EFFECT OF COMPUTER-ASSISTED LEARNING ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN BIOLOGY IN KENYA: A CASE OF MT-ELGON, BUNGOMA COUNTY.

BY

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DECLARATION

Declaration by the Candidate

This Thesis is my original work and has not been presented for a degree in any other University. No part of this Thesis may be reproduced without the prior permission of the author and/or University of Eldoret.

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DEDICATION

This Thesis is dedicated to: My parents; Mr and Mrs Samikwo Sabilah who gave me a chance to go to school. To my husband Daniel Moturi and my Children Victor Moogi, Alvin Mariaria, Berryl Nyamoita and Alex Motanya for their support in my academic endeavors.

ABSTRACT

The study was designed to investigate the effect of computer-assisted learning (CAL) on secondary school students' achievement in Biology in Mt-Elgon sub-county, Bungoma County, Kenya. The purpose of the study was therefore to investigate the effect of CAL on secondary school students' achievement in Biology among the form three students in Mt-Elgon sub-county. The study was carried out in twelve selected secondary schools in Mt Elgon sub-county, where students have persistently scored low grades in the subject. The study therefore investigated the effect of CAL as an intervention on students' achievement in Biology. The objectives of the study were: to investigate the effect of computer-assisted learning on students' retention of biological knowledge, to establish the influence of computer-assisted learning on students' attitudes towards Biology and to find out the influence of computer-assisted learning on students' self-efficacy in Biology. The study was guided by the Cognitive Theory of Multimedia Learning (CTML) coined by Mayer (2001). Literature was reviewed using secondary such as books, journals and theses. The study was based on a pragmatist philosophical stance and employed mixed methods research methodology. The study adopted a quasi-experimental. Stratified sampling was used to separate secondary schools in the sub-county that were equipped with and without computers hence 6 schools equipped with computers and 6 schools without computers participated in the study. Simple random sampling technique was used to select the study respondents from the sampled schools. Data were collected from a sample of 274 students sampled from a population frame of 946 students. Teachers in the sampled schools with computers were interviewed. Data collection instruments included questionnaires, interview schedules and a computer-assisted learning achievement test (CALAT). Data were analyzed using both descriptive statistics and inferential statistics (t-test) with the aid of SPSS version 20 and MS Excel statistical packages. The findings of the study showed that CAL was effective in improving the students' retention of biological knowledge hence achievement as compared to the conventional approaches of teaching. The results also established that the Biology students in the experimental group showed positive attitude and self-efficacy towards CAL. The study concluded that computer-assisted learning programme has the potential to improve achievement, attitudes and self-efficacy in the learners. Based on the findings of this study, the researcher recommended that all schools should strive to be equipped with computers and the necessary software, Biology text books to have digital content included, and teacher preparation programs to include e-learning so that both learners and their teachers can access them for meaningful learning to take place. It is hoped that the findings of this study will be useful to Biology teachers, curriculum developers (KICD), policy makers and the general public about the necessity for introducing computers as tools for learning Biology.

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LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms were used in this study to convey the meaning shown:

BBC British Broadcasting Corporation

CAL Computer Assisted Learning

CALAT Computer Assisted Learning Achievement Test

CALP Computer Assisted Learning Programme

CBI Computer Based Instruction

CBT Computer Based Training

CD Compact Disc

CD-ROM Compact Disc, Read-Only-Memory

CTML Cognitive Theory of Multimedia Learning

DVD Digital Versatile Disc

DVRs Digital Video Recorders

EAC East African Community

EDNA Educators Network of Australia

EFA Education for All

GDP Gross Domestic Product

GOK Government of Kenya

GPS Global Positioning Service

GTLS Group Teaching and Learning Software

H I V Human Immuno Deficiency Virus

ICT Information, Communication and Technology

Infor Dev Information for Development Programme (World Bank)

KCSE Kenya Certificate of Secondary Education

KICD Kenya Institute of Curriculum Development

KNEC Kenya National Examination Council

MOEST Ministry of Education Science and Technology

MT Elgon Mount Elgon

P21 Partnerships for 21st Century Skills

SDG's Sustainable Development Goals

SPSS Statistical Package for Social Sciences

TEL Technology Enhanced Learning

UNESCO United Nations Educational Scientific and Cultural Organization.

VCD Video Compact Disc

VLE Virtual Learning Environments

VUP Virtual University of Pakistan

WBT Web-Based Training

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CHAPTER ONE

INTRODUCTION OF THE STUDY

1.1 Introduction to the Chapter

This chapter presents the essentials of the study on the effects of computer-assisted learning (CAL) on secondary school students' achievement in Biology. It begins with the background of the study which lays ground for the statement of the problem of the study. The significance of the study is also covered. The research objectives, questions and hypothesis have been stated to guide the study. Other key components of the chapter include: justification of the study, significance of the study, limitations of the study, scope of the study, assumptions of the study, theoretical and conceptual frameworks guiding the study and operational definition of terms. The chapter ends with the chapter-summary.

1.2 Background of the Study

Quality education is a critical factor to the development of individuals' potentials and/or democratic awareness; gross domestic product (GDP); infrastructure development; and ability for a country to participate fully in the global economy (Ewing, Javier; Chevrolier, Nicholas; Leenderste, Matthijs; Quigless, Maryanna; Verghese, & Thomas, 2014). The development of any country will therefore depend upon the quality of education programs offered to its citizens. Investment in information and communication technology (ICT) infrastructure was one of the key priorities of education policies of countries all over the world over the past decades. For example, European Commission (2000) developed several action plans which aimed at implementing and integrating ICT (e-Learning) into primary schools,

secondary schools, colleges and universities. The integration of information communication and technology (ICT) in education, to some great extent, has become one of the issues in improving the quality of educational systems. Kozma (2014) asserts that with ICT, developing countries can support education and economic development. This can be done at lower operational cost and greater time and space advantage with digital technologies such as computers, internet, bandwidth, wireless networks and related software, while industrialized countries can reform further their education systems. Among the World Bank four pillars of the knowledge economy is the pillar on information infrastructure, where a dynamic information infrastructure ranging from radio to the internet is required to facilitate the effective communication, dissemination and processing of information (World Bank, 2013). In this respect technology plays a key role in today's classrooms as means of delivering quality education/information to the learners. It has become necessary to improve the quality of teaching, increase access to digital technology and integrate the use of ICT in all subjects. Veselinovska (2014) supports this by saying that in the times of communication revolution, ICT is the catalyst of reforms in education.

