and interdependence. Lai (2010) points that collaboration can have powerful effects on student learning, particularly for low-achieving students. However, a number of factors may restrain the impact of collaboration on student learning which include; group composition, task characteristics and student characteristics. Unlike individual learning, people engaged in collaborative learning capitalize on one another’s resources and skills. Collaborative learning have been found to be beneficial in assisting students learn effectively and efficiently than if the students were to learn independently (Smith & MacGregor, 1992).

Collaboration entails: working together, group work or team work, cooperation, relate and partnership, sharing and joint collaboration (Intel Corporation, 2008). Collaborative activities that the teacher would engage learners in are most often based on four principles:

a) The learner is the primary focus of instruction

b) Interaction and doing are of primary importance
c) Working in groups is an important mode of learning
d) Structured approaches to developing solutions to real-world problems should be incorporated in learning.

Johnson and Johnson (1999), mentioned some of the benefits from collaborative activities as such as; students are able to learn more materials by engaging one another, students retain more information from engaged discussion, students have a more positive attitude about learning and good collaborative skills by working together. Also collaborative activities provides opportunities for developing social skills and communication skills. Wachanga and Mwangi (2004) affirms that weak students benefit from interaction with brighter students and when bright students explain their ideas to others, they learn the material they are explaining in more depth and remember it longer. Collaborative learning also serves to build peer relationships that foster learning (Coble & Koballa, 1996). According to Ssempala (2011), small-group interaction provide support for the construction of mathematical meaning by pupils, since it allows more time and space for pupil talk and activity.

A study conducted by Springer, Stanne and Donovan (1999) demonstrated that various forms of small group learning were effective in promoting greater academic achievement and increased persistence through courses and programmes. Johnson and Johnson (1999), cautions that just placing students in groups does not guarantee collaboration and therefore incentive to collaborate has to be structured within the groups. For this reason, instructors need to design collaborative classroom environments. According to Chiu (2004) collaborative learning activities include collaborative writing, group projects, joint problem solving, debates, study teams. Research suggest that collaboration provides opportunities for students
to improve academic successes in that they must ask questions, discuss ideas, explore solutions, clarify their own thinking and develop deeper understanding of the content.

For example, a meta-analysis study by Prince (2004), compared small-group work to individual work in K-12 and college classrooms and found that students working in small-groups achieved significantly more than students working individually. The optimal group for learning tended to be three to four member teams with lower ability students working best in homogeneous group, for higher ability students, group ability levels made no difference. Similarly, studies of elementary, middle and high school English classrooms, discussion-based practices showed improved comprehension of the text and critical thinking skills for students across ethnic and socioeconomic backgrounds (Alexander, 2009). Webb (1993) found that seventh-grade students working in groups of 3–4 on computational math problems earned significantly higher scores working in groups than equivalent-ability students working individually.

The studies above have showed that collaboration can have a powerful effects on students learning than individualized learning (Prince, 2004; Wachanga & Mwangi, 2004; Alexander, 2009; Johnson, Johnson & Smith, 2013). However, the studies have not made a comparably study involving two or more instructional conditions such as Computer Aided Instruction and conventional methods to determine under which condition is collaboration more or less effective in learning chemistry. The study therefore, sought to determine how use of CAI facilitates development of collaborative of students in learning of chemistry as compared to conventional methods.
2.9.1 Development of Collaborative skills in CAI

According to Johnson and Johnson (1999), social interaction is a prerequisite for collaboration and collaborative learning. If there is no social interaction then there is also no real collaboration. Kearsley (1995), echoes that social interaction in computer-supported collaborative learning must be organized, otherwise it is unlikely to occur or be meaningful. Kreijns et al. (2003) caution that, in contrast to face-to-face interactions, social interaction should not be taken for granted just because the technology to support interaction is there. Coble and Koballa (1996) indicated that social interaction is necessary if learners are to be exposed to new ideas about science teaching and learning and to coordinate their own ideas with those of others. Social interaction is therefore, key element for the development of collaborative skills in CAI environment.

Fall et al. (1997) and Webb (1995) recommend, providing explicit instruction to developing collaboration skills, such as instruction in effective communication, how to seek help, and how to provide help to others. Similarly, Webb (1991 and 1995) recommends training students in general interpersonal and teamwork skills, including coordination, communication, conflict resolution, decision making, problem solving, and negotiation. Such training could assist learners on how to give explanations, how to directly and explicitly ask for help, and how to respond appropriately to others’ requests for help. Teachers should also provide ample opportunities for students to practice collaboration skills, using tasks that are similar to those used during group-based assessments. To institute measures which support
the development of collaborative skills through group roles, Brush (1998) suggests, consistent prompting and reminding the group members of their roles throughout the learning activity.

The individual student roles should define horizontal rather than vertical division of labor. For example, one student may assume responsibility for the “learning leader”, responsible for summarizing and recounting the main points of the material, whereas the other group member as the “learning listener”, responsible for detecting errors or omissions in the summary and asking questions to clarify the material. Therefore, teachers should preparing students for collaboration by providing explicit instruction, and teachers also structure tasks to support collaboration.

Research on collaborative learning focusing on computer-supported collaborative learning has emerged for supporting distance interactions, such as email, chat, instant-messaging capability and more recently, resources for synchronous video conferencing, such as Skype (Kreijns et al., 2003). Research on computer-supported collaborative learning has attempted to determine whether the theoretical benefits of collaborative learning in face-to-face settings can be realized through computer-mediated or computer-aided interactions that are limited to asynchronous, text-based interactions. For example Dukuzumuremyi (2014), investigated the use of computer supported collaborative learning software and applications and its associated theories of learning and pedagogical models into inclusive classroom as well as conception of knowledge of diverse pupils in collaborative learning. The data suggested that use of computer supported collaborative learning are a resourceful ways of developing collaborative skills. This study, therefore sought to determine students’ development of collaborative skills in learning chemistry when taught with CAI approach and conventional methods.
2.10 Summary of Literature Review

Numerous studies from reviewed literature have reported that Computer Aided Instructional method is successful in raising students’ achievement scores (Kiboss, 2004; Wanjala, 2005; Olga, 2008; Serin, 2011; Mwei, Too & Wando, 2011; Jesse, Twoli & Maundu, 2014). From the literature reviewed, it was realized that the earlier studies that were conducted on how the use of computer aided instruction affect students’ achievement mainly considered the study of Mathematics, Biology and Science subjects in general, which employed two-group quasi-experimental pretest-posttest design in Kenyan schools. Moreover, the few studies have focused on impact of use of computer aided instruction on students’ achievement in Chemistry (Jesse, 2012), have not explored the issue of gender difference in chemistry achievement. Due to this gap, the present study sought to investigate the influence of computer aided instruction on students’ achievement as well as gender achievement in chemistry.

Several past studies on self-efficacy have mainly focused on the relationship between self-efficacy and achievement or performance in general (Pasana & Teresa, 2004; Schunk, 1989; Ochieng, 2015; Schunk & Swartz, 1993). Other research studies have explored on the effects of teaching methods on students’ self-efficacy in classroom (Bandura & Locke, 2003; Fencel & Scheel, 2005). Few studies have been conducted on relationship between teaching strategies such as computer supported learning and self-efficacy in science learning (Susskind, 2005; Chen & Liu, 2013; Yien, Hung, Hwang & Lin, 2011) but no research has
established a firm connection between computer aided instruction and self-efficacy of students in learning secondary (high) school Chemistry.

Based on the results of existing research studies, however, there appears to be a relationship between self-efficacy and computer supported learning in higher and elementary science education (Liu & Chen, 2013; Yien, Hung, Hwang & Lin, 2011).

From the literature reviewed, it was clear that the way the students interact with one another socially is a neglected aspect of instruction. Most of the studies reviewed were devoted to helping the teachers on how to arrange appropriate interactions between students and materials such as textbooks, while other studies focused on how teachers should interact with students (Coble & Koballa, 1996; Ssempala, 2011; Wachanga & Mwangi, 2004). Studies on how students interact with one another to develop collaborative skills such as concepts of team working, sharing, belonging and respect have attracted less attention. In particular, studies on collaborative learning in Kenyan secondary schools that have so far been conducted have mainly focused on improvement of cognitive component of learning while the social component, that is students’ development of collaborative skills, is lacking in scholarly work. Due to this gap in research literature, the present study aimed at determining the development students’ collaborative skills in learning of chemistry when taught using computer-aided instruction and conventional methods. Generally, from the literature reviewed, no comparably study that has so far been conducted to assess the influence of use of computer aided instruction on students’ cognitive (achievement), affective (self-efficacy) and social (collaborative skills) components simultaneously in Kenya. It was therefore important to carry out a study to establish influence of computer aided instruction approach
on students’ achievement, self-efficacy and students’ development of collaborative skills in Chemistry at secondary school level in Kenya.

CHAPTER THREE
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction
This chapter provides the research design and methodology used in this study. It covers the research design, location of the study, research variables, target population, sampling procedures and sample size, instrumentation, piloting, reliability and validity, logistical and ethical considerations, data collection procedures and data analysis methods.

3.2 Research Design
The study adopted Quasi-Experimental design based on Solomon Four-Group, Non-equivalent Control Group Design. Solomon Four-Group design is rigorous enough for quasi-experimental studies (Borg & Gall, 1989). Quasi-experimental design involves no randomization of the subjects to the sample groups but rather involves random assignment of intact classes to sample groups. This design controls all major threats to internal validity except those associated with history and maturation (Cook & Campbell, 1979). Solomon four-group design comprises of four groups, two experimental groups and two control groups. Solomon four group design has two extra groups, which serve to reduce the influence of confounding variables and allow the researcher to test whether the pre-test itself has an effect on the subjects (Kumari, 2013). Two groups being exposed to a pre-test and all the groups exposed to a post-test. This design attempts to eliminate the possible effect of pre-testing. The Solomon-Four group design is illustrated in figure 3.1
<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Treatment</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group E1</td>
<td>$O_1$</td>
<td>X</td>
<td>$O_2$</td>
</tr>
<tr>
<td>Group C1</td>
<td>$O_3$</td>
<td>X</td>
<td>$O_4$</td>
</tr>
<tr>
<td>Group E2</td>
<td></td>
<td>X</td>
<td>$O_5$</td>
</tr>
<tr>
<td>Group C2</td>
<td></td>
<td>X</td>
<td>$O_6$</td>
</tr>
</tbody>
</table>

Figure 3.1: Solomon-Four Group, Non-equivalent control group design

**Key:**

- EI: Experimental group 1
- E2: experimental group 2
- C1: control group 1
- C2: control group 2
- X: Treatment
- No treatment
- $O_2, O_4, O_5, O_6$: Post-test
- $O_1, O_3$: Pre-test
- Non randomization

The various combinations of tested and untested groups with treatment and control groups in Solomon Four-Group design, allows the researcher to ensure that confounding variables have not influenced the results (Shuttleworth, 2009). For example, it enabled the researcher to check whether the pre-test did influence the results or not. Pre-test enabled the researcher to assess the groups’ homogeneity in terms of students’ academic level before the start of the
experiment. In order to avoid effects of experimental contamination, the treatment and control groups were from different schools.

3.2.1 Research Variables
In this study the main independent variable was the Computer Aided Instruction (CAI) and Conventional Instructional Methods (CIM). The CAI was the variable that was manipulated in order to measure its effects on the dependent variables while the CIM variable was the control variable. The dependent variables of the study included students’ academic achievement in Chemistry, Students’ self-efficacy in Chemistry and collaborative skills of students in Chemistry lessons. The study focused on Form Two Chemistry students in Maara Sub-County, Tharaka Nithi County. The Form Two students were preferred because they had acquired some computer skills and at this level the study of Chemistry subject is compulsory. The study focused on the topics in “Atomic Structure, Periodic Table and Chemical Families”. This topics were taught by the Chemistry teachers of the sample schools for a period of six weeks as guided by Chemistry syllabus (KIE syllabus, 2007). The study was conducted during the lesson time as per the school timetable for the schools that participated in the study. This ensured the time of exposure of the treatment and non-treatment to be the same in all participating groups. In this study only qualified trained Chemistry teachers with at least three years of teaching experience were involved and it was assumed that these teachers in the sample schools would relatively teach in the similar way.

3.3 Location of the study
The study was carried out in Maara sub-county which is in Tharaka Nithi County. It has two administrative Divisions; Mwimbi and Muthambi. The sub-county borders Imenti South sub-
county to the East, Meru South to the West, Mt Kenya forest to the North and Tharaka District to the South (Appendix VIII). The sub-county was deemed appropriate for the study because the students’ performance in Chemistry has been low. For instance, analysis of KCSE data in the years 2009 to 2015 reveals an average achievement mean score of 26.52% to 39.42% at the sub-county level and mean score of 19.13% to 34.36% at the national level. The performance data at the Sub-County and at the national level were comparable and therefore, the Sub-County provided a representative case of many other sub-counties in the country. The Sub-County remained well placed for the study because, it had a wide range of schools with computer laboratories which was a key resource for CAI approach. Also, the Sub-County was conveniently located in the County. This enabled major operations like population identification, sampling and data collection to be undertaken with less time. Lastly, no recent documented similar studies have been carried out in the sub-county.

3.4 Target Population

The target population included all secondary schools with computer laboratory in Maara Sub-County in Tharaka Nithi County. The total population of schools with computer laboratory in the Sub-County was 15 schools out of 43 schools. Secondary schools with computer laboratory were deemed appropriate for the study because a computer laboratory was a key resource that was required for Computer Aided Instruction lessons. The Form Two Chemistry students from schools with computers were preferred to other levels (forms) for the study because at this level study of Chemistry was compulsory and the students were acquainted with computer skills. The total population of Form Two Chemistry students in the 15 schools with computers was 2520.
3.5 Sampling Procedures and Sample Size

3.5.1 Sampling Procedures

Sampling is a process of selecting a number of individuals or subjects from a population such that the selected group contains elements representative of the characteristics found in the entire group (Orodho & Kombo, 2002). The secondary schools with computer laboratory in Maara Sub-County formed the sampling frame. The nature of the study, however, required the research sample be purposively sampled. This is because the study on CAI had to be conducted in secondary schools where computer laboratories were available for CAI lessons.