Traditionally, instructional technologies have been used as means for delivering instruction in the teaching and learning process. During the "instructional" process, learners perceive and endeavor to understand the messages stored in the technology as they "interact" with it. Technologies should therefore be used to support learning by instructing the learners as knowledge construction tools that students should follow, (Jonassen, 1998). Many computer-assisted learning (CAL) applications have been developed explicitly to engage learners in critical thinking. This enables learners to engage in critical thinking about the content they are studying. CALs make curriculum implementation learner-centered with a self-regulated learning

environment that enables the student customize his/her own learning experiences. Mikre (2011) noted that ICTs greatly facilitate the acquisition and absorption of knowledge, offering developing countries unprecedented opportunities to enhance educational systems in their curricula. Furthermore, the use of ICTs in education also shifts the learning approaches from teacher centered towards learner centered approaches. As expressed by Bransford, Brown, and Cocking (1999) as cited by Mikre (2011), the use of ICTs in education contributes to a more constructivist learning. This leads to an increase in activity and greater responsibility of students, hence learning becomes a learner-centered approach. This has limited the role of the teacher to supporting, advising, and coaching students rather than merely transmitting knowledge (Yonazi, 2012). The gradual progress in using computers changed from learning about computers, to learning computers, and subsequently to learning with computers (Mikre, 2011). The latter makes learning especially in science subjects interesting and motivating to learners which subsequently boosts their performance.

Computers in the classroom will certainly not offer a cure for all science education problems but they can definitely be seen as complementary to other approaches to teaching science if properly integrated. It is in this direction that there has been a massive drive to incorporate ICT into every aspect of school life in the developed countries. For example, UK invested over £1.7 billion in training hardware and software packages in recent years (Baggott La Velle, John, McFarlane, & Wishart, 2007). This was to ensure the applicability of technology in all sectors was timely. Learning institutions in the developed countries were also not left behind in terms of technology. Wells and Lewis (2006) reported that nearly 100% of public schools in the United States had access to the Internet by 2005. In recent studies in the UK and

USA, ICTs are the students' preference in the delivery of course content in colleges and universities (Salaway & Caruso, 2008).

The ICT sector has proven to be a powerful driver of GDP growth in nations across the world and in delivering quality education. From developing countries such as South Africa, India and the Philippines, to developed nations such as the United States of America and Ireland, the ICT sector has contributed to the success of each of these nations' economies. In addition ICT has advanced peoples' skills and capabilities and positioned the nation as a place for global firms to more efficiently do business (Yonazi, Kelly, Halewood & Blackman, 2012). The ICT sector is socially and economically relevant to Africa in that it has been the major economic driver in Sub-Saharan Africa over the past decade (Souter, Adam, Butcher, Sibthorpe, & Tusubira 2014). Although mobile and internet penetration remains comparatively low in Africa, never before in the history of the continent has the population been as connected as it is today (Ewing *et al*, 2014). ICT use in education is at a particularly dynamic stage in Africa; new developments and announcements happening on a daily basis somewhere on the continent. Thus the presence of digital technologies in schools makes it possible to enhance students' understanding and exploration of biological concepts and phenomena that were previously too abstract or just too difficult (Van Rooy, 2012). For instance, cell reactions can be demonstrated at varying speeds while diagrams and pictures of different specimens can be shown at different magnification with the use of technology. Use of ICTs such as computer technology and internet is intended to enable teachers to facilitate learning more effectively and enhance students' understanding of concepts which are expected to translate into expansion of knowledge and improved examination outcomes (Omollo,

2013). The ultimate goal of incorporating technology in the teaching/learning process is to enable learners improve in their performance.

East African Community (EAC) member countries (Kenya, Tanzania, Uganda, South Sudan, Rwanda and Burundi) have adopted or are in the process of adopting competency based curriculum and assessment. This will enable its members acquire skills to execute tasks to meet the ever changing needs. Kenya has made remarkable progress putting in place an ICT policy framework and implementation strategy, complete with measurable outcomes and time frames. Education for global citizenship through ICT, teleconferencing and electronic discussions has increasingly become popular in Kenya (Davy, 2011). Incorporated in the Flagship Projects for education and training in Kenya's vision 2030 is the establishment of a computer supply programme that will equip students with modern IT skills. Kenya Vision 2030 places great emphasis on the link between education and the labour market, as such there is need to address issues related to quality, service delivery, curriculum, relevance, teacher development and management at all levels as well as trainers in the areas of technology. In order to address these issues, the government provides policy direction for reforms in education service delivery through introduction of technical, talent and academic curriculum pathways. In all these, information Communication Technologies (ICT) is seen as a teaching-learning tool (Sessional paper, 2012). Hence the government has prioritized science, technology and innovation in its guiding principles. The Ministry of Education also acknowledges the need to reform the secondary school curriculum with the emphasis shifting from knowledge reproduction to knowledge production and, to make ICT central to it (Nyaga, 2014). The Kenya Government, therefore, recognizes the role of ICTs in the social and economic development of the nation and has promulgated a national ICT Policy based on the

Economic Recovery Strategy for Wealth and Employment Creation (Kenya ICT Policy, 2006). This policy seeks to stimulate investment and innovation in ICT, and achieve universal access technology in the country. Practically ICT literate students are generally better at problem solving, more creative and can communicate ideas more efficiently. Therefore, schools should facilitate developing ICT literacy skills. However, universal implementation is challenging given the lack of resources, national ICT infrastructure, and even electrical supply – particularly in the rural areas. Kenya ICT Policy 2006 further notes that lack of adequate ICT infrastructure has hampered provision of efficient and affordable ICT services in the country. Due to this, learners exiting secondary schools have limited skills and abilities to join the world of work, trade or to join middle and tertiary level (GOK, Sessional paper, 2012). This therefore creates limited workforce for the ever expanding job opportunities in the country.

Biology is the scientific study of living organisms. The future of Biology holds many exciting promises because it is a practical subject which equips learners with concepts and skills necessary for solving day to day problems of life. As we enter what some have dubbed the 'Age of Bioscience' we are looking at an ever-growing range of complex issues and careers with a foundation in Biology (Ajaja, 2013). Biological research can lead to advances in various basic disciplines; medicine, genetics, biotechnology, molecular biology, microbiology and biochemistry, pharmaceutics, dentistry, agriculture and veterinary studies. Biological knowledge also forms a part of an understanding of the self and responsible behavior, of maintaining health and wellbeing, and of environmental citizenship. No student intending to study these disciplines can do without Biology. Mwirigi, (2011) in his study supports that Biology plays a key role in industrialization and other sectors of the economy. Therefore the

most important contexts for learning Biology are the Biology classrooms. Biology education is not at the best it can be and for this purpose it is necessary to improve the quality of teaching and learning which will in turn help learners achieve success in the global knowledge-based economy and integrate the use of ICT in all subjects, with special emphasis on science (Veselinovska, 2014).