Purposive sampling was also used to select the schools that were similar in academic performance because the research was a comparative study and also to select only the schools that had a computer laboratory. Therefore, four Extra County schools which were similar in academic rating, that comprised of two “Boys only” and two “Girls only” schools were purposively sampled to form the study sample. The assignment of the two categories (“Boys only” and “Girls only”) to either experimental or control conditions was done using simple random sampling. Random sampling gives each and every school from the target population a known and equal probability of selection (Kothari, 2004). In case the school had more than one stream, only one stream was randomly sampled for the study. The other streams, not randomly sampled were exposed to similar conditions (treatment and non-treatment) only, but no research instruments were administered to them. Only one stream was involved in the
study in order to have equivalent group size, bearing in mind that some schools have more streams than others.

### 3.5.2 Sample Size

The units for sampling in this study were schools not individual students. According to Mugenda and Mugenda (2003) at least 30 cases per group are required for experimental studies. The recommended number of students per class is 40. Four intact classes (groups) of Form Two students from Extra County schools with computer laboratory formed the study sample groups. The Form Two classes were used for the study because at this level the students were computer literate and study of Chemistry subject was compulsory. The sample comprised of four extra County schools which included two Boys only and two Girls only schools.

Experimental Group schools 1 and 2 had 45 and 46 students respectively, while Control Group schools 1 and 2 had 45 and 38 students respectively. The total number of students in the four groups (schools) was 174 and this constituted sample size for the study. The percentages of schools and study used in the study are shown in Table 3.1. These percentages meet the recommended statistical value of 10 percent (Orodho & Combo, 2002)
Table 3.1: The sampling Frame

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Total number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary schools that have computer laboratory</td>
<td>15</td>
<td>100%</td>
</tr>
<tr>
<td>Population of students in the 15 schools</td>
<td>9643</td>
<td>100%</td>
</tr>
<tr>
<td>Population Form Two students in the 15 schools</td>
<td>2520</td>
<td>26%</td>
</tr>
<tr>
<td>Form Two students in 4 schools of study</td>
<td>765</td>
<td>30%</td>
</tr>
<tr>
<td>Population of Experimental Group 1 (Boys)</td>
<td>45</td>
<td>25.9%</td>
</tr>
<tr>
<td>Population of Control Group 1 (Girls)</td>
<td>45</td>
<td>25.9%</td>
</tr>
<tr>
<td>Population of Experimental Group 2 (Girls)</td>
<td>46</td>
<td>26.4%</td>
</tr>
<tr>
<td>Population of Control Group 2 (Boys)</td>
<td>38</td>
<td>21.8%</td>
</tr>
<tr>
<td>Sample Size</td>
<td>174</td>
<td>23%</td>
</tr>
</tbody>
</table>

3.6 Research Instruments

The instruments for this study were Chemistry Assessment Test (CAT), Students’ Self-efficacy Scale (SSES) and Classroom Observation Schedule (COS). The study also used the treatment instrument “Computer Aided Instruction” (CAI) software as an instructional package for the experimental groups. The tests, questionnaire and observation schedule instruments were developed by the researcher to measure students’ achievement, their self-efficacy and collaborative skills in Chemistry.
3.6.1 Chemistry Achievement Test (CAT)

Chemistry achievement tests was used to measure the learners’ achievement in Chemistry subject. Two chemistry assessment tests were used; the pre-test (Appendix I) and post-test (Appendix IV). The pre-test assessment test was used to measure the students’ achievement in chemistry before the exposure of the treatment. The post-test was used to measure the students’ achievement in Chemistry subject for both experimental and control groups after the treatment. Both pre-test and post-test chemistry assessment tests contained either short-answer questions or structured questions with different scores in each question and total score of 40 marks (Appendix I and IV). The pre and post-achievement tests were constructed by a panel of qualified and experienced teachers and under the supervision of two specialists each in Chemistry education and measurement and evaluation.

The questions for the pre-test was based on the “Matter and its constituents” in Form One chemistry syllabus, which is pre-requisite knowledge for the topics under study. The questions were generated based on selected Chemistry contents the students were taught in the first session of academic year, namely; Structure of an Atom, Periodic Table and Chemical Families” in Form Two Chemistry syllabus. Content validity was ensured by including questions from all the topics taught during the study period. A table of specification (Blueprint) was used to ensure that the test had construct validity. The test content was based
on Blooms taxonomy which is knowledge, comprehension, application, analysis, and synthesis and evaluation levels of cognitive domain (Anderson et al, 2001).

3.6.2 Students’ Self-efficacy Scale (SSES)

This instrument was developed and was used to measure the perceived chemistry self-efficacy (confidence) of the students. Students’ self-efficacy scale was used as pre-test and post-test (Appendix II). The pre-test self-efficacy scale was used to measure perceived chemistry self-efficacy of the students before the exposure of the treatment to the experimental groups. On the other hand, the post-test self-efficacy scale was used to measure students’ self-efficacy after the treatment. The items of the pre-test self-efficacy scale were re-arranged to form the post-test self-efficacy scale items. The items of the scale assessed students’ level of confidence (self-efficacy) in mastering chemistry concepts, for example, generally perceived self-efficacy in chemistry subject and choice of chemistry and career courses related to chemistry. The SSES comprised of 12 items on a five-point likert scale namely; 1= strongly disagree, 2= disagree, 3= not sure, 4= agree and 5= strongly agree.

3.6.3 Classroom Observation Schedule (COS)

Observational research serves to collect objective information (Mugenda & Mugenda, 2003). A classroom observation schedule was used as the pre-test and post-test (Appendix III) observation schedule. The observation schedule was used to record observed collaborative skills of students in learning of chemistry before (pre-test) and after (post-test) the administration of the intervention (CAI). Collaborative skills were rated by the researcher
during chemistry lessons for both the experimental and control groups. The observation schedule contained 10 items for collaborative skills which is a four point likert scale (1-4). Where: 1= never observed, 2= rarely observed, 3= occasionally observed, 4= consistently observed.

The second section of classroom observation schedule contained items on challenges of employing CAI in classroom which were “yes” or “no” response and open response. These responses on CAI integration were obtained before the administration of treatment (CAI), during the first classroom observation by the researcher from chemistry teachers who were used in the study.

3.6.4 Treatment instrument (CAI Program)

The study used a CAI program obtained from the Kenya Institute of Curriculum Development (KICD). The KICD is the institution mandated for providing approved learning materials and content for primary, secondary and college curricula. The CAI programs are compatible with most computer operating systems and therefore can be used with a variety of computers. To be able to use the CAI program properly, the computers needed to have at least the following specifications; 1.6 GHz processor, 256MB read only memory (RAM), 40 gigabytes (GB) hard disk, CD rom drive and be fully multimedia. The computers needed also to be installed with adobe flash player version eight or higher to play the CAI program educational content. The CAI program consisted of tutorials and drill and practice applications. The CAI program contained a set of quizzes, exercises and assignments at the end of each topic and sub-topics. The CAI Program also consisted of an in-built evaluative system which provided immediate responses for answers supplied by the students in the
program. For instance, if the answer supplied is right, the computer responds ‘correct’, if wrong, it responded either by saying ‘try again’ or ‘please try again’.

3.7 Piloting of Instruments

To enhance reliability and validity of the instruments a pilot study was necessary. Piloting is important as it helps identify misunderstandings, ambiguities, and inadequate items (Wiersma, 1985). The researcher conducted a pilot study using two secondary schools with same characteristics as sample schools in Maara Sub-County. The instruments; pre and post chemistry achievement test, students’ self-efficacy scale, classroom observation schedule were pilot tested. To make sure that the treatment instrument “CAI program” was free from any problems before its application, it was trial tested. The schools that were involved for the pilot study were not included in the major study. The data obtained from the trial tests was used to determine the reliability of the instruments.

3.7.1 Reliability

The Cronbach’s coefficient Alpha determines how items correlate among themselves and hence tests the internal consistency of the instrument in measuring the construct of interest (friech, 1951). The reliability of the chemistry assessment test and the self-efficacy scale was estimated using Cronbach Alpha method. This is because the items of the CAT were open-ended while those of the SSES and COS had range scores and therefore yields a data that was not dichotomous (Borg & Gall 1989). The pre-test CAT and post-test CAT internal consistency reliability estimate of 0.720 and 0.702 were obtained respectively. Regarding the
students’ self-efficacy Scale (SSES), the reliability estimate obtained was 0.884. The SSES was also tested for stability as it was used for pre and post-SSES. The data obtained through a re-administration of the instrument after two weeks were correlated with the data obtained earlier using Pearson product moment correlation method and the stability estimate of 0.842 obtained.

According to George and Mallery (2003), an alpha coefficient greater than 0.9 is considered as excellent, an alpha greater than 0.8 is considered as good, an alpha greater than 0.7 is considered as acceptable, that of greater than 0.6 is considered as questionable while an alpha less than 0.5 is considered as poor and unacceptable. Thus, the instruments were considered appropriate for this study.

3.7.2 Validity

Validity is the degree to which results obtained from the analysis of data actually represent the phenomenon under study (Mugenda & Mugenda, 2003). The CAT questions were generated based on the test blueprint developed and face validated by the two experienced chemistry teachers who were also KNEC examiners, two specialists in Chemistry education and two others in measurement and valuation. This was done to ensure the content validity of the achievement test. The test items generated were compared with the same group of specialists to ensure their suitability in terms of appropriateness of language and clarity for the level of the students. A final document was thus produced.

3.8 Data Collection procedure

The software (CAI programs) was first installed in the computers of the schools that were used as experimental groups. Secondly, the researcher trained Chemistry teachers of the
experimental groups for two hours, on how to use computer aided instruction program (Appendix V). Thirdly, before the commencement of the treatment, the CAT and SSES instruments were administered by the regular Chemistry teachers to both Experimental and Control schools. The CAT test lasted for 40 minutes whereas the SSES for 10 minutes. Two classroom observations were made to all the groups. During the observation, the students’ participation, engagement, interactions (collaborative skills) were observed and challenges for employing CAI determined. This pre-treatment period was designed to last for one week. During this duration the researcher visited all the four schools before the administration of the treatment. It was then followed by exposure of treatment (CAI) to the experimental groups teaching the topics “Structure of an Atom, Periodic Table and chemical families” for a period of six weeks with one session per week. Each session lasted for 40 minutes. The treatment was administered during the normal lesson time as per the school timetable for the schools that were involved. Students in the control groups were taught the same selected topics for the same period of time with the normal chemistry classes (conventional methods or non-CAI).

Chemistry teachers of experimental groups presented and explained the content of the topics using CAI program for about one-third of the lesson time at appropriate moments. After the teacher presented the material to be learnt, students working in groups (usually composed of different students each session) discussed the questions that were provided at the end of every sub-topic in the CAI program. After the discussion, students selected or entered their answers in the CAI program which evaluated the answers supplied by the students, if the answer was right, the computer would respond ‘correct’, if wrong, it responded either ‘try again’ or “please try again”. The teacher, then gave a brief clarifying which lasted approximately 5
minutes of the class period and focused on those questions that students listed as most difficult.

During the treatment period the researcher made three classroom observation after fortnight to each school and observed Chemistry lessons; the participation, engagement and interactions both student-student and student-teacher, and also assessed the collaborative skills of students for all the four groups (Appendix III). At the end of treatment period, the regular Chemistry teachers administered the post-test CAT and SSES, and the classroom observation schedule was applied to the students in both experimental and control groups.

3.9 Data Analysis

The nature of data of this research was quantitative. The data collected using the tests, questionnaire and observation schedule was first collated and analyzed using SPSS package version 20. Data analysis was done using both descriptive (mean and standard deviation) and inferential statistics (t-tests, ANOVA and ANCOVA). The descriptive statistics were used to describe the data while the inferential statistics were used to test the significance difference between the groups. Firstly, ANCOVA test was performed using KCPE marks as the covariate in order to cater for the initial difference among the groups. Secondly, ANOVA test was performed to determine the differences in the means of the four groups. Lastly, independent samples t-test was performed to determine the differences in the means of two groups (boys and girls). This is because t-test has the power to detect differences between two means (Borg & Gall, 1989). The statistical significance of the hypothesis was tested at $\alpha = 0.05$. The data analyzed was finally presented in tabular form and graphics. The main graphics used in presenting analyzed data for this study were pie charts and bar graphs.
Table 3.2: A summary of the Methods of data analysis as per the study hypotheses.

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Independent variable</th>
<th>Dependent variable</th>
<th>Statistical Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₀₁: There is no statistically significant difference in students’ achievement scores in Chemistry between those taught using CAI and those taught using conventional teaching methods (CTM).</td>
<td>CAI</td>
<td>Posttest Scores on CAT</td>
<td>ANOVA ANCOVA</td>
</tr>
<tr>
<td>H₀₂: There is no statistically significant difference in students’ self-efficacy scores in Chemistry between those taught using CAI and those taught using CTM.</td>
<td>CAI</td>
<td>Posttest Scores on SSES</td>
<td>ANOVA</td>
</tr>
<tr>
<td>H₀₃: There is no statistically significant difference in students’ achievement scores by gender in chemistry when students are taught using CAI.</td>
<td>Gender</td>
<td>Posttest Scores on CAT</td>
<td>t-test</td>
</tr>
<tr>
<td>H₀₄: There is no statistically significant difference in students’ collaborative skills scores in Chemistry between those taught using CAI and those taught using CTM</td>
<td>CAI</td>
<td>Posttest Scores on COS</td>
<td>ANOVA</td>
</tr>
<tr>
<td>H₀₅: There is no statistically significant difference in self-efficacy scores by gender in chemistry when students are taught using CAI</td>
<td>Gender</td>
<td>Posttest Scores on SSES</td>
<td>t-test</td>
</tr>
</tbody>
</table>
3.10 Logistical and Ethical Considerations

An authorization letter from Kenyatta University was provided, then a permit from National Commission for Science, Technology and Innovation (NACOSTI) and also a letter from County Director of Education (Tharaka Nithi County) was obtained in order to conduct research in the sample schools.