Computer-assisted learning in Biology education is the use of computers to teach or learn biological aspects of education, for instance, in a general Biology laboratory for a frog dissection and simulations for anatomy (Tabin and Fraser, 1987). Tabin and Fraser further reiterated that computers allow Biology teachers to teach better, teach more easily, and teach in greater depth. For example, several different sets of students are able to pool results of genetics crosses by use of computer-assisted learning. Simulations provide a situation that is similar to the laboratory setting, yet it is a safer learning environment in which solutions for different problems are sought. The learner has the opportunity of interacting with real experimental situations, can draw diagrams similar to the original one and can get feedback as if she/he is in a real world situation (Issenberg, Mcgaghie, Petrusa, Gordon, & Scarlese, 2005). Other examples include increased ease and depth of learning about such dynamic phenomena as protein synthesis, predator-prey relationships, and the evaluation of effects of different insect or weed control strategies. Computers can decrease lengthy tasks associated with even simple exercises. For example, when teaching ecology, it is valuable to generate several large, random or clumped samples to represent the distribution of individual weeds in an agricultural field. The computer can do this faster and more reliably than students might do. Naturally, computers can also decrease some of a teacher's lengthy tasks (Crovello, 1985, Friedler, Merin, and Tamir, 1992)

Computers can create an enhanced learning context that can contribute to students' academic growth. Computer-assisted learning in Biology can increase students' interest in the subject matter. Yapici and Akbayin (2012) investigated the effect of blended learning model and found that the blended learning model contributed more to the students' Biology achievement than traditional teaching methods did and that the students' attitudes towards the internet developed significantly. From educational perspective it is known that students can learn more in cognitive aspects of Biology if they have a positive attitude towards the subject. If computers can contribute to this, then good results will be achieved. One reason why many students like computers is that they realize the greatly expanded mental power and creativity that is under their control. The Biology teacher can use a computer to create illustrations for lecture or laboratory, or to create short bibliography of relevant articles from a much larger literature data bank. Computers are not only used effectively in the laboratory but also many Biology assignments are completed on a student's own time (Lutfullah, 1998). Biology teachers can use computers during lectures to demonstrate dynamic phenomena more easily and exhaustively. This can be done with the computer screen with additional television-type monitors placed around the room, or with a large-screen projection system linked to the computer. Computers allow students to learn at their own paces, hence allow students to grasp concepts at their pace if a student does not easily understand a concept. Computers permit a high level of individualized instruction since each student must interact with a computer directly and continuously.

Many studies have been carried out on how CALs have been used in education to disseminate knowledge. Tella, Tella, Toyobo, Adika, & Adeyinka, (2007) did an assessment of secondary school teachers use of ICT's in Nigerian secondary schools and found out that teachers generally had access to ICT in various schools though technical support lacked hindering teachers' readiness and confidence of using ICTs during lessons. Basturk (2005) investigated the effectiveness of computer-assisted instruction in teaching introductory statistics and found out that learning could be improved successfully when CAL was used as a supplement to regular lecture in teaching introductory statistics course. Hevedanli (2015) examined the influence of web-aided cooperative learning environment on motivation and self-efficacy belief in biology teaching. The findings demonstrated that the motivation levels of biology pre-service teachers trained in the web-aided cooperative learning environment increased, and there was no significant difference regarding self-efficacy beliefs in biology teaching. Hevedanli (2015) further noticed that web-aided cooperative learning made the lesson more entertaining; that the pre-service teachers enjoyed working together; that the environment resulted to permanent learning; and that their motivation increased. However, some studies did not find any difference; for example, Kocakaya & Gonen (2010) investigated the effect of the computer assisted teaching and 7e model of the constructivist learning methods on the achievements and attitudes of high school students. The results indicated that the students' attitudes towards physics learning were not affected by different instruction methods.

The concept of CAL integration into an educational system begins with the teaching/learning process and the ways in which teachers teach. The challenge for many teachers, particularly in developing countries Kenya included, is changing their practice of teaching in ways that accommodate the use of computers in the process of

teaching. The future development of Biology and its participation in the contribution of knowledge to the society will be greatly influenced by how teachers manage to deliver quality education. CAL is a tool that teachers may use in a number of ways within the ever changing society that can impact on greater student learning and positive outcomes. CAL brings hope to the possibility of schools being able to use new technologies to leapfrog over many of their problems such as a shortage of school books and low achievement levels. It will also train students in technologies and to have "21st century skills" such as creative thinking, manipulative skills and problem solving.

The need for computer-assisted learning for Biology classes is therefore unarguable. Despite the many challenges facing effective ICT implementation such as insufficient computers, internet connectivity and power unreliability (Nyaga, 2014) the benefits are quite numerous. Currently, instead of conventional methods in Biology classroom, Biology teachers and students would prefer the usage of computers to assist in the learning of biological aspects. The main benefits of CAL can be summarized as follows; a) Simulations for many Biology experiments in laboratories make students easily control variables and see the results on the monitor and b) Animal dissection can be remembered by learners when they participate in the actual simulations. Lately many animal rights associations protest the use of animals in laboratories and in medical experiments. However, with help of computer animations and simulations, dissection of various animals such as frogs including human beings can be done via computer. Studies have been conducted on the use of CALs in Education in developed countries where the use of ICTs has come of age, and where there are resources and material to maintain them. However, the use of CALs by teachers in Kenya is just beginning to gain popularity and researches in the area have just started emerging.

Emphatically, studies on the use of CAL by teachers to teach Biology has been shown to be highly meritorious. It enables teachers plan, implement, and manage learning and teaching in open and flexible learning environment (UNESCO, 2004). In the light of these therefore, more research is needed to showcase further development of CAL's use by secondary school teachers and learners in Kenya.

The Kenyan government has made efforts to close the digital divide in the Kenya's one laptop per child initiative by the Jubilee government. Mutua (2013) noted that the Kenyan government was to equip every child starting their primary school education with laptops from the onset of Jubilee government and was expected to run from 2014. However the project has faced difficulties ranging from infrastructure (schools not connected electricity grids, dilapidated classrooms, ICT illiterate teachers) to poor timing (Banju, 2014). The success of the laptop project will in Kenya will be a milestone in the area CAL since achievement will be improved at national exams. This will go a long way towards the achievement of Kenya's vision 2030 with flagship project in education among others.