Before commencement of data collection, ethical guidelines which included; informed consent, anonymity and confidentiality must be observed. The sample schools were visited to seek consent and inform the principals about the study involving their students. Permission by the school principal was taken as representing the consent of the students, who at Form 2 class level are minors by law (GOK, 2010), who cannot enter consent for participating in a research study. Meetings with chemistry teachers and computer teachers were held to make arrangements on how to install and use CAI programs.

The information provided by participants was to be treated with absolute confidentiality and anonymity. No name of respondents or name of the schools or personal information were to be divulged. An assurance was made to the participants that the data obtained from them was for research purposes only and would be kept confidential.
CHAPTER FOUR
PRESENTATION OF FINDINGS, INTERPRETATION AND DISCUSSION

4.1 Introduction

This study aimed at assessing the influence of Computer Aided Instruction (CAI) on students’ academic achievement, self-efficacy and collaborative skills in Chemistry in Kenyan secondary schools. Data were collected from three sources namely; chemistry achievement test, students’ self-efficacy scale and classroom observation schedule in Form two class. The chapter presents the findings, interpretation and discussion according to objectives of the study. It describes the data generated from the study using descriptive and inferential statistics. The findings are presented in form of tables, graphical methods and their interpretation is thereafter discussed. Analysis of Covariate (ANCOVA), Analysis of variance (ANOVA) and t-test were used to test the five hypotheses of the study. The findings of the study were based on the following hypothesis:

i) There is no significant difference in students’ academic achievement scores in Chemistry between those taught using CAI and those taught using CIM.

ii) There is no significant gender difference in Chemistry achievement scores when students are taught using CAI.

iii) There is no significant difference in students’ self-efficacy scores in Chemistry between those taught using CAI and those taught using CIM.

iv) There is no significant gender difference in students’ self-efficacy scores in Chemistry when students are taught using CAI.
v) There is no significant difference in students’ collaborative skills scores in Chemistry between those taught using CAI and those taught using CIM.

vi) There are no challenges faced by teachers in integrating CAI in teaching chemistry.

### 4.2 General and Demographic Information

This section presents the general information of the respondents’ groups and their gender. This was to check for normality of the data collected in terms of number and representation respondents per group and gender considering that data was collected from intact groups.

#### 4.2.1 Proportions of Groups of the respondents

Four groups were involved in the study, of which two of them were Experimental and the other two were Control. A total of 174 students participated in the study. Out of these, 45 and 46 were participants of experimental group 1 and 2 respectively while 45 and 38 were participants of control group 1 and 2 respectively. The frequency and percentage of the respondents in each group were calculated and the results were represented in form of a pie-chart as shown in Figure 4.1.
The results from Figure 4.1 revealed that 26% of the participants were members of Experimental group 1, 26% were members of Experimental group 2, 26% were members of Control group 1, and 22% were Control group 2 members. From these percentages, it is apparent that the number of respondents among the groups were approximately proportional. This, therefore showed that the intact groups which were involved in the study were proportionately represented. If the groups are proportionately represented, then it is possible to make unbiased comparison between the groups using statistical tests.

### 4.2.2 Gender of the Respondents

Both boys and girls secondary schools were included in this study. There were two boys’ and two girls’ schools. The number of the participants based on gender was calculated and the proportions expressed in percent. Their proportionality was represented by use of pie chart as shown in Figure 4.2.
From Figure 4.2, it is evident that the number of boys and girls involved in the study was almost equal, with girls being slightly more. This shows that sample was equally distributed across the gender. Thus, there was minimal gender difference in the participation in this study. The reason why the boys and girls samples were almost the same is because in Kenyan secondary schools Chemistry is compulsory at Form Two level. Therefore, the groups had similar and comparable characteristics in terms of number of participation, hence homogenous representation.

4.3 Students’ level of academic achievement, self-efficacy and collaborative skills before treatment

The aim of the pre-treating the groups was to ascertain whether the students selected to participate in the Experimental group and Control group had comparable academic characteristics. Experimental group and Control group students were exposed to CAT pre-test, Self-efficacy pre-questionnaire and Collaborative skills pre-observation before the application of treatment.

4.3.1 Pre-treatment scores in CAT

The students in both Experimental and Control groups were given a chemistry achievement test (CAT) that tested their prior-knowledge on the topic “Matter and its constituents” from Form One Chemistry syllabus to answer. The CAT instrument was administered to students before the application of treatment CAI. The question items were marked and scored out of a maximum of 40. The data obtained were analyzed using descriptive statistics and t-test and the results indicated in Table 4.1.
Table 4.1: Descriptive and Independent Sample t-test of Pre-treatment scores in CAT

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>df</th>
<th>t-value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT</td>
<td>Exp 1</td>
<td>45</td>
<td>23.23</td>
<td>3.750</td>
<td>88</td>
<td>1.314</td>
<td>0.192</td>
</tr>
<tr>
<td></td>
<td>Control 1</td>
<td>45</td>
<td>22.23</td>
<td>4.125</td>
<td>88</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results from Table 4.1 show that the Experimental group 1 had 45 participants while control group 1 had 45 participants. Experimental group obtained an average score of 23.23 out of 40 while the Control group obtained 22.23 out of 40 in the achievement tests. The t-test analysis reveals that the computed p-value (0.192) was greater than the alpha of 0.05. Therefore, the pre-test CAT mean scores of both experimental group and control group were not significantly different at 0.05 alpha level (t (88) = 1.314, p = 0.192). Thus, H₀₁, which stated that there is no statistically significant difference in chemistry achievement pre-test scores between experimental and control groups was accepted. Therefore the groups were deemed similar on CAT measure and had comparable characteristics, hence homogenous.

The analysis of the difference in gender achievement on CAT pre-test scores was also done. The results were indicated in Table 4.2.

Table 4.2: Descriptive and Independent Sample t-test of Pre-treatment scores in CAT by Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>df</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT</td>
<td>Female (C₁)</td>
<td>45</td>
<td>22.33</td>
<td>4.125</td>
<td>88</td>
<td>1.302</td>
<td>.190</td>
</tr>
<tr>
<td></td>
<td>Male (E₁)</td>
<td>45</td>
<td>23.23</td>
<td>3.750</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results in Table 4.2 shows that 45 respondents were female and 45 respondents were male. The males obtained an average score of 23.23 while females had 22.33 out of 40 on a Chemistry assessment test. The male obtained slightly a higher score than the female. A t-test was done to assess whether the mean scores of female and male students were significantly different or not on CAT. The t-test analysis revealed that the computed p-value (0.190) was greater than the set alpha (0.05). Therefore, the pre-test CAT mean scores for male and female students were not significantly different, $t(88) = 1.302, p > 0.05$. This implied that the male and female students’ samples were similar on CAT measure before the exposure of the treatment. Hence homogenous.

### 4.3.2 Students’ pre-treatment scores in Self-efficacy

Both experimental and control group students were exposed to a self-efficacy scale (SSES) before the application of treatment (CAI). Self-efficacy scale contained 12 items, in which students were asked to report their confidence in learning Chemistry on a five point scale calibrated Strongly Disagree (SD), Disagree (D), Not Sure (NS), Agree (A) and Strongly Agree (SA). In analyzing the results, “strongly disagree” was rated as 1, “disagree” as 2, “not sure” as 3, “agree” as 4 and “strongly agree” as 5. The data obtained were analyzed using descriptive statistics and t-test and the results indicated in Table 4.3.
Table 4.3: Descriptive and Independent Sample t-test of pre-treatment scores in Self-efficacy

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>df</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy</td>
<td>Exp 1</td>
<td>45</td>
<td>37.25</td>
<td>5.445</td>
<td>88</td>
<td>-0.333</td>
<td>.740</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>45</td>
<td>37.59</td>
<td>5.328</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results from Table 4.2 show that the Experimental group had 53 respondents while Control group had 56 respondents. Experimental group obtained an average score of 37.25 out of 60 on SSES. For control group the average score was 37.59. The t-test analysis revealed that the computed p-value (0.740) was greater than the set alpha value 0.05. Therefore, there was no significant difference in self-efficacy pre-mean scores between experimental group and control group, (t (88) = -0.333, p > 0.05. Thus, the Experimental and Control groups were similar on self-efficacy measure, hence they were homogenous at the beginning of the study. This made the groups suitable for the study. Regarding difference in gender self-efficacy in learning Chemistry, descriptive and t-test was performed. The results of analysis were as indicated in Table 4.4

Table 4.4: Independent Sample t-test of pre-treatment scores in Self-efficacy by Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>df</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy</td>
<td>Female</td>
<td>45</td>
<td>37.59</td>
<td>5.328</td>
<td>88</td>
<td>-0.333</td>
<td>.740</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>45</td>
<td>37.25</td>
<td>5.445</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results in Table 4.4 show that the self-efficacy average score of male and female were 37.25 and 37.59 out of 60 respectively. Both female and male obtained relatively the same mean score. The t-test analysis showed that the computed p-value (0.740) was greater than the set alpha value (0.05). Therefore, the self-efficacy mean scores of female and male students were not significantly different, $t(88) = -0.333$, $p > 0.05$. Thus, the female and male student samples were similar before the application of the treatment.

4.3.3 Students’ pre-treatment scores in Collaborative skills

Students in both experimental and control groups were observed before the application of the treatment. The observation schedule contained learners’ social engagements such as demonstrating team work, taking roles and responsibilities, giving and accepting help, sharing ideas and materials, and taking turns. These skills were rated on a likert scale of 1-4: where 1-Not observed, 2-rarely observed, 3-occassionally observed and 4- consistently observed. The data obtained were analyzed using descriptive statistics and t-test and the results indicated in Table 4.5

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>t-value</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative skills</td>
<td>Exp 1</td>
<td>2</td>
<td>19.50</td>
<td>0.707</td>
<td>-0.447</td>
<td>2</td>
<td>.698</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2</td>
<td>20.00</td>
<td>1.414</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results in Table 4.5 shows that two observations (N=2) were made for each group (experimental and control) and average collaborative skills scores were obtained as 19.50 and 19.50 out of 40 respectively. The computed p-value (0.698) was greater than the set alpha value 0.05. Therefore, the collaborative skills mean scores of both experimental group and control group were not significantly different, t (2) =-0.447, p > 0.05. This implies that the Experimental and Control groups were similar on collaborative skills scores measure before the administration of the treatment, hence homogenous. This made the groups suitable for the study.

From the pre-treatment findings, it is evident that only one of the experimental and one of the control groups were exposed to a pre- treatment CAT, Self-efficacy Scale and collaborative skills observation. An arrangement of this nature enabled the researcher to determine whether groups were similar or not before the application of the treatment. The findings of this study showed that the groups were similar on Chemistry academic achievement, self-efficacy and collaborative skills before commencement of the treatment.

4.4 Effect of CAI and CIM on students’ academic achievement in Chemistry

The study aimed at investigating whether there was significant difference in students’ achievement in Chemistry were taught with CAI and CIM (H01). There were four groups that were involved in the study. Two Experimental and two Control groups. The Experimental groups were exposed to the treatment (CAI) and the Control groups were not exposed to the treatment.
4.4.1 Overall post-test scores in chemistry achievement

At the end of the treatment period, all the four groups did a Chemistry assessment test (CAT) which the researcher marked and scored. The scores obtained were analyzed using descriptive statistics as well as inferential statistics, namely ANOVA and ANCOVA. The results were indicated as in Table 4.6, Table 4.7 and Table 4.8 respectively.

<table>
<thead>
<tr>
<th>Table 4.6: Descriptive Statistics of Overall Post-test Scores in CAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>CAT Post-test</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

From Table 4.6, it is apparent that the average CAT post-test scores of Experimental groups were relatively higher than those of the Control groups. For instance, the mean scores for experimental groups were (Experimental 1= 25.60 and Experimental 2= 26.59) while Control groups mean scores were (Control 1= 16.07 and Control 2= 14.71). The mean scores for the chemistry assessment post-test scores obtained by the four groups were graphically represented as in Figure 4.3.
Figure 4.3, clearly show that the average CAT post-test scores of Experimental groups were higher than those of the Control groups. This indicates that students who were taught using computer aided instruction performed better than the students who were taught using conventional methods. In order to establish whether there was significant difference between the group means, OneWay ANOVA test was performed on CAT Post-test scores and the results obtained were as shown in Table 4.7.

Table 4.7: OneWay ANOVA of Post-test scores in CAT

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>4986.380</td>
<td>3</td>
<td>1662.127</td>
<td>94.421</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>2992.568</td>
<td>170</td>
<td>17.603</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7978.948</td>
<td>173</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results in Table 4.7 show that the difference in Chemistry achievement mean post-test scores of the students between the Experimental and Control groups was significant, $F(3,170) = 94.42$, $p < 0.05$. In order to eliminate the confounding variable associated with students’ initial academic differences among the groups, ANCOVA test was conducted using students’ science KCPE examinations marks (Appendix IV) as a covariate. A covariate variable is a continuous variable that is not part of the main experimental manipulation but has an influence on the dependent variable (Field, 2013). In this study the participants were from same category of extra-county schools although there could have been differences in academic entry behavior among students. Thus, the ANCOVA test was important to confirm the results of the ANOVA. The results are indicated in Table 4.8.