1.3 Statement of the Problem

Kenya Certificate of Secondary Examinations (KCSE) has indicated general poor achievement in science subjects country wide, (MOE, 2005). Students' performance in Biology in secondary schools in Mt. Elgon Sub-county has recorded consistent poor achievement in the last five years as evidenced in County Education Annual Report (2013) as shown in appendix XII, despite teachers making efforts using conventional approaches of teaching. The poor achievement certainly underlies the fact that students do not get the opportunity to acquire very important scientific skills attitudes and values. The persistent poor achievement of learners in Biology in both

external and internal examinations has been a concern of many researchers, science educators, parents and even the students in Kenya. In their study, Ngesu, Gunga, Wachira, & Kaluku (2014) pointed out that students' performance at KCSE level seemed to be affected by a combination of factors; methodologies, teachers' and students' related factors, school factors and socio-economic factors. Studies carried out by various researchers showed that use of CAL versus conventional approaches of teaching such as lecture, discussion and question and answer have showed varied results in Biology subject. Some studies reported that CAL improved students' achievement while others did not find any differences. On the contrary some researchers reported that conventional approaches of teaching were more effective than CAL. The problem facing Mt Elgon sub-county is which appropriate and innovative teaching methodology would help improve the achievement in Biology subject. For this reason the study aspired to establish the effect of CAL in the teaching of Biology as an innovative teaching approach and instructional technique that may improve achievement in Biology subject in Mt. Elgon sub-county.

1.4 Purpose of the Study

The purpose of this study was to find out the effect of Computer Assisted Learning on secondary school students' achievement in Biology in Mt-Elgon, Bungoma county Kenya.

1.5 Research Objectives

The main objective of this study was to establish the effect of computer Ak,ssisted learning on secondary school students' achievement in biological knowledge, attitudes and self-efficacy.

This study was guided by the following specific research objectives;

1) To investigate the effect of computer-assisted learning on students' retention of biological knowledge.
2) To establish the influence of computer-assisted learning on students' attitudes towards biology subject.
3) To establish the influence of computer-assisted learning on students' self-efficacy in Biology.

1.6 Research Questions

1. What is the difference in retention of biological knowledge between learners taught by Computer Assisted Learning (CAL) and those taught using traditional approaches of teaching?
2. To what extent does computer-assisted learning (CAL) influence secondary school students' attitudes towards Biology subject?
3. What is the influence of computer-assisted learning (CAL) on secondary school students' self-efficacy?

1.7 Hypothesis of the Study

HO_1. There is no significant difference in the retention of biological knowledge between learners taught by computer-assisted learning and those taught using conventional approaches of teaching.

1.8 Justification/Rationale of the Study

Information and communication technology (ICT) literacy skills reflect 21st Century requirements for searching and communicating information. Biott (1999) noted that through effective instructional strategies, achievement in any subject will improve. An investigation into the use of CAL as a strategy to improve teaching and learning is therefore necessary. This will help to improve the quality of education through better teaching and learning strategies which will in turn improve achievement in the acquisition of biological knowledge. Biological knowledge becomes very crucial in achieving sustainable development goals (SDG's) which touch on combating HIV, malaria and child mortality in the attainment of vision 2030 with flagship activities in agriculture, health and environmental conservation. Improved achievement will lead to the development of positive attitudes and self-efficacy among the learners. This will help produce quality personnel in Biology related careers such as medicine, dentistry, and veterinary who can promote development in scientific research in these fields. Therefore the role played by computer-assisted learning in the learning of biological knowledge cannot be underscored since it prepares learners for future Biology-related careers. Therefore there was need to carry out this study on the effect of computer-assisted learning on secondary school students achievement in Biology.

1.9 Significance of the Study

Information and communication technologies (ICT) continue to impact on all aspects of contemporary education around the world. Cotton (1991) observed that the acquisition of computer hardware and educational software programs involves a considerable monetary investment. Therefore educational institutions require a careful planning of finances to establish such an infrastructure. Back up from empirical evidence is therefore required to underscore its significance while constant review of the same be done periodically. As Kenya incorporates the use of computers in her educational system as a tool in the teaching and learning process, it becomes important that the effect of computer assisted learning be explored. The study endeavored to establish the effect of CAL on secondary school students' attitude, self-efficacy and retention of biological knowledge. These study findings will therefore be of significance to Biology curriculum developers and planners to include technological modern methods of teaching in content delivery. Ministry of education (MOE) is also likely to benefit and equip the schools with the necessary infrastructure to accommodate new approaches in the teaching and learning process. Universities and teacher training colleges will also access the findings of this study in order to include technological content delivery method in their syllabus as they train teachers. The findings will also provide the Biology teachers with the understanding of additional teaching strategies so as to increase retention, improve the learners' attitudes and self-efficacy. This will contribute to the improvement of Biology teaching and learning as we plan to implement the millennium goal on education for all (EFA) commitment. The study will also be of benefit to students since their retention rates of the content they have learned can be greatly enhanced by CAL.

Finally the findings of this study would contribute to the existing body of knowledge in Biology education.

1.10 Assumptions of the Study

Assumptions in a study are things that are somewhat out of the researcher's control, but if they disappear the study would become irrelevant (Simon, 2011). Leedy and Ormrod (2010) also posited that assumptions are so basic that, without them, the research problem itself could not exist. For the purpose of this study the following assumptions were made.

1. That the responses of the respondents were honest and true. This was attained through asking the participants of the study not to write their names in the test and questionnaires to assure them of anonymity. They were also assured that their responses would be kept confidential. The assurance ensured that the respondents participated freely without fear, bias or prejudice.
2. That the sample used was a representative of the population the researcher wished to make reference to. The researcher systematically used the sampling techniques to select the schools that participated in the study. Furthermore, Krejcie and Morgan (1970) table for determining sample size from a given population was used to select the number of participants.
3. That the schools sampled in the study have fully equipped computer laboratories and the necessary software to be used in the teaching and learning of Biology. The researcher ensured that the experimental group was drawn from schools that were equipped with computers. In addition the researcher prepared the necessary soft-ware that was used in the study.

1.11 Scope of the Study

The study investigated the effect of computer-assisted learning on secondary school students' academic achievement in Biology. There are other computer soft-wares used for learning such as internet that were not included in the study. Computer-assisted learning entailed use of power point projected slides with the teacher's explanations. The achievement of the learners' taught by computer-assisted learning were compared to those taught by conventional approaches of teaching such as lecture method.

The study respondents were form three students. Other classes were not used because the topic 'classification' which the researcher used the content in the research, is taught in form three. The topic classification was used in the study among the many topics in biology subject. Classification topic was selected for the study because it encompasses all the aspects taught in all topics in the entire Biology syllabus such as identification, drawing, naming, and grouping of organisms in their taxonomic units, which completes the concept development in the learning of Biology.

The study was carried out in Mt Elgon sub-county among the other sub-counties in Bungoma County. This is because it had continually registered poor results in Biology at KCSE as shown by the County education report (2014).

1.12 Limitations of the Study

Simon (2011) defines limitations as potential weaknesses in a study and is out of the researcher's control. The following were the limitations regarding this study.