**Table 4.8: ANCOVA of Post-test scores in CAT**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>KCPE science marks</td>
<td>105.349</td>
<td>1</td>
<td>105.349</td>
<td>6.166</td>
<td>.014</td>
</tr>
<tr>
<td>Group</td>
<td>2646.916</td>
<td>3</td>
<td>882.305</td>
<td>51.645</td>
<td>.001</td>
</tr>
<tr>
<td>Error</td>
<td>2887.219</td>
<td>169</td>
<td>17.084</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The ANCOVA test results in Table 4.8 reveals that the difference in CAT mean scores between the Experimental and Control groups after controlling for the effect initial academic difference among students using KCPE science marks was statistically significant, $F(3, 169)= 51.65$, $p < 0.05$. Thus, $H_0$, which stated that there is no significant difference in chemistry achievement scores between students who are taught using CAI and those taught using CIM was rejected.
In order to determine which groups were significantly different, Least Significant Difference (LSD) Post hoc comparison test was performed based on ANCOVA. In this study four groups were compared. The groups are identified as Experimental 1, Experimental 2, Control 1 and Control 2 and the results are indicated in Table 4.9.

Table 4.9: LSD Post Hoc multiple Comparisons of Group Means based on CAT scores

<table>
<thead>
<tr>
<th>(I) group</th>
<th>(J) group</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental 1</td>
<td>Control 1</td>
<td>9.533*</td>
<td>.885</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Experimental 2</td>
<td>-.987</td>
<td>.880</td>
<td>.263</td>
</tr>
<tr>
<td></td>
<td>Control 2</td>
<td>10.889*</td>
<td>.924</td>
<td>.000</td>
</tr>
<tr>
<td>Control 1</td>
<td>Experimental 1</td>
<td>-9.533*</td>
<td>.885</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Experimental 2</td>
<td>-10.520*</td>
<td>.880</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Control 2</td>
<td>1.356</td>
<td>.924</td>
<td>.144</td>
</tr>
<tr>
<td>Experimental 2</td>
<td>Experimental 1</td>
<td>.987</td>
<td>.880</td>
<td>.263</td>
</tr>
<tr>
<td></td>
<td>Control 1</td>
<td>10.520*</td>
<td>.880</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Control 2</td>
<td>11.876*</td>
<td>.920</td>
<td>.000</td>
</tr>
<tr>
<td>Control 2</td>
<td>Experimental 1</td>
<td>-10.889*</td>
<td>.924</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Control 1</td>
<td>-1.356</td>
<td>.924</td>
<td>.144</td>
</tr>
<tr>
<td></td>
<td>Experimental 2</td>
<td>-11.876*</td>
<td>.920</td>
<td>.000</td>
</tr>
</tbody>
</table>

*The mean difference is significant at 0.05 level

Table 4.9 shows the pair-wise comparisons of the groups. Each row involves the comparison of one group to each of the other remaining three groups. The results show that there was significant difference between the post-test CAT mean scores of Experimental group 1 and Control group 1 (p = 0.001). Also, there was significant difference between the post-test mean scores of Experimental 1 and Control 2 (p = 0.001).
Similarly, there was significant difference between the post-test mean scores of Experimental 2 and Control 1 (p = 0.001) as well as Experimental 2 and Control 2 (p = 0.001). In this comparisons, the significant values were less than the 0.05 level required for statistical significance. Applying the same procedure to the Experimental 1 versus Experimental 2 (p = 0.263) and Control 1 versus Control 2 (p = 0.144) comparison, the results indicate that the groups were not significantly different. This implies that the experimental group 1 and 2 performed relatively the same on CAT post-test scores. Similarly, Control group 1 and 2 had comparable mean scores on CAT.

However, the experimental groups and control groups performed differently with experimental groups obtaining significantly higher CAT post-test mean scores than control groups. Thus, the students taught with CAI achieved higher scores in CAT than the students taught with CIM. This is because the experimental groups 1 and 2 obtained relatively higher mean scores than the control groups 1 and 2 from the research findings. From the findings of this study, it is clear that use of computer aided instruction improves students’ achievement in Chemistry subject, particularly the topic “Structure of the atom, the Periodic table and Chemical families” more than use of conventional teaching methods.

The present study has revealed that there was significant difference in Chemistry achievement scores between students those taught with CAI and those taught with CIM. The findings of this study are consistent with the results of Serin (2011) which found a statistical significant difference between the students who received the computer based science and technology instruction and non- computer based in the achievements.
Also, the findings of this study concurs with another study conducted by Olga (2008), that revealed significant difference between the groups on the post achievement tests in favor of experimental group that received computer assisted instruction in Mathematics. The research findings of Ahiatrogah, Madjoub and Bervell (2013) provides similar results with those of the current study. They conducted a study on effects of Computer Assisted Instruction (CAI) on the achievement of Junior High School (J.H.S) students in Pre-Technical skills and the results revealed that the CAI group performed better than the traditional method of instruction. The findings of the present study are in agreement with Jesse, Twoli and Maundu (2014) study, which showed that the learners taught through CAI performed significantly better than students taught through conventional instructional techniques.

The findings of this study are in consistent with the findings of Charagu (2015) which indicated a significant improvement in Chemistry performance for students from the experimental group who were exposed to computer assisted learning than those students from control group, who were not exposed to computer assisted learning. The findings of the present study are also in agreement with Kareem (2015) study that investigated the effects of introduction of CAI in Biology compared to the conventional method of teaching on senior secondary school students’ achievement and the results revealed that CAI improved students’ academic achievement in Biology. In addition, the findings of this study concurs with Olakanmi, Gambari, Gdodi and Abalaka (2016) findings which revealed that students who were taught chemistry with computer assisted instruction had higher extrinsic and intrinsic motivation as well as achievement than those in conventional teaching methods.
Generally, several research findings concurs that the use of Computer aided Instruction (CAI) raises students’ achievement more than traditional methods of instruction (Olga, 2008; Serin, 2011; Ahiatrogah, Madjoub & Bervell, 2013; Jesse, Twoli & Maundu, 2014).

4.4.2 Post-test scores in CAT by Gender

The study aimed at establishing whether there was significant difference in achievement in chemistry by gender when students were taught with CAI ($H_0$). Experimental group 1 and group 2 which were taught with Computer aided instruction had 45 boys and 46 girls respectively. In order to describe the variation of Chemistry achievement scores by gender descriptive statistics was obtained.

<table>
<thead>
<tr>
<th>Variable</th>
<th>gender</th>
<th>N</th>
<th>Mean (max= 40)</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT</td>
<td>Boys ($E_2$)</td>
<td>45</td>
<td>25.60</td>
<td>3.360</td>
</tr>
<tr>
<td></td>
<td>Girls ($E_1$)</td>
<td>46</td>
<td>26.59</td>
<td>4.145</td>
</tr>
</tbody>
</table>

The results from Table 4.10 show that the average CAT scores for female students was slightly higher than that of their male counterpart. In order to establish whether the means of two groups (boys and girls) were statistically significant different, an independent sample t-test was performed to compare the students’ achievement in chemistry by gender.
Table 4.11: Independent Sample t-test of Post-test scores in CAT by Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>N</th>
<th>Mean(max=40)</th>
<th>Std.dev</th>
<th>t-value</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT</td>
<td>Boys</td>
<td>45</td>
<td>25.60</td>
<td>3.360</td>
<td>-4.112</td>
<td>89</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>46</td>
<td>26.59</td>
<td>4.145</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The t-test analysis reveals that the difference between the CAT mean scores for boys (Mean=25.60, SD=5.9) and girls (Mean=26.59, SD=4.1) was significant, t (89) = -4.11, p < 0.05. Thus, H₀₂, which stated that there is no significant difference in chemistry achievement based on gender scores when students are taught with CAI, was rejected. This, therefore suggests that the achievement in chemistry by gender is significantly different. The results from this study showed that female students achieved higher scores in Chemistry test than the male students when taught through CAI.

This implies that use of CAI in teaching and learning of Chemistry increases the academic achievement for girls more than boys. The findings of this study concur with study of Klainin and Fenshams (1987) which showed that Thai girls perform better than boys in Chemistry. The findings of this study also find support from FAWE (1999) reports that noted that girls excel academically and are better to face the challenges that hinder their achievement when they have favorable learning environment. From the results of the present study, it is clear that girls can perform better than boys in Chemistry when taught with CAI approach. Thus, CAI approach can play a vital role in bettering the female achievement in Chemistry more than their counterpart male students.
The CAI approach provides a creative and favorable learning environment. Favorable environment of learning enables the female students to face the challenges to learning. For example, girls in conventional classroom may feel shy to answering oral questions as opposed to boys. However, in the CAI classroom, the computer software has in-built evaluative questions and scores that assesses the answers of the student; if the answer was right the CAI- application would respond “correct”, if wrong, it would respond by saying “try again”. With CAI environment, the girls, then can answer many questions and also make several trials to each question without shying off. These factors made the girls to perform better than the boys in Chemistry. Therefore, the type of learning environment is a crucial factor that enables the female students to better achievement in Chemistry than their counterpart male students.

4.5: Effect of CAI and CIM on Students’ Self-efficacy in Chemistry

The research aimed at investigating whether there was significant difference in students’ self-efficacy in Chemistry when taught with CAI and CIM (H0.3). The overall post-test scores in self-efficacy of CAI and CIM were compared.

4.5.1 Overall post-test scores in self-efficacy

Self-efficacy scale was administered to the four groups after the exposure of the treatment. Self-efficacy scale contained 12 items in the instrument, in which students were asked to report their confidence in learning Chemistry on a five point scale calibrated Strongly Disagree (SD), Disagree (D), Not Sure (NS), Agree (A) and Strongly Agree (SA).
In analyzing the results, “strongly disagree” was rated as 1, “disagree” as 2, “not sure” as 3, “agree” as 4 and “strongly agree” as 5. The data obtained were analyzed using descriptive statistics (Table 4.12) and Analysis of Variance (ANOVA) (Table 4.13).

**Table 4.12: Descriptive Statistics of Post-test scores in Self-efficacy**

<table>
<thead>
<tr>
<th>group</th>
<th>Mean (Max =60)</th>
<th>N</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group1</td>
<td>47.11</td>
<td>45</td>
<td>5.793</td>
</tr>
<tr>
<td>Control group 1</td>
<td>40.91</td>
<td>45</td>
<td>5.854</td>
</tr>
<tr>
<td>Experimental group2</td>
<td>49.04</td>
<td>46</td>
<td>5.362</td>
</tr>
<tr>
<td>Control group 2</td>
<td>42.92</td>
<td>38</td>
<td>5.952</td>
</tr>
</tbody>
</table>

The post-test mean scores in self-efficacy obtained by the Experimental groups 1 and 2 and Control groups 1 and 2 were then represented graphically as in Figure 4.4.

![Figure 4.4: Group Mean scores in self-efficacy](image-url)
Table 4.12 and Figure 4.4, shows that the average self-efficacy scores of Experimental groups were higher than those of the Control groups. This indicates that the students of experimental groups who were taught Chemistry with CAI approach were more self-efficacious in learning Chemistry than those of the control groups. To determine whether the groups were significantly different, OneWay ANOVA was performed. The results are indicated in Table 4.13.

**Table 4.13: OneWay ANOVA of Post-test scores in Self-efficacy**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1867.373</td>
<td>3</td>
<td>662.458</td>
<td>18.934</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>5888.765</td>
<td>170</td>
<td>32.875</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7456.738</td>
<td>173</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results in Table 4.13 show that the difference in self-efficacy post-test means scores of the students between the Experimental and Control groups was significant, $F(3,170) = 18.93$, $p < 0.05$. Therefore, $H_0$3, which stated that there is no significant difference in students’ self-efficacy in Chemistry when taught with CAI and CIM, was rejected. In order to determine how groups significantly differed from one another, Least Significant Difference (LSD) Post hoc multiple comparisons test was done. In this study four groups were compared. The groups are labelled as Experimental 1, Experimental 2, Control 1 and Control 2. The results are indicated in Table 4.14.
Table 4.14: LSD Post hoc Multiple Comparisons of Group Mean scores in Self-efficacy

<table>
<thead>
<tr>
<th>(I) Group</th>
<th>(J) Group</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group1</td>
<td>Control group 1</td>
<td>6.200</td>
<td>1.209</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Experimental group 2</td>
<td>-1.932</td>
<td>1.202</td>
<td>.110</td>
</tr>
<tr>
<td></td>
<td>Control group 2</td>
<td>4.190</td>
<td>1.263</td>
<td>.001</td>
</tr>
<tr>
<td>Control group 1</td>
<td>Experimental group1</td>
<td>-6.200</td>
<td>1.209</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Experimental group 2</td>
<td>-8.132</td>
<td>1.202</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Control group 2</td>
<td>-2.010</td>
<td>1.263</td>
<td>.113</td>
</tr>
<tr>
<td>Experimental group 2</td>
<td>Control group 1</td>
<td>1.932</td>
<td>1.202</td>
<td>.110</td>
</tr>
<tr>
<td></td>
<td>Control group 2</td>
<td>8.132</td>
<td>1.202</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Control group 1</td>
<td>6.122</td>
<td>1.257</td>
<td>.000</td>
</tr>
<tr>
<td>Control group 2</td>
<td>Experimental group1</td>
<td>-4.190</td>
<td>1.263</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Control group 1</td>
<td>2.010</td>
<td>1.263</td>
<td>.113</td>
</tr>
<tr>
<td></td>
<td>Experimental group 2</td>
<td>-6.122</td>
<td>1.257</td>
<td>.000</td>
</tr>
</tbody>
</table>

* The mean difference is significant at 0.05 level

From Table 4.14, it is evident that the pair-wise comparison between Experimental 1 versus Control 1, Experimental 1 versus Control 2, Experimental 2 versus Control 1 and Experimental 2 versus Control 2 were significantly different, since their significant values are less than the .05 level required for statistical significance. However, the comparisons between Experimental group 1 versus Experimental group 2 (p = 0.110) and Control group 1 versus Control group 2 (p = 0.113) were not significantly different as the significance level is greater than the 0.05 level. This indicates that the Experimental group 1 versus Experimental 2 performed relatively the same on self-efficacy post-test scores. Similarly, Control group 1 versus Control group 2 obtained similar self-efficacy mean scores.
However, the Experimental groups and Control groups performed differently with experimental groups obtaining significantly higher CAT post-test mean scores than control groups. This study has revealed that there was significant difference in Chemistry self-efficacy scores of students between those taught with CAI and those taught with CTM. The students taught with Computer Aided Instruction (CAI) teaching method achieved higher self-efficacy mean scores than the students taught with Conventional Teaching Methods (CIM). This implies that CAI enhances students’ self-efficacy in Chemistry subject more than the CIM.

The findings of this study are in agreement with the report by Fencl and Scheel (2005) which investigated the effects of different teaching methods on the classroom climate and self-efficacy in non-majors Physics students. The results indicated that use of electronic applications had a positive correlation with increased self-efficacy in non-majors physics students. The findings of this study are in agreement with findings of Chen and Liu (2013) observed that grade 5 students from elementary school in Northern Taiwan demonstrated effectiveness in learning science when taught through computers. Similarly, Yien, Hung, Hwang and Lin (2011), observed that computer aided learning was more effective in enhancing the self-efficacy of students in learning nutrition course than conventional methods.

The findings of this study may be explained in line with the study of Zimmermam (2000); Pajares and Miller (1994) which observed that learning skills acquisition enhances self-regulated learning behaviour which in turn ensures motivation and confidence as a learner engages in learning tasks.
The confidence to approach learning in an independent manner which promotes the belief in one’s ability to execute a given task may invariably lead to enhanced self-efficacy. The instruction in CAI could have been the reason for the higher self-efficacy demonstrated by students in treatment condition.

4.5.2 Post-test scores in Self-efficacy by Gender

The research aimed at establishing whether there was significant difference in self-efficacy in learning Chemistry by gender when students were taught with CAI. Experimental group 1 and group 2 which were taught with Computer aided instruction had 45 boys and 46 girls respectively. After the application of CAI treatment to both groups, self-efficacy questionnaire was administered to both boys’ and girls’ groups. In the questionnaire, students were asked to report their confidence in learning Chemistry on a five point scale calibrated Strongly Disagree (SD), Disagree (D), Not Sure (NS), Agree (A) and Strongly Agree (SA). In analyzing the results, “strongly disagree” was rated as 1, “disagree” as 2, “not sure” as 3, “agree” as 4 and “strongly agree” as 5. Descriptive statistics was performed to describe the difference of self-efficacy scores between male and female students. The results are indicated as in Table 4.15.

Table 4.15: Descriptive statistics of post-test Scores in Self-efficacy by Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>gender</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy</td>
<td>Boys (E₁)</td>
<td>45</td>
<td>47.11</td>
<td>6.348</td>
<td>1.239</td>
</tr>
<tr>
<td></td>
<td>Female(E₂)</td>
<td>46</td>
<td>49.04</td>
<td>5.362</td>
<td>.791</td>
</tr>
</tbody>
</table>
From Table 4.15, it is apparent that the average self-efficacy post-test scores of girls were relatively higher than those for the boys. This indicates that girls were more confident in learning chemistry than boys when they were taught with CAI. In order to determine whether the difference in self-efficacy post-test scores by gender was statistically significant, an independent sample t-test was carried out. The results are shown in Table 4.16.

**Table 4.16: Independent sample t-test of post-test scores in Self-efficacy by gender**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>t-value</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT</td>
<td>Male</td>
<td>45</td>
<td>47.11</td>
<td>6.348</td>
<td>-2.445</td>
<td>89</td>
<td>.016</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>46</td>
<td>49.04</td>
<td>5.362</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The t-test analysis results in Table 4.16 shows that the difference in self-efficacy post-test mean scores between male and female students was statistically significant, (t (89) = -2.445, p < 0.05. Thus, H04, which stated that there is no statistically significant difference in self-efficacy chemistry mean scores by gender when students are taught using CAI method was rejected. This revealed that on average girls obtained a higher chemistry self-efficacy mean score than boys. From the findings of this study, it is clear that use of computer aided instructional method enhances chemistry self-efficacy of female more than it does to the male students.
The findings of the present study concurs with the results of Britner and Pajares (2006), which reported that the middle school girls had higher science self-efficacy than do boys. The findings of this study found similar results, which indicate that there exists a gender difference in science self-efficacy (DeBacker & Nelson, 1999). In addition, the findings of this study agrees with the report of (AAUW, 1999) that suggested, females are more likely to take both Biology and Chemistry in high school than males. Moreover, the findings of this study finds support from Bandura (1997) argument that gender can influence academic performance through its mediating effects on self-efficacy.

This study has revealed that female students obtained higher chemistry self-efficacy scores than male students. This implies that use of CAI in classroom instruction can and do make a difference to gender’s self-efficacy with female students being more efficacious in learning chemistry. Thus, CAI plays a crucial role in enhancing girls’ self-efficacy more than their counterpart boys. The CAI approach provides an immediate feedback and reinforcement to each and every question to the learners. It also allows the learners to make as many trials for the question as they can. This kind of learning environment enables the female students to build more self-efficacy in the learning chemistry tasks and concepts than male students. With CAI environment, the girls, may persist and persevere in the learning by answering as many questions as possible and also making several trials to each question. Therefore, the type of learning environment is a crucial factor that enables the female students to better their self-efficacy in chemistry than the male students.
4.6 Effect of CAI and CIM on Students’ development of Collaborative skills in Chemistry

The study aimed at establishing whether there was significant difference in collaborative skills scores of students in Chemistry between those students taught with CAI and those taught with CIM. Four groups were involved in this study. Two groups (experimental) were taught Chemistry with computers (CAI) while the other two groups (control) were taught without computers (CIM). Three impromptu classroom observations to each of the four groups were observed on how students interacted and related among themselves during Chemistry lessons. The major aspects observed were: team work and leadership skills, finding and sharing information, discussing and sharing ideas, giving and accepting help, taking turns in the discussion, adapting to varied roles and responsibilities. The observed skills were rated on a four-point likert scale (1-4), where: 1- skill not observed, 2- skill rarely observed, 3-skill occasionally observed and 4- skill consistently observed. The data obtained was analyzed using descriptive statistics and Analysis of Variance (ANOVA). The descriptive results are indicated in Table 4.17.

Table 4.17: Descriptive statistics of post-test scores in Collaborative skills

<table>
<thead>
<tr>
<th>Name of group</th>
<th>N</th>
<th>Mean</th>
<th>Max. score</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental 1</td>
<td>3</td>
<td>36.50</td>
<td>40</td>
<td>2.646</td>
</tr>
<tr>
<td>Control 1</td>
<td>3</td>
<td>18.40</td>
<td>40</td>
<td>3.055</td>
</tr>
<tr>
<td>Experimental 2</td>
<td>3</td>
<td>35.60</td>
<td>40</td>
<td>2.646</td>
</tr>
<tr>
<td>Control 2</td>
<td>3</td>
<td>17.10</td>
<td>40</td>
<td>1.000</td>
</tr>
</tbody>
</table>
The mean scores for collaborative skills post-test scores obtained by the experimental groups 1 and 2 and control groups 1 and 2 were graphically represented as in Figure 4.5.

![Figure 4.5: Group mean scores in collaborative skills](image)

The results in Table 4.17 and Figure 4.5, indicate that the collaborative skills post-test mean scores for Experimental group1 and 2 (36.50 and 35.60) were much higher than those for the control group 1 and 2 (18.40 and 17.10). This shows that the students of experimental groups who were taught Chemistry with CAI had achieved more in collaborative skills than students of control groups. To determine whether the groups were significantly different on collaborative skills mean scores, OneWay ANOVA test was performed and the results are indicated in Table 4.16.
Table 4.18: OneWay ANOVA of Post-test scores in Collaborative skills

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1011.000</td>
<td>3</td>
<td>337.000</td>
<td>55.397</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>48.667</td>
<td>8</td>
<td>6.083</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1059.667</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The ANOVA test in Table 4.18, reveals that the difference in collaborative skills post-test means scores between the students in the Experimental and Control groups was statistically significant, \( F (3, 8) = 55.397, p < 0.05 \). Therefore, \( H_0 \), which stated that there is no statistically significant difference in collaborative skills scores between students who are taught using CAI and those taught using CIM, was rejected. After obtaining a statistically significant difference between the groups, post hoc multiple comparisons were performed to determine how groups significantly differed from one another. For this study, four groups were compared. These are; Experimental 1, Control 1, Experimental 2 and Control 2.
Table 4.19: LSD Post hoc multiple comparisons of Group Means in collaborative skills

<table>
<thead>
<tr>
<th>(I) Group</th>
<th>(J) Group</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental 1</td>
<td>Control 1</td>
<td>17.667*</td>
<td>2.014</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Experimental 2</td>
<td>.000</td>
<td>2.014</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Control 2</td>
<td>19.000*</td>
<td>2.014</td>
<td>.000</td>
</tr>
<tr>
<td>Control 1</td>
<td>Experimental 1</td>
<td>-17.667*</td>
<td>2.014</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Experimental 2</td>
<td>-17.667*</td>
<td>2.014</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Control 2</td>
<td>1.333</td>
<td>2.014</td>
<td>.527</td>
</tr>
<tr>
<td>Experimental 2</td>
<td>experimental 1</td>
<td>.000</td>
<td>2.014</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Control 1</td>
<td>17.667*</td>
<td>2.014</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Control 2</td>
<td>19.000*</td>
<td>2.014</td>
<td>.000</td>
</tr>
<tr>
<td>Control 2</td>
<td>Experimental 1</td>
<td>-19.000*</td>
<td>2.014</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Control 1</td>
<td>-1.333</td>
<td>2.014</td>
<td>.527</td>
</tr>
<tr>
<td></td>
<td>Experimental 2</td>
<td>-19.000*</td>
<td>2.014</td>
<td>.000</td>
</tr>
</tbody>
</table>

* The mean difference is significant at 0.05 level

The Least Significance Difference (LSD) Post hoc multiple comparison test shows that the collaborative skills mean scores for Experimental 1 versus Control 1 (p = 0.001), Experimental 1 versus Control 2 (p = 0.001), Experimental 2 versus Control 1 (p = 0.001) and Experimental 2 versus Control 2 (p = 0.001) were significantly different since their significant values were less than the .05 level required for statistical significance. On the other hand, Experimental 1 versus Experimental 2 (p = 1.00) and Control 1 versus Control 2 (p = 0.527) were not significantly different since their significant values were greater than the 0.05 level required for statistical significance (p > 0.05). Thus, students who were taught with CAI had acquired more collaborative skills during Chemistry instruction than those students who were taught with CIM.
The findings of the present study concur with the data of Dukuzumuremyi (2014), which suggested that use of computer supported collaborative learning software and applications in which group members shared one laptop to collaboratively achieve a group task, are a resourceful ways of learning social skills. From the findings of this study, it is apparent that use of CAI method enhanced collaborative skills of students during Chemistry instruction more than use of Conventional Methods. Thus, CAI approach plays an important role in enhancing students’ collaborative skills during chemistry lessons. CAI software is a powerful tool that helps students to learn chemistry concepts in a collaborative manner. For instance, in a CAI learning in which group members (2 to 4) shared one computer to collaboratively achieve a group task, helped the students develop collaborative skills such team work and leadership skills. This kind of classroom arrangement caused the students in the experimental group to achieve more in collaborative skills than the students in conventional group in chemistry lessons.

4.7 Challenges of Employing CAI in teaching and learning chemistry

Despite the fact that the schools that were sampled had computers laboratories, it was still necessary to find out from Chemistry teachers the challenges they face in integrating CAI in teaching and learning chemistry. These findings were important because the mere presence of computer laboratory does not guarantee effective use of CAI in classrooms. The responses about the study questions were obtained from chemistry teachers from sampled schools.
4.7.1 School ICT policy

Chemistry teachers’ responses to the question as to whether their schools had developed ICT-policy that aimed at ICT integration in teaching and learning, showed that only one school out of four sampled schools had clear and defined ICT policy. Interestingly, the school that had ICT policy had also adequate ICT resources including educational software. Based on this observation, it is clear that were no structured procedures to be followed to guide schools on the ICT integration process in teaching and learning. The observation of this study concur with the findings of Ramorola (2013) that revealed unavailable technology policy in senior secondary schools in South Africa. Also, Murithi, Gitonga and Kimanthi (2013), observed that schools which had an ICT policy were able to fully implement Computer Studies curriculum. A school ICT policy seem to be an important element to foster ICT integration in teaching and learning. Although the GOK has developed ICT integration policy at national level (Republic of Kenya, 2006), this has not yet cascaded at secondary school level.

4.7.2 ICT Resources

When chemistry teachers were asked whether their schools had adequate ICT resources including computers and educational software, the results showed that one out of the four schools had adequate computers, but the educational software, specifically for chemistry subject were insufficient for all schools. Inadequacy of computers poses a challenge to these schools, as students have to work in groups of five on one computer. It was important to find out the extent of adequacy of ICTs in order to enable teachers to effectively integrate CAI for classroom instruction. This study showed clearly that schools lacked
adequate computers and educational software to effectively utilize CAI in teaching and learning.

The findings of this study are in line with CFSK (2008) that cited lack of educational software as one of the reasons for lack of ICT integration in schools. The observation of this study concur with the findings of Ramorola (2013) that revealed insufficient technology equipment in senior secondary schools in South Africa.