1) This study investigated the effect of CAL on secondary school students' achievement in Biology. Computer use was limited to the presentation of

Biology curriculum contents using Power- point software programme only. The study did not examine other alternative means like Internet for delivering the course content.

2) CAL in the teaching and learning of Biology involved the use of computers used for the delivery of curriculum content blended with conventional methods of teaching such as lecture method, discussion method and question and answer method. The computers did not replace the teacher in the teaching and learning process.
3) The study utilized one topic, Classification, amongst the several other topics in the entire Biology syllabus taught at form three levels.

Despite these limitations, the findings of this study are significant especially in the use of computer-assisted learning in Kenyan secondary schools. These findings will form a point of reference during this time when the MOE is digitizing the teaching learning content.

1.13 Theoretical Framework

The study was guided by the Cognitive Theory of Multimedia Learning (CTML) coined by Mayer (2001). The principle known as the "multimedia principle" states that "people learn more deeply from words and pictures than from words alone" (Mayer, 2001). These therefore contrasts with most classroom learning activities which involve knowledge acquired in an abstract way. Mayer's CTML contends that words and pictures presented to the learner via a multimedia presentation are processed along two separate, non-conflicting channels. They enter the sensory memory through the ears and eyes. The theory proposes 3 main assumptions when it comes to learning with multimedia. 1) There are two separate channels (auditory and

visual) for processing information, also known as Dual-coding theory. 2) Each channel has a limited capacity. 3) Learning is an active process of filtering, selecting, organizing, and integrating information based upon prior knowledge (Mayer, 2001). Words and images are actively selected by the learner from the sensory memory and enter the working memory where they are organized into a verbal model and a pictorial model. In this case, there is gradual acquisition of knowledge and skills as they learn from the pictures and words they see and hear. The knowledge acquired is then integrated into the long term memory hence learners can recall it in times of application. Retention of knowledge yields improved achievement which impacts positively on the learners' attitudes and self-efficacy.

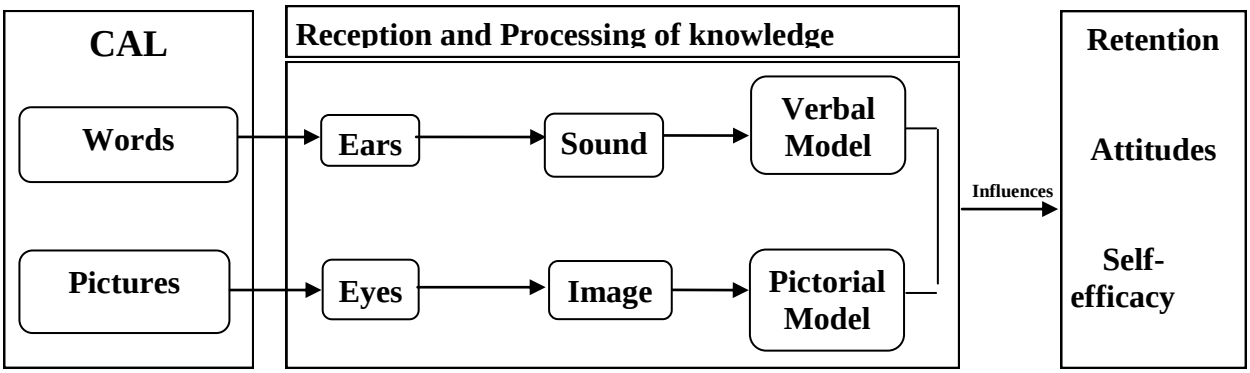


Figure 1.1 Adapted from R.E. Mayer's Cognitive Theory of Multimedia Learning (CTML).

Source: Mayer 2001

Mayer's CTML incorporates four elements from research on how people learn: (a) dual-coding theory, where verbal and visual stimuli are processed separately but simultaneously in working memory. (b) Limited capacity working memory, it is postulated that the working memory can hold a limited number of items or "chunks"

of information at one time which requires us to choose where to allocate cognitive resources. Mayer allows for the concept of the limited capacity of working memory by recommending segmenting of instruction and excluding extraneous information. (c) Active processing hence we do not passively receive information into our memory. The CTML acknowledges that humans are actively engaged in cognitive processing in order to make sense of the stimuli presented, and (d) information transfer. When meaningful learning takes place, people are able to retrieve newly acquired knowledge from long-term memory when they need it to perform a given task hence the repository of all things learned. Furthermore Mayer underscores the importance of learning (based upon the testing of content and demonstrating the successful transfer of knowledge) when new information is integrated with prior knowledge.

1.14 Conceptual Framework

The conceptual framework in this study is illustrated in Figure 1.2. The figure shows the relationship between the variables. Ideally the computer-assisted learning (CAL) would affect the attitudes, self-efficacy and retention in Biology. Practically this is not the case, students' attitudes, self-efficacy and retention during learning is influenced by various extraneous variables such as; (1) teachers methodology and training, (2) learners age, gender and socio-economic status, and (3) infrastructure in terms of availability of computers and electricity (power), computer software and computer malware. These factors need to be controlled in the study so as to make the results obtained meaningful. The teachers were trained/ inducted before the study begun so as to familiarise them with the requirements of the study. The learners who participated in the study were form three students who are between the ages of about

17-18 years. The 12 schools which participated in the study were sampled out, 6 of these schools were equipped with computers and have access to electricity while the other 6 were not equipped with computers. Finally, a programme used to teach the learners was prepared in advance so that the learners were uniformly catered for and learners were not be required to use the internet.

The following framework was used to guide the study.

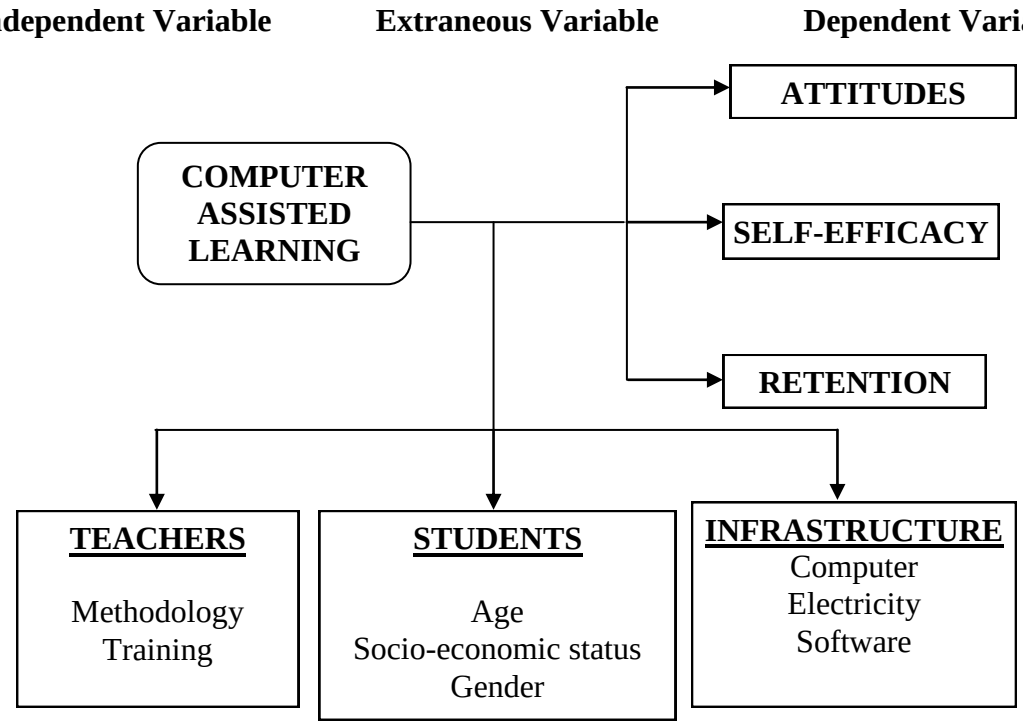


Figure 1.2 Shows the Conceptual Framework of the Study.

Source; Researcher, 2015

The independent variable in this study was the computer-assisted learning (CAL). This is the variable that was manipulated and its outcome was measured on attitudes, self-efficacy and biological knowledge retention which were the dependent variables. CAL in this study involved teaching learners in the experimental group by the use of CAL programme which entailed the treatment, whereas the control group was taught

by the conventional approaches of teaching. A pre-test and a post-test were used to measure the effect of both methods on the learners' achievement of biological knowledge. A questionnaire was then administered after the treatment to determine the learners' attitudes and self-efficacy.

However, there are intervening variables that are likely to affect the outcome of the study. First is the teachers' approach of teaching which is largely affected by training, teachers' computer literacy, and the teachers' preparedness on whether the teacher will employ lecture method or go for methods that involve the learner in the teaching learning process. Secondly students' socio-economic status would determine the interaction of the learners with the digital content. Lastly, infrastructure in terms electricity, availability of computers hardware and software would also determine the use of the digital content in schools.

1.15 Definitions of Operational Terms

The following terms were used in this study to convey the meaning shown:

Computer-assisted Learning (CAL)

Refers to the process of delivering learning material through the use of computers with mediation from the teacher.

Conventional Methods of Teaching

This refers to the approaches of teaching of Biology such as lecture, discussion and question and answer methods that do not involve the use of computers.

Attitude

A consistent tendency to react in a particular way often positively or negatively towards any matter.

Self-efficacy

Self-efficacy is one's perceived capabilities for learning or performing actions at designated levels. In this study self-efficacy is the students' perceived likely hood of success, self-drive, enjoyment and personal satisfaction in the learning of Biology.

Retention

Retention refers action of keeping something or of being kept. In this study retention is the ability to recall information or knowledge after a particular period of time.

Biology Lessons

Refers to teaching and learning process in the delivery of biological content.

Achievement

Refers to the status of a learner with regard to acquisition/attainment of biological knowledge, attitudes and self-efficacy measured by set objectives.

Effect

Refers to change that is a result or consequence of an action or any other cause.

Computer software

Refers to a collection of computer programs, procedures and documentation that perform some tasks on a computer system. In this study it is the Computer-assisted Learning Programme (CALP)

Computer laboratory

Refers to a room or space equipped with computers devoted to pedagogical use in an educational institution. In this study it is the room where CAL is presented to the learners.

1.16 Summary of the Chapter

This chapter in the introduction has discussed the back ground of the study. This study observes that there was need for CAL in the teaching/learning of Biology because of the existence of more benefits than challenges associated with it. The statement of the problem gave an indication that there was need to solve poor performance in Biology examinations through CAL. The purpose of the study was to investigate the effect of CAL on secondary school student's achievement in Biology in Kenya. To guide the study the objectives, research questions as well as the hypothesis of the study were stated. The role played by CAL in enhancing the learners' achievement justified the study. Furthermore, the findings of the study will be of benefit to many stakeholders. The assumptions and limitations which underlie the study were given. Schools located in Mt. Elgon sub-county, whose learners were taught Biology by the use of CAL formed the scope of the study. The cognitive theory of multimedia learning (CTML) together with a diagrammatic conceptual framework guided the study. Finally, the terms used in the study were operationalized. In chapter two, review of literature related to this study was presented.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction to the Chapter

The main purpose of this chapter is to review literature related to the effect of computer-assisted learning on secondary school students' attitudes, self- efficacy and retention in Biology. The review of the literature is based on a systematic search of journals, magazines, books, and theses, and from reports of recent international conferences and seminars. The chapter ends with a summary of the literature reviewed.

2.2 ICT Technologies

ICT technologies is an umbrella term that involves any communication devices or applications. There are various educational ICT technologies in use throughout the world;

2.2.1 Audio-based Technology

Audio-based instruction includes radio broadcasts; Interactive Radio Instruction (IRI); one- and two-way audio instruction; and, increasingly, podcasts. Content is designed for students (commonly called radio lessons), and the primary locus of learning is the classroom. Because it is a broadcast technology, new listeners can be brought on board at very low unit costs (Gaible & Burns, 2007). Furthermore, radios and audiocassette and CD players are easy-to-use, widely available technologies, even in the poorest corners of the globe. The Virtual University of Pakistan uses *Virtual University Radio (VUP)—Sound of Knowledge*, a Web-based radio program that

delivers educational and informational content to Pakistani and Kenyan citizens in general (PricewaterhouseCoopers, 2010).

2.2.2 Televisual Technology

As a tool for education, televisual technology is often used to show real teacher-student interactions in the classroom, thus enabling them to observe the management of learning activities. In this respect television *shows* images of teachers and students in action. Television's strengths include the power to engage viewers, to present conceptual information visually, and to show real people doing real things in environments both local and international (Gaible & Burns, 2007). As televisions connect to the Internet directly or through set-top boxes, Blu-ray players, and game consoles, there promises to be an explosion of offerings and formats that, though geared toward consumers in the short term, will undoubtedly impact television as a distance learning mode in the medium and long term. Time-shifting technologies such as digital video recorders (DVRs) allow users to view television programs at a time of their choosing. In addition, place-shifting technologies such as Slingbox, which stream content from home televisions to a tablet, laptop, or phone in another location, allow users to view programs far from home (Economist, 2010).

In 2010 Britain's BSkyB introduced its Anytime+ service, which uses broadband to deliver on-demand programming. BSkyB also allows viewers to share the content of their DVRs. The British Broadcasting Corporation (BBC) and other British broadcasters set up home box sets that unlock the online program stores (Economist, 2010). As this technology expands beyond U.S. and British borders, distance education providers may potentially search the Internet for appropriate topics for

teacher education and call up this content to be viewed by teachers as part of a professional development offering.