4.7.3 ICT training

Chemistry teachers’ responses to the question as to whether they had been trained on ICT integration, showed that all chemistry teachers from the four sampled schools had received ICT training. Teachers’ competencies in ICT integration was necessary because this study required teachers with ICT skills for effective utilization of CAI in teaching and learning. Although Chemistry teachers had ICT skills, they used ICT for classroom instruction to a less extent. This observation find support from Wilson-Strydom et al. (2005) who pointed that many schools that have access to ICTs, the focus has tended to be on learning about ICTs rather than learning with or through the use of ICTs. Also, Minae (2014) reports that the use of computers in teaching subjects rather than for computer studies was yet to gain ground. The observation of this study are in consistent with the report of National Council for Science and Technology (2010) that revealed that teachers were advancing ICT-skills and to a less extend use ICT in teaching and instruction support. Therefore, teachers should be encouraged to expand their ICT-skills for pedagogical practices.
4.9 Chapter Summary

The findings of the study have clearly shown that the students taught with Computer Aided Instruction performed better in chemistry achievement test than the students taught with Conventional method. Moreover, the findings revealed that girls achieved higher scores in chemistry than boys when taught with Computer Aided Instruction. Furthermore, the findings shown that the students taught with Computer Aided Instruction obtained higher self-efficacy scores than the students taught with Conventional method. The findings also revealed that girls obtained a higher self-efficacy mean score than boys. In addition, the findings manifested an improvement of collaborative skills of students upon application of Computer Aided Instruction. Finally, the findings revealed that teachers had challenges of inadequate and insufficient ICT resources and absence of school ICT policy that hindered effective integration of CAI in teaching and learning chemistry.
CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction
This chapter presents the summary of the main findings and conclusions drawn from the study. The chapter also presents recommendations for various stakeholders and suggestions for further research.

5.2 Summary of the Study
The aim of this study was to assess the influence of Computer Aided Instruction (CAI) on students’ academic achievement, self-efficacy and development of collaborative skills in Chemistry in secondary schools in Kenya. This entailed comparing the outcomes in the use of CAI and Conventional Instructional Methods (CIM). To realize the research purpose, the study was guided by the following specific objectives: To determine the effect of CAI on students’ academic achievement in Chemistry as compared to CIM; to establish gender difference in Chemistry achievement when students are taught using CAI; to assess self-efficacy of students in the learning of Chemistry when taught using CAI and CIM; to establish gender difference in Chemistry self-efficacy of students when taught using CAI; to determine students’ development of collaborative skills in learning Chemistry when taught using CAI and when taught using CIM; to establish the challenges of integrating CAI in teaching and learning Chemistry. The study adopted quasi experimental design, based on Solomon Four- Group design and involved Form Two Chemistry students in secondary
schools with computer laboratory. Four schools were purposively sampled, in which two schools employed CAI while the other two used CIM in teaching Chemistry. Data was collected using tests, questionnaire and classroom observation schedule. The t-test, ANOVA and ANCOVA were used to test the significance difference between the groups. The study provides useful information on a practically CAI approach for use in teaching Chemistry that would help in improving students’ academic achievement, self-efficacy and collaborative skills.

5.3 Summary of Main Findings and Implications

5.3.1 Students’ level of academic achievement, self-efficacy and collaborative skills before treatment

The descriptive statistics of pre-test CAT scores revealed that both Experimental students (CAI) and Control students (CIM) obtained similar mean score before the application of treatment CAI. The mean scores of those students that were taught through CAI intervention ($M_1=23.23$, $SD= 3.750$) were similar to the mean of those students taught through CTM ($M_2= 22.23$, $SD= 4.125$). The t-test analysis revealed that there was no statistically significant difference in pre-test CAT mean scores between those students taught through CAI and those taught through CTM before the application of the treatment ($t (107) = 1.314$, $p = 0.192$).

Regarding difference in gender achievement, the t-test analysis revealed that there was no significant difference in pre-test CAT mean scores between male and female students ($t (107) = 1.302$, $p = 0.190$) at the beginning of the study. On pre- self-efficacy scores, the study revealed that there was no difference between those students taught with CAI and those taught with CIM before the application of treatment. The mean scores of those students
taught with CAI was (M = 37.25, SD = 5.445), while that of those students taught with CTM was (M = 37.59, SD = 5.328).

The t-test results revealed that there was no statistically significant difference in pre- self-efficacy mean scores between those students taught through CAI and those taught through CTM before the application of the treatment (t (107) = -0.333, p = 0.740). This implied that the experimental and control groups were similar on achievement, gender, self-efficacy and collaborative skills measures before the exposure of the CAI treatment, hence homogenous.

5.3.2 Effect of CAI and CIM on students’ academic achievement in chemistry

The findings of this study showed that there was a significant difference between the means of post-test Chemistry Achievement Test (CAT) scores of the students in Experimental and Control groups (F (3,170) = 94.42, p = 0.000). In addition, the post-test CAT mean scores for the experimental groups 1 and 2 (M₁ = 25.60, M₂ = 26.69) were higher than those for the control group 1 and 2 (M₁ = 16.07, M₂ = 14.71). This implied that students who were taught with CAI performed better than the students who were taught with the CIM. Thus, H₀₁, which stated that there is no significant difference in Chemistry achievement scores between students who are taught using CAI and those taught using CIM was rejected.

5.3.3 Effect of CAI on academic achievement in chemistry by gender

Regarding difference in gender achievement in Chemistry when male and female students were taught with CAI, the findings showed that there was a significant difference in CAT post-test mean scores between male students and female students (t (89) = -4.1, p = 0.000). Additionally, the findings revealed that female students obtained a higher mean score in CAT post-test (M= 26.59) than the male students (M= 25.60) when taught with CAI.
This implied that the female students performed better than the male students when both were taught using CAI method. Thus, H₀₂, which stated that there is no statistically significant difference in Chemistry achievement scores by gender when students are taught with CAI, was rejected.

5.3.4 Effect of CAI and CIM on Students’ self-efficacy in Chemistry

The findings of the study showed that there was a significant difference in the post- self-efficacy mean scores between those students in the Experimental group who were taught Chemistry with CAI and those in the Control groups who were taught Chemistry with CIM (F (3,170) =18.93, p = 0.001). The post- self-efficacy mean scores for those students in the experimental groups 1 and 2 (M₁ = 47.11, M₂ = 49.04) were higher than those in the control group 1 and 2 (M₁ = 40.91, M₂ = 42.92). This implied that the students who were taught with CAI were more self-efficacious in Chemistry than the students who were taught with CIM. Therefore, H₀₃, which stated that there is no significant difference in students’ self-efficacy scores in chemistry between students who are taught with CAI and those taught with CIM, was rejected.

5.3.5 Effect of CAI on Students’ self-efficacy in Chemistry by gender

Regarding gender chemistry self-efficacy, the findings revealed that there was a statistically significant difference in self-efficacy post-test mean scores between male and female students (t (89) = -2.445, p = 0.016). Additionally, the findings showed that the average self-efficacy post-test scores for female students (M= 49.04) was relatively higher than those for the male students (M= 47.11).
This revealed that on average, female students obtained a different self-efficacy mean score compared to male students, with females having a higher mean score when taught with computer aided instruction. Thus, $H_{04}$, which stated that there is no significant difference in students’ self-efficacy scores in Chemistry by gender when students are taught using CAI method was rejected.

### 5.3.6 Effect of CAI and CIM on Students’ development of Collaborative skills in Chemistry

The analysis of the post-collaborative skills mean scores revealed that those students in the Experimental group 1 and 2 ($M_1 = 36.00$, $M_2 = 36.00$) obtained higher scores than those students in the Control group 1 and 2 ($M_1 = 18.33$ and $M_2 = 17.00$). The OneWay ANOVA test revealed that there was a statistically significant difference in post-collaborative skills mean scores between the students in the Experimental group who were taught with CAI and those students in the Control groups who were taught with CIM ($F(3, 8) = 55.397$, $p = 0.001$). This implied that the students who were taught with CAI method had engaged more collaborative skills in Chemistry lessons that those students taught with CIM. Therefore, $H_{05}$, which stated that there is no statistically significant difference in collaborative skills scores in Chemistry between students who are taught using CAI and those taught using CIM, was rejected.

### 5.3.7 Challenges of integration CAI in teaching chemistry

Data analysis revealed that teachers felt that ICT resources including computers and educational software for teaching chemistry were inadequate. Inadequacy of computers poses a challenge to these schools, as students have to work in groups of five on one
The teachers indicated to have received had ICT training for effective utilization of CAI teaching.

Table 5.1: Summary of hypotheses testing

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Statistical Test</th>
<th>df</th>
<th>p</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>(H_01:) There is no statistically significant difference in students' Chemistry achievement scores between those taught using CAI and those taught using conventional instructional methods (CIM).</td>
<td>F = 94.42</td>
<td>3, 170</td>
<td>0.000</td>
<td>Reject</td>
</tr>
<tr>
<td>(H_02:) There is no statistically significant difference in students' self-efficacy scores in Chemistry between those taught using CAI and those taught using CIM.</td>
<td>F = 18.93</td>
<td>3, 170</td>
<td>0.000</td>
<td>Reject</td>
</tr>
<tr>
<td>(H_03:) There is no statistically significant difference in students' achievement scores by gender in chemistry when students are taught using CAI</td>
<td>t = -4.1</td>
<td>89</td>
<td>0.000</td>
<td>Reject</td>
</tr>
<tr>
<td>(H_04:) There is no statistically significant difference in students' collaborative skills scores in Chemistry between those taught using CAI and those taught using CIM</td>
<td>F = 55.397</td>
<td>3, 8</td>
<td>0.000</td>
<td>Reject</td>
</tr>
<tr>
<td>(H_05:) There is no statistically significant difference in self-efficacy scores by gender in chemistry when students are taught using CAI</td>
<td>t = -2.445</td>
<td>89</td>
<td>0.016</td>
<td>Reject</td>
</tr>
<tr>
<td>(H_06:) There are no challenges faced by teachers in integrating CAI in teaching and learning chemistry.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data analysis revealed the teachers faced some challenges including inadequate ICT resources in employing CAI effectively. Therefore $H_0$, was rejected

5.4 Conclusions

Based on the findings of this study, the following main conclusions were drawn:

From the pre-testing findings, it was evident that the administration of pre-tests (CAT, self-efficacy scale and collaborative skills) to the Experimental and Control groups did not interact significantly with the treatment (CAI).

Therefore, greater scores in Chemistry achievement, self-efficacy, collaborative skills by the experimental groups than control groups were not as a result of effect of pre-tests but as a result of effect of the treatment (CAI).

Firstly, the findings showed that students who were taught with Computer Aided Instruction (CAI) method achieved higher Chemistry scores than those students who were taught with Conventional Instructional Methods (CIM). Therefore, the study concludes that use of computer aided instruction improves students’ achievement in Chemistry as it stimulates memory for better coding and understanding of concepts. Thus, CAI is a very crucial tool needed for the successful teaching and learning of Chemistry.

Secondly, the findings of the study showed that the students who were taught Chemistry with Computer Aided Instruction method obtained higher Chemistry self-efficacy mean scores than the students who were taught with Conventional Instructional Methods. The study therefore, concludes that use of computer aided instruction method enhances students’ self-efficacy in learning Chemistry more than use of Conventional Methods. CAI seemed to capitalize on students’ active participation in the course material or concepts learning. It also follow that CAI provide opportunities for students’ group work which have a dual outcome of
improving both self-efficacy and academic achievement. This is particularly an impressive instructional strategy, and worth adopting by Chemistry teachers.

Thirdly, the findings showed that the female students scored higher mean scores in Chemistry achievement test (CAT) than the male students when both groups were taught with Computer Aided Instruction. This implies that use of computer aided instruction method improves female students Chemistry achievement scores more than it does for their male students counterparts. Therefore, female students can perform relatively better than male students if they are taught in an innovative and interesting learning environment. It is therefore imperative that the Chemistry teachers adopt teaching methods like CAI approach that improves female students’ chemistry achievement that has been an outcry in many Kenyan schools.

Fourthly, the findings of the study showed that the students who were taught Chemistry with computer aided instruction method obtained higher collaborative skills scores than the students who were taught with conventional methods. Therefore, it is logical to conclude that use of computer aided instruction (CAI) method enhances collaborative skills of students during Chemistry instructions more than use of conventional teaching methods. Thus, CAI is an effective instructional tool that aids collaborative learning.

Fifthly, the findings showed that the female students scored higher self-efficacy mean scores than the male students when taught with computer aided instruction method. This implies that use of computer aided instruction method has a greater impact on female’s self-efficacy in learning Chemistry than the males. It is apparent that the use of CAI in classroom instruction can make female students more self-confident in learning chemistry. Therefore, teachers of
chemistry, more so in girls’ schools need to incorporate CAI in their teaching in order to improve motivation of girls which has been reported to be low by many studies. Lastly, from the classroom observations, it was evident that the students who were exposed to computer-aided instruction interacted frequently with one another and with the learning materials in their computers. This kind of arrangement motivated students to learn, to put more effort in the learning tasks as well as to positively interact amongst themselves. It therefore appears social interactions plays an important role during CAI lessons. The social interaction in learning lead to the development of both cognitive and socio-affective processes and subsequently improves learning performance and socio-affective performance. This viewpoint of thinking has been supported by constructivists’ theory that advocates social learning. It is assumed that social interactions are responsible for the improved learning outcomes. These findings challenge the Conventional Instructional Methods that dominates Kenyan chemistry secondary school classroom instructions.