2.2.3 Video Technology

A large percentage of instructors and students believe that video adds to the quality of a course, improves understanding of content, and increases learner motivation (PBS & Grunwald Associates, 2010). On the World Wide Web, where video is increasingly stored and viewed, VoiceThread, a free, collaborative multimedia space, allows teachers to post still and moving images and view and comment on video in real time or asynchronously, using a microphone to record comments, type comments, or phone in comments. Like audio and print, video has blended well with the World Wide Web. The Web has made video more flexible, while video has added value to the Web itself. Compressed video streamed via the Internet is now a viable alternative to DVD players, and new television sets such as the Sony Brava can play video directly from Internet feeds to smart phones (Naone, 2010). Because of this convergence, video can now be used for more personalized instruction, while also reaching a potentially mass audience. For instance, at New York University and Carnegie Mellon University, many lecturers videotape their class lectures and post them online for students to access. This system not only allows students to view videos at their own convenience but also, more critically, frees the lecturers up to use class time to offer more personalized, one-on-one instruction, a process sometimes referred to as “flipped teaching” or to offer greater computer-based support (Parry, 2010)

2.2.4 Videoconferencing

Videoconferencing is a set of interactive technologies that allow individuals in two or more locations to interact via full-motion, two-way video, and audio transmissions simultaneously. Videoconferencing can take place through high-end dedicated systems (consoles and remote control video cameras) such as Polycom's Converged Management Application and Cisco's Telepresence system, which use multiple video cameras and high-definition screens, or via low-end Internet-based desktop systems, such as TeamViewer or Skype, in which participants communicate via a built-in or external computer Web camera (Economist, 2010). Videoconferencing is a powerful distance education option, since it approximates face-to-face interactions at a distance. Learners are able to see their colleagues and instructors remotely, discuss topics with them at length, participate in learning experiences that might otherwise have been inaccessible, and view live examples of the types of instruction they should be doing.

2.2.5 Multimedia-based Technology

Multimedia is media that combines a number of content formats: text, audio, full-motion video, still images, animations, or applets. It includes CD-ROMs, DVDs/VCDs, group teaching and learning software (GTLS), computer-aided instruction, intelligent tutoring systems, and digital learning games (both on- and offline).

Multimedia helps individuals learn more effectively and meaningfully through the "dual coding" of information in which the learner processes text and images simultaneously. This dual coding has been shown to aid learners' working memory (Mayer, 2001). The way in which multimedia is stored and viewed is rapidly

evolving. Multimedia used to be accessed and used via commercial CD-ROMs, VCDs, and DVDs that were installed in computers.

Computer-aided instruction (CAI) is instruction by a computer "tutor." Typically used as remediation and enrichment for students. In areas that are geographically remote, mountainous, sparsely populated, or lacking qualified instructors, computer-based training—either via distance learning or via local stand-alone CAI applications—is an attractive professional development option. Indeed, the tutoring component of CAI is essentially its most attractive feature as a distance learning tool.

Digital learning games, in contrast to the larger genre of general computer games, have an explicit educational focus. They are virtual worlds, designed experiences (Squire, 2006) in which learners play some role as they solve problems by learning to think like scientists, historians, journalists, or any other group that employs systematic methods of inquiry and problem framing in order to investigate an issue. They can be CD-ROM- or DVD-based. They can be Internet-based, such as Skoolaborate, EcoMUVE, or Urgent Evoke. They can be played on mobile devices such as portable gaming systems (e.g., the Wii, Xbox or PlayStation), televisions, computers, iPads, and smart phones. Input can be touch-, joystick-, keyboard-, or motion-based. Cumulatively, digital games can be both off- and online, collaborative (multi-user/multiplayer), or solitary learning tools.

Widgets are gaining increasing attention as a stand-alone multimedia tool for teacher education. Widgets reside somewhere between applications ("apps") and full-blown computer programs. A widget is a small, Web-delivered, module of content (a mini-application) that can be easily added to a webpage, social networking profile, or blog—or in some cases run as a stand-alone application on a computer (*Economist*,

2010). Websites such as Widget Box and Kick Apps offer educationally based widgets that can be used in blogs and wikis and allow users to create their own simple widgets.

2.2.6 Established Web-based Technology

The potential of online learning rests on its ability to do the following:

1. Deliver *multichannel instruction* encompassing print, audio, visual, and video-based content

2. Provide multiple formats for text-based, audio, and video-enabled *real-time communication and collaboration* with peers across the globe

3. Offer *"anytime, anyplace" learning*, provided learners have access to the Internet.

Online or Web-based training has been used extensively throughout the globe, mainly in countries that have very good broadband access, high penetration of or access to personal computers, and a critical mass of computer-literate instructors and learners.

Blended or hybrid learning involves a blend of face-to-face and online instruction. As online learning has increased in popularity, so too have blended learning programs and "dual-mode" institutions (Horn & Staker, 2011). Blended or hybrid learning involves a blend of face-to-face and online instruction (Burns, 2011). Horn and Burns (2010) noted that teachers who participated in the blended approach (online learning and face-to-face, school-based coaching) reported higher levels of technology proficiency, better understanding of learner-centered methodologies, and greater

confidence in integrating one computer into the classroom than did teachers who participated in the purely online approach. There are several models of blended learning which require weekly check-ins and an instructor/ teacher. Horn & Staker (2011) identify six models of blended learning that institutions can employ. These include:

- **Face-to-Face Driver Model**: it delivers most of the curriculum and uses online materials to supplement. This model often occurs in a computer lab.
- **Rotation Model**: Students rotate equally between face-to-face and online components of the course on a fixed schedule. They have the same teacher for each component. The online component occurs remotely.
- **Flex Model**: The online component delivers most of the information, with an in-class teacher present to provide flexible support as needed. This model includes lots of individual and small-group, face-to-face tutoring.
- **Online Lab Model**: The online teacher delivers the course in a brick-and-mortar classroom, but with paraprofessional or teacher aides supervising students.
- **Self-blend Model**: Individual students take online courses à la carte. Online learning is remote, but traditional instruction is brick-and-mortar.
- **Online Platform Model**: Instruction and materials are all online, with students taking the course remotely.

Virtual schools, also called cyber schools, are one of the fastest-growing subsets of Web-based learning for students and teachers. These schools are full-time online learning programs in which learners enroll and receive credit. Students must fulfill all course requirements, complete assigned readings, participate in discussions, turn in assignments, and take tests—all online. Teachers design content, communicate with

students, provide lectures, answer questions, check for understanding, grade projects, and assign grades. Another, more individually focused model of online learning is virtual or online tutoring where individual learners interact with an individual tutor in a one-to-one relationship. Teachers interact with students via chat and Web cameras. InTuition is presently developing online labs for physics, chemistry, and biology that will be broadcast online (PricewaterhouseCoopers, 2010).