From chemistry teachers’ responses, it was evident that schools that had well formalized and defined policy about ICT integration in their schools, had adequate ICT resources, both computer hardware and educational software, more specifically educational courseware for Chemistry. It therefore appears that schools’ ICT policy plays an important role in guiding the schools about ICT integration. Generally, CAI integration in teaching and learning chemistry is made possible, first, if the government has well outlined ICT policy in education, then the schools have their ICT policy that will guide them on suitable and relevant CAI resources, adequate CAI resources in the schools, teachers with ICT skills and finally the willingness of teachers to use CAI for classroom instruction.
5.4.1 Instructional model for enhancing learning of Chemistry using CAI

In this section, the researcher makes an attempt to consolidate the findings of this study and the literature reviewed to develop a model that guide effective integration of CAI in chemistry instruction. The model for effective use of CAI for teaching and learning chemistry, starts with the core section which outlines the links of the key variables.

Step 1

Figure 5.1: Initial step for the Instructional model for enhancing learning of Chemistry using CAI

In this initial step, it is ideal for any country to have established the ICT policy to direct or support use of CAI in teaching and learning. For this reason, the government policy on ICT is the primary component for this model. From the literature reviewed, it is indeed clear that countries that have harnessed the potential of ICT in schools and institutions in general have attained significant social and economic development (Republic of Kenya, 2007). The GOK has established well outlined policy for ICT integration in schools. For instance, in the Kenya national ICT policy 2006, one of its focus is to encourage the use of IT in schools, colleges, universities and other educational institutions in the county so as to improve the quality of teaching and learning (Republic of Kenya, 2006). Therefore, government ICT policy is an
important foundation stage for the realization of improved learning outcomes using CAI in teaching and learning.

**Step two**

![Diagram showing the steps for the Instructional model for enhancing learning Chemistry using CAI](image)

**Figure 5.2: Step Two for the Instructional model for enhancing learning Chemistry using CAI**

The second step shows that government ICT policy cannot solely lead to improved learning outcomes using CAI and therefore other intervening variables are crucial. One of the intervening variable that is key to the implementation of government ICT policy is the school ICT policy. From the findings of this study, it is clear that the schools who seemed to have ICT policy, had more ICT resources, and made use of ICT resources for their instruction. When schools develop and implement their ICT policy and strategies, they are able to create a technology-based learning environment which will guide in ICT-resources and skills to improve computer aided instruction (CAI). It is therefore imperative that schools develop and implement ICT policy and strategies. This would probably result in improved students’ learning outcomes when CAI is incorporated in teaching and learning.
Step three

Figure 5.3: Step Three for the Instructional model for enhancing learning of Chemistry using CAI

In the third step, the government ICT policy and the school ICT policy, together with ICT resources can enhance effective integration of CAI in teaching and learning. The government contribution and donations by the non-governmental organizations on provision of ICT resources to the schools are necessary. When the government and non-governmental organizations, such as the Computers For Schools, Kenya (CFSK) provide computer hardware and software to schools, teachers are able to use CAI in their teaching and learning.

From the findings of this study, it is evident that the schools which had ICT resources (computers and educational software) used them for instruction. Therefore, ICTs are key resources while teaching using CAI approach. It is, therefore imperative that the government of Kenya together with other educational stakeholders facilitate the provision of ICT resources in schools. This can enable the teachers to use CAI in the teaching and learning and probably translate to improved students’ learning outcomes.
Step four

Figure 5.4: Step Four for Instructional model for enhancing learning of Chemistry using CAI

The fourth step shows the interactions and relationship between government ICT policy, school ICT policy, ICT resources, ICT skills and training of teachers and the impact of CAI use in the classrooms in terms of students’ achievement, self-efficacy and collaborative skills.

It is clear from the findings of this study that the schools whose teachers had acquired ICT skills and training, made use of CAI for instruction. Therefore, teachers need to acquire the necessary ICT skills and training so that they are able to implement the ICT policy and also to be able to use the ICT resources effectively in teaching and learning using CAI approach. This can enable the students to learn more, become more self-confident in learning and work
more collaboratively. It is the role of the government through the ministry of education and school administration to provide the necessary support to the classroom teachers for full integration of CAI in teaching and learning.

Again, it need to ensure that teachers are trained on CAI integration in classroom and also provide the schools with ICT resources. This can probably make the classroom teachers effective while using CAI approach for instruction.

**Final Step**

![Diagram of Final Step](image)

**Figure 5.5: Final Step for the proposed model representation for enhancing learning of Chemistry using CAI**

The final step showed the four key components that must interact for the full benefits of CAI integration in learning chemistry to be realized. These key components are the government ICT policy, school ICT policy, ICT resources and ICT skills and training of teachers. The government ICT policy is the starting and ending point for the model of teaching using CAI.
With government ICT policy established, integration of CAI in schools is made possible and thus would lead to improved students’ learning outcomes.

In a nutshell, when the government and school ICT policy are well set, the ICT resources such as computers and educational software are available in schools and teachers have been trained and possesses the basic ICT skills, then the teachers would probably use CAI approach in classroom teaching. With the use of CAI approach in classroom, students can be more interactive in learning; their motivational effects towards learning can be raised as well as social interactions among themselves. Consequently, these factors would probably lead to improved students’ achievement, self-efficacy and collaborative skills.

5.5 Recommendations

Based on the findings and conclusions of this study, some classroom based recommendations, policy recommendations for various stakeholders and recommendations for further research have been suggested hereunder. These are provided in the subsequent sections 5.5.1, 5.5.2 and 5.5.3.

5.5.1 Classroom based recommendations

Chemistry teachers should be encouraged to use Computer Aided Instruction (CAI) in their teaching so as to improve students’ performance, self-efficacy and collaborative skills in Chemistry that has remained low for decades of years. The Chemistry teachers should ensure that they expose their students to more CAI to help improve their mastery in Chemistry thus improve their performance in the subject.
5.5.2 Policy Recommendations

i) The Ministry of Education, through Center for Mathematics, Science and Technology Education in Africa (CEMASTEA), should allocate more time for in-service training of chemistry on integration of CAI to empower them, thus enable its application in the classroom. Currently, teachers are given in-service training for only two weeks during the school holidays which may not be sufficiently enough for them to acquire the essential ICT skills. Additional time should be created for training during each school term.

ii) Teacher training institutions such colleges and universities should emphasize Computer Aided Instruction Method as part of their Chemistry training curriculum. Chemistry teacher trainees should be subjected to external assessment on use of computer aided instruction method during their teaching practice (TP).

iii) The Kenya Institute of Curriculum Development (KICD) should emphasize use of computer aided instruction method as one of the teaching methods in secondary school Chemistry curriculum.

iv) The government of Kenya should provide adequate ICT infrastructure and equipment, including computer hardware and software (CAI) in all schools. Availability of adequate
computer aided instruction hardware and software in schools will enable the Chemistry teachers to utilize available CAI approach in the teaching and learning processes.

v) School administrators should endeavor to provide an enabling environment for the use of CAI. This they can do by either providing or expanding existing ICT resources or facilities in schools to help foster enhanced CAI. They should also provide incentives to motivate chemistry teachers so as to empower them to better use CAI in their teaching and learning activities

5.5.3 Recommendations for further Research

i. This study used secondary schools with computers in Maara Sub-county in Tharaka Nithi County. More secondary schools countrywide should also be studied in order to find out if the research findings of this study can be generalized on a wider scale.

ii. Longitudinal researches are recommended that might be useful to investigate the effect of computer aided instruction on students’ achievement, self-efficacy and collaborative skills for an extended period of time.
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APPENDIX I
CHEMISTRY ASSESSMENT TEST (PRE-TEST)

Gender: Male ☐ Female ☐ (tick appropriately)

Class Register serial Number ____________ SCIENCE KCPE MARKS ____________

INSTRUCTIONS
Answer all the questions in the spaces provided  Total marks: 40  Time: 1hr

1. a) Define the term matter. (1 mark)
   b) Name the three states of matter. (1 mark)
   c) State three properties of each state of matter. (3 marks)

2. State whether the following are compounds, elements or mixtures. (3marks)
   a) Air
   b) Rust
   c) Iron filings
   d) Magnesium oxide

3. Name two elements and two compounds found in air. (1mark)

4. Explain briefly the behavior of particles in the three states of matter when the temperature is raised. (3 marks)

5. State four differences between physical and chemical changes. (4marks)

<table>
<thead>
<tr>
<th>Physical Change</th>
<th>Chemical Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>1)</td>
</tr>
<tr>
<td>2)</td>
<td>2)</td>
</tr>
<tr>
<td>3)</td>
<td>3)</td>
</tr>
<tr>
<td>4)</td>
<td>4)</td>
</tr>
</tbody>
</table>
6. Give two examples of substances that undergoes physical change when heated. (1 mark)

7. Complete the table below by filling the blanks. (4 marks)

<table>
<thead>
<tr>
<th>Substance (compound)</th>
<th>Elements in Compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) __________________</td>
<td>Hydrogen and oxygen</td>
</tr>
<tr>
<td>b) Carbon (IV) oxide</td>
<td>Carbon and____________</td>
</tr>
<tr>
<td>c) _________________</td>
<td>Oxygen, sulphur and copper</td>
</tr>
<tr>
<td>d) Magnesium chloride</td>
<td>______and ______</td>
</tr>
</tbody>
</table>

8. Write word equations for the following reactions. (3 marks)
   a) Magnesium burning in oxygen.
   b) Carbon burning in limited oxygen
   c) Solid wax changing to liquid wax

9. A student put a crystal of copper (II) sulphate in water. After some time the water was uniformly coloured blue. Explain how this happened. (2 marks)

10. Explain why gases are so easily compressed whereas it is practically impossible to compress a liquid or a solid. (2 Marks)

11. Assign appropriate state symbols for the following. (at room temperature) (2 marks)
   a) Ice
   b) Oxygen
   c) Steam
   d) Carbon (II) oxide (Use s- for solid, g- for gas and l-for liquid).
12. What is meant by the following terms?
   i) Compound (1 mark)
   ii) Mixture (1 mark)
   iii) Element (1 mark)

13. State four differences between a compound and a mixture. (4 marks)
   (i)
   (ii)
   (iii)
   (iv)

14. How can you use iron filings, sulphur powder, dilute hydrochloric acid and a magnet to demonstrate the difference between a mixture and compound? (3 mks)
MARKING SCHEME FOR CHEMISTRY TEST (CAT pre-test)

1(a) anything that has mass and occupies space/has volume
(b) solid - Liquid - gas (1 mark for 3 correct answers)

(c) solid
- Has definite shape
- Has definite size/volume
- Particles are packed closely to each other (1 mark for 3 correct answers)

Liquid
- Has no definite shape
- Has definite volume
- Particles are close but not as close as in solid (1 mark for 3 correct answers)

Gas
- Has no definite shape
- Has no definite volume
- Particles making it are scattered (1 mark for 3 correct answers)

2(a) Mixture
(b) Compound
(c) Element
(d) Compound

(1/2 mark for each correct answer)

3. Elements Compounds
Oxygen Carbon (IV) oxide
Nitrogen Water vapour (1/2 mark for each correct answer)

4) When a solid is heated, the heat energy is gained by the particles. The energy makes the particles vibrate but within the same positions. Further heating weakens the forces of attraction between the particles and solid changes to liquid. When the liquids get hot enough all the particles acquire energy to overcome the forces of attraction between them and most escape from each other to the air. (3 marks for 3 correct explanation)

5) Physical change Chemical change
- No new substance is formed - A new substance is formed
- No energy is either given out or absorbed - Energy is usually given out or absorbed
- The mass of the substance does not change - The mass of the substance change
- The change is usually reversible - The change is usually irreversible

(1/2 mark for each correct answer)

6) (i) heating of wax/zinc oxide/iodine
(ii) Heating of copper (II)sulphate/potassium Manganate (IV) (1/2 mark for each correct answer)
7) (a) water  (b) oxygen  (c) copper (II) sulphate  (d) magnesium and chlorine  
(1 mark for each correct answer)

8) Magnesium + Oxygen \[ \rightarrow \text{Magnesium oxide} \]
Carbon + Oxygen \[ \rightarrow \text{Carbon (II) oxide} \]
Solid wax + Oxygen \[ \rightarrow \text{Liquid wax} \]

9) Copper(II) sulphate particles move slowly from crystal into the water because they keep on colliding with water particles as they move eventually become evenly distributed and water colour turn blue.  
(2 marks for correct answer)

10) Gases have a lot of free space between the particles, unlike solids, liquids.  
(2 marks for correct answer)

11(a) solid(s)  
(b) Gas(g)  
a) Gas(g)  
b) Gas(g)  
(1/2 mark for each correct answer)

12(i) compound is made up of two or more chemically combined.  
(1 mark for correct answer)
(ii) A substance which contains two or more elements and or compounds physically combined.  
(1 mark for correct answer)
(iii) A pure substance which cannot be split into anything simpler by any chemical means.  
(1 mark for correct answer)

13) Compound  
- Cannot be separated by physical method  
- The substances in a compound are in fixed proportions  
- Compound is formed by a chemical method  
- New substance is formed  
- Energy is liberated or absorbed during  
- The properties are different from the substances average of the properties of the substances  
(Mixture  
- Can be separated by physical method  
- Substances in the mixture need not be in fixed proportions  
- Mixtures are formed by physical method  
- No new substance is formed.  
- No energy is liberated or absorbed  
- The properties of a mixture are the properties of the substances.  
(1/2 mark for 8 correct answer)

14) Mixture- iron fillings and sulphur powder can be separated by use of magnet  
Compound- sulphur powder reacted with hydrochloric acid forms a substance that cannot be separated by use of magnet  
(3 marks)
APPENDIX II
STUDENTS’ SELF EFFICACY SCALE

This scale sought to find out the self-efficacy of students in chemistry when taught using computer aided instruction and conventional teaching methods. The information you give will be treated with absolute confidentiality. Therefore neither your name nor the name of the school should be recorded. Please respond to all statements in the scale as honestly and correctly as possible.

Instructions

Class Register Serial Number____________________

Gender: Male [ ] Female [ ] (tick appropriately)

i. Read the statements carefully and try to understand before choosing what truly agrees with your thought.

ii. Tick [√] the choice that responds to how much you are confident towards the chemistry course. Tick only one of the choices.

iii. The choices are; strongly disagree [SD], Disagree [D], Not sure [NS], Agree [A], Strongly Agree [SA].

<table>
<thead>
<tr>
<th>Item</th>
<th>Statement</th>
<th>SD</th>
<th>D</th>
<th>NS</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I am confident that I can draw atomic structures of various elements correctly.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I am confident that I can write electronic configurations of various elements correctly.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I am confident that I can identify the group and period of various elements.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I am confident that I can explain the reactivity of elements down the groups and across a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>period in the periodic table</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Chemistry tests/examinations makes me feel uncomfortable and nervous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I am confident that I can calculate the relative atomic mass (RAM) of elements consisting of two or more isotopes correctly.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I am confident that I can do well in chemistry tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I am confident that I can get a grade D or better in Chemistry examinations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I am confident that I can write and balance chemical equations correctly.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>If I had options of selecting subjects I would choose Chemistry.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I am confident that I can tutor/teach another student on the topics “structure of an atom, periodic table and chemical families”.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>I am confident that I can undertake a career course related to Chemistry in future.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX III
CLASSROOM OBSERVATION SCHEDULE

This observation schedule sought to determine the development of students’ collaborative skills during teaching/learning of Chemistry. It also sought to compare the collaborative skills of students when taught using computer-aided instruction and conventional teaching methods. The observed skills were rated on a likert scale of 1-4: Where: 1-never observed, 2-rarely observed, 3-occasionally observed, 4- consistently observed.

(a) Students Collaborative skills in chemistry lessons

<table>
<thead>
<tr>
<th>Item</th>
<th>Aspects observed from the learners during the learning of chemistry</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Are learners demonstrating team work?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Are the learners seeking information from one another?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Are learners sharing information and materials?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Are learners discussing and sharing ideas?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Are learners giving and accepting help?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Are learners taking turns in the discussion?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Are learners adapting to varied roles and responsibilities?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Are learners demonstrating leadership skills?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Are learners working productively with others?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Are learners respecting diverse views from others?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Are the students participating actively in learning?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(b) This section seeks to find out challenges facing teachers in employing computer aided instruction in chemistry. The responses on challenges of CAI integration were obtain during the first classroom observation before the exposure of treatment (CAI) by the researcher from chemistry teachers who were used in the study.

i) Have you been trained on the use of CAI?

- **YES** [ ]
- **NO** [ ]

(ii) Do your school have ICT policy?

- **YES** [ ]
- **NO** [ ]

(iii) Are there adequate CDs of CAI program?

- **YES** [ ]
- **NO** [ ]

(iv) Are there adequate computers?

- **YES** [ ]
- **NO** [ ]

(v) In your opinion, what are some of the challenges facing you as a teacher in the use of computer aided instruction?
APPENDIX IV

CHEMISTRY ASSESSMENT TEST (POST-CAT)

Gender: Male ☐ Female ☐ (tick appropriately)

Class Register serial Number ____________ KCPE MARKS ____________

INSTRUCTIONS
Answer all the questions in the spaces provided       TIME 1hr       Total

Marks: 40

1(a) Name the particles that are found in an atom of an element and state the charge of each particle. (2 marks)

(b) Atoms are said to be electrically neutral. Explain. (2 marks)

2. Differentiate the terms atomic number and mass number. (2 marks)

3(a) Define the following terms:

(i) Isotopes (1 mark)

(ii) Relative atomic mass (1 mark)

4. Calculate the relative atomic mass of elements consisting of two isotopes with atomic masses 6 and 8 and relative abundance 65% and 35% respectively. (3 marks)

5. An element X has an atomic number 8 and atomic mass of 16.2. It consists of three isotopes of mass numbers 16, 17 and 18. What is the mass number of the most abundant isotope? Explain your answer. (2 marks)

6. An element Q has a mass number of 34 and 18 neutrons.
(a) Define the term an element.  
(1 mark)

(b) Write the electron configuration of element Q.  
(1 mark)

(c) Draw a diagram to show the arrangement of electrons in an atom of element Q.  
(2 marks)

(d) To which period and group does Q belong in the period table? Explain your answer.  
(2 marks)

7(a) what are the oxidation numbers of hydrogen in the compounds HCl and NaH?  
(1 mark)

(b) Explain why hydrogen is able to form compounds with the oxidation numbers you have given in (7a) above.  
(1 mark)

8. The grid below represents part of the periodic table. The letters are NOT the actual symbols of the elements. Use it to answer the questions that follow.

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Q</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a) Write down the valency of the elements P, Q, R and S in the grid.  
(2 marks)
b) From the grid above, select two letters that represents elements that will lose electron(s) to attain stable configuration. 

(1 mark)

c) Write the formula of the compound formed when elements P and R react. 

(1 mark)

d) Which letter represents an element that forms an ion with a positive charge of 1? 

(1 mark)

e) Give the letter that represents an element which would gain one electron to acquire an octet (outermost energy level with eight electrons) structure. 

(1 mark)

9. The number of protons, neutrons and electrons in atoms A to F are given in the table below the letters do not represent the actual symbol of the elements:

<table>
<thead>
<tr>
<th>Atoms</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>9</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>D</td>
<td>17</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>E</td>
<td>17</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>F</td>
<td>18</td>
<td>22</td>
<td>18</td>
</tr>
</tbody>
</table>

(a) Choose from the table the letters that represent:

(i) An atom of a metal .................................................................

(ii) A neutral atom of a non-metal .............................................

(iii) An atom of a noble gas .........................................................

(iv) A pair of isotopes .................................................................

(2 marks)

10. The grid below shows a part of the periodic table. The letters do not represent the actual symbols. Use it to answer the questions that follow:

<table>
<thead>
<tr>
<th>C</th>
<th></th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>Y</td>
<td>M</td>
</tr>
<tr>
<td>J</td>
<td></td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Q</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Z</td>
</tr>
</tbody>
</table>
(a) How do the atomic radius of element X and Y compare. (2marks)

(b) (i) Using crosses (X) to represent electrons, draw the atomic structure of element Q. (2marks)

(ii) State the period and the group to which element Q belong. (1mark)

(c) (i) The ionic configuration of element G is 2.8. G forms an ion of the type G⁻¹.

Indicate on the grid, the position of element G. (1mark)

(ii) To which chemical family does element G belongs? (1mark)

(iii) State one use of element U. (1mark)

(iv) What is the nature of the compound formed between K and U (1mark)
MARKING SCHEME: CHEMISTRY ASSESSMENT TEST (POST-TEST)

1. (a) Protons are positively charged
   Electrons are negatively charged
   Neutrons have no charge  (3 marks)
(b) The number of protons is equal to number of electrons with oppositely charges. (1 mark)

2. Atomic number is the number of protons while mass number is the sum of protons and neutrons. (1 mark)

3. (a) Isotopes are atoms of the same element with same atomic number but different mass number. (1 mark)
   (ii) Relative atomic number is the mass of any element compared to that of a single 1/12 carbon-12. (1 mark)

4. \[
\frac{6 \times 65}{100} + \frac{8 \times 35}{100} = 6.7
\] (2 marks)

5. 16 is the most abundant- it is close to the R.A.M (2 marks)

6. (a) Element is a pure substance that cannot be split into simpler substances by any chemical means. (1 mark)
   (b) 2.8.6 (1 mark)
   (c) Diagram with 2 electrons in 1st energy level, 8 electrons in the 2nd energy level and 6 electrons in the 3rd energy level. (2 marks)
   (d) Period- 3 has three occupied energy levels
      Group- VI - has 6 electrons in the outermost energy level. (2 marks)
(7) HCl: oxidation number is +1    NaH oxidation number is -1 (2 marks)
      Hydrogen can lose or gain an electron

8. (a) P : 1    Q: 4    R: 2    S: 1 (2 marks)
   (b) S and R (1 mark)
   (c) P_2R (1 mark)
   (d) P (1 mark)
   (e) S (1 mark)

9. (i) A and C (ii) D and E (iii) F (iv) D and E (5 marks)

10. (a) Atomic radius decreases across a period. Therefore the atomic radius of Y is smaller/less than that of X. (1 mark)
   (b) Diagram of electron arrangement.
      (ii) Period of Q is 3 and the group is VI.
      (c)(i) G is above W in the periodic table
      (ii) G is a Halogen
      (iii) U is Oxygen- Used for welding
         Mountain climbers and deep sea divers
         Patients with breathing difficulties (1 mark for each correct point)
      (iv) Basic compound (1 mark)
APPENDIX V

TEACHERS’ TRAINING MANUAL FOR COMPUTER AIDED INSTRUCTION

1.1 Computer Aided Instruction Software
Computer-aided instruction program used for this study was prepared by Kenya Institute of Curriculum Development (KICD). The contents contained in CAI program was based on the approved (KICD) syllabus and approved textbooks. The CAI program consisted of tutorials, and drill and practice applications. At the end of each topic and sub-topics a set of quizzes, exercises and assignments were provided for which immediate responses are supplied. The CAI Programs has an in-built evaluation questions and scores which gives students the opportunity to obtain immediate feedback.

A copy of CD of Computer Aided Instruction
### The Interface of Computer Aided Instruction Program

<table>
<thead>
<tr>
<th>Click a button to choose a topic/subtopic:</th>
<th>Quizzes</th>
<th>Exercises</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>❖ Structure of an atom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Particles of an atom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Characteristics of particles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Electron arrangement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Relative atomic mass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>❖ The periodic Table</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Periods</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 1.2 The Lesson development for Computer Aided Instruction

The teacher first explains to the students how to open the installed computer aided program.

i. The teacher presents and explains the content of the topic (structure of an atom and periodic table and chemical families) using computer projection for about one-third of the lesson time.

ii. After the teacher presents the material to be learnt, students working in groups (usually composed of different students each session) they solve the problems that are provided after the sub-topic.

iii. After students finish solving the problems, they input their answers in the computer. The computer would test the answers supplied by the student, if the answer is right, the computer will respond ‘correct’, if wrong, it respond either by saying ‘try again’ or ‘please try again’.
# APPENDIX VI

## PUBLIC SECONDARY SCHOOLS WITH COMPUTERS IN MAARA

<table>
<thead>
<tr>
<th>SCHOOL NAME</th>
<th>LEVEL OF SCHOOL</th>
<th>TYPE OF SCHOOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Chief Mbogori</td>
<td>Extra county</td>
<td>Girls Boarding</td>
</tr>
<tr>
<td>2 Chogoria Boys</td>
<td>Extra county</td>
<td>Boys Boarding</td>
</tr>
<tr>
<td>3 Chogoria Girls</td>
<td>National</td>
<td>Girls Boarding</td>
</tr>
<tr>
<td>4 Igwajau</td>
<td>Extra county</td>
<td>Mixed Boarding</td>
</tr>
<tr>
<td>5 Iruma Girls</td>
<td>County</td>
<td>Girls Boarding</td>
</tr>
<tr>
<td>6 Kajiuduthi High</td>
<td>Extra county</td>
<td>Boys Boarding</td>
</tr>
<tr>
<td>7 Kiini</td>
<td>County</td>
<td>Mixed Boarding</td>
</tr>
<tr>
<td>8 Kiriani Boys</td>
<td>County</td>
<td>Boys Boarding</td>
</tr>
<tr>
<td>9 Kiurani</td>
<td>County</td>
<td>Mixed Boarding</td>
</tr>
<tr>
<td>10 Makuri Girls</td>
<td>Extra county</td>
<td>Girls Boarding</td>
</tr>
<tr>
<td>11 Muraga tech</td>
<td>County</td>
<td>Mixed Boarding</td>
</tr>
<tr>
<td>12 Muthambi Boys</td>
<td>Extra county</td>
<td>Boys Boarding</td>
</tr>
<tr>
<td>13 Muthambi Girls</td>
<td>Extra county</td>
<td>Girls Boarding</td>
</tr>
<tr>
<td>14 Magundu (OLOM)</td>
<td>County</td>
<td>Girls Boarding</td>
</tr>
<tr>
<td>15 Thigaa</td>
<td>County</td>
<td>Mixed Boarding</td>
</tr>
</tbody>
</table>
APPENDIX VII

LOCALE MAP OF MAARA SUB-COUNTY

Nairobi

Tharaka Nithi County (Maara District)
APPENDIX VIII: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:

MS. JUDITH KIBA JULIUS
of KENYATTA UNIVERSITY, 733-60202
has been permitted to conduct research in Tharaka-Nithi, County,

on the topic: STUDENTS’ ACHIEVEMENT AND SKILLS IN CHEMISTRY; A COMPARISON OF COMPUTER AIDED INSTRUCTION AND CONVENTIONAL METHODS AMONG STUDENTS IN MAARA DISTRICT, KENYA

for the period ending:
2nd April, 2017

[Signature]

Applicant’s Signature

Permit No: NACOSTI/P/16/69212/9744
Date of Issue: 8th April, 2016
Fee Received: Ksh 2000

[Signature]

Director General
National Commission for Science, Technology & Innovation

169
APPENDIX IX: RESEARCH AUTHORISATION

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Ref No. NACOSTI/P/16/69212/9744

Judith Kinya Julius
Kenyatta University
P.O. Box 43844-00100
NAIROBI

Date: 6th April, 2016

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on “Students’ achievement and skills in chemistry: A comparison of computer aided instruction and conventional methods among students in Maara District, Kenya.” I am pleased to inform you that you have been authorized to undertake research in Tharaka Nithi County for a period ending 2nd April, 2017.

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

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

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Tharaka Nithi County.

The County Director of Education
Tharaka Nithi County.