Online communities They may be part of formal online courses or separate entities having their own organization and server space, such as Australia's me.edu.au, a component of the Educators Network of Australia (EDNA). Or they may be social media sites using a Ning platform such as *Les Professeurs Documentalistes* or Classroom 2.0 (PricewaterhouseCoopers, 2010).

Webcasts are one-way video transmissions in which a presenter or instructor presents audiovisual information via a Web-based platform, such as Elluminate, or via prerecorded video (PricewaterhouseCoopers, 2010).

Webinars, also known as virtual seminars, online conferences, live meetings, web meetings—and sometimes, confusingly, webcasts—are Web-based video seminars hosted by a synchronous live platform or Web-based conferencing system such as Elluminate, Adobe Connect, and WebEx, as well as free, open source platforms such as Big Blue Button123 or free online platforms such as Skype.

Portals are Web-based repositories or clearinghouses of "e-resources" and "e-content" designed to provide one-stop shopping. Alternatively known as intranets, virtual learning environments, limited area search engines, or learning platforms,132 portals typically include instructional materials, lesson plans, worksheets, and

sometimes access to professional development via multimedia applications, online chats, or webcasts and webinars

2.2.7 Emerging Web-based Technology

The World Wide Web is a rapidly evolving medium, Hydra-like in its ability to replenish fading applications (e.g., bulletin boards) with more robust variations of itself (e.g., social media and social networking sites). And the Internet and World Wide Web are still taking shape. Web 2.0 applications and immersive environments, allow users to have both individualized and collaborative learning experiences and tap into the collective wisdom of multiple sets of virtual colleagues and often used in tandem in order to exchange information, build teams, and strengthen team building among virtual partners. They also serve as a channel to provide induction, guidance, and support for new members of an immersive environment (Kopfler, 2009). Examples of some common education-related Web 2.0 tools include the following:

Blogs. Blogs ("Web logs") are online journals usually maintained by one person, though several people can maintain a blog. Typically free, they allow subscribed users to read, comment on existing ideas, and share new ideas. Blogger is an example of a free blogging tool.

Wikis. Wikis are akin to group journals. They allow multiple users to collaboratively create and edit webpages using a Web browser. The best-known example of a wiki is *Wikipedia*. Wikispaces and Wetpaint are free wiki-creation tools.

Media sharing/file sharing. These are sites that allow users to post media (e.g., images and video), tag media, have conversations around media, and form interest

groups. These are also often called “peer-to-peer” or P2P sites. Examples include Flickr and YouTube.

Social media. Social media are Web applications that use simple composition and publishing techniques allowing users to interact and communicate, as in the case of micro-blogging. Examples include Twitter and Facebook.

Social bookmarking. Users annotate websites through “tags,” share Web-based resources, and communicate and form communities around such resources. Examples include Digg, Stumble Upon, and del.icio.us.

Conferencing. Web conferencing sites such as VYew allow users to meet and collaborate in real-time.

Location-based services. Available through the Global Positioning Service (GPS) function of mobile devices, these services or “applications” can be downloaded to smart phones or tablets. They pinpoint a user’s geographic position as well as the position of others, and allow users to send text messages and communicate with one another. Two examples include FourSquare and Scoville. Far more powerful examples are Web 2.0 applications that allow users to view, edit, and use geographical data in a collaborative way from anywhere on Earth, such as OpenStreetMap and Ushahidi.

Data-visualization services. These sites, also available via apps downloaded onto a smart phone, tablet, or computer, allow users to generate, share, and communicate data in a variety of visual formats. One such example is Daytum.

The use of Web 2.0 applications must take place within an explicitly designed learner-centered approach that helps learners understand the importance of constructing knowledge and the importance of being members of an active, online community (Burns & Bodrogini, 2011).

2.2.8 Mobile Technologies for Distance Learning

Users employ phones for all facets of life—recreation, leisure, education, and economic purposes, to name but a few (Donner, 2010).There are a number of mobile or cell phone–based education initiatives throughout the globe, some involving teacher training. For instance, The Indira Gandhi National Open University offers courses on mobile phones to more than 2.5 million students. Mobile phones have been used for learning in Kenya (the SEMA project) via text messaging among teachers. They have been used in South Africa with the piloting of the Math on MXit209 and MobilEd210 programs introduced by the Meraka Institute (Farrell & Isaacs, 2007). Part of this program, *Dr. Math*, involves students sending SMS math questions to math tutors who provide cell phone–based tutoring (Snyman, 2010).

Smart Phones, Simple voice- and text-enabled phones have demonstrated that they can, either alone or in tandem with other forms of distance education, be used as teacher education tools, either to deliver content and instruction, connect teachers to peers and facilitators, and/or provide in-class support mechanisms. Smart phones, which allow users to surf the Internet, download music, use online data services, make calls, and send text messages, are even more promising and powerful. So exponentially powerful are the iPhone and Droid (to name but two smart phone brands) that they are often referred to as “pocket computers.” Virtual School has

launched a set of “meStudying” iPhone, iPad, iPod Touch, and Android apps in Algebra I and reading (Watson, Murin, Vashaw, Gemin, & Rapp, 2010)

E-readers, also known as e-books or digital readers, are slate-like devices that use electronic ink to deliver books digitally; they are designed exclusively for reading. They function just like a paper book: the user can turn pages, skip ahead to the end of the book, annotate sections, and save his or her place with a “bookmark.” Amazon’s Kindle e-reader has gray backlighting, making it ideal for reading in bright sunshine, and a battery that lasts for weeks, or even months. Barnes and Noble’s Nook e-reader is color-enabled. iPad apps such as iBooks have adjustable color background for optimal reading in sunlight and darkness. These e-readers, like the iPad, can access cellular networks that allow the user to download a book onto the e-reader instantly. Other e-readers can access the Internet (Harris, 2013).

RazorBee, is an offline/online media player, it captures online multimedia content and allows users to create custom playlists. The device has five gigabytes of storage; is highly peripheral-dependent; operates via Ethernet cables, USB flash drives, headphones, and microphones; and is controlled by a device that resembles a cross between a cell phone and television remote control. Instructors search for content on the Internet and download multimedia, video, audio, and text files onto the device. They then assemble this material to create lesson playlists to complement the instructional process, adding audio in the local language to enhance comprehension. This playlist can then be broadcast or shared. RazorBee allows teachers with no Internet access to capture and remix Web-based content to be used in their own classrooms (Harris, 2013).

2.3 Information Communication and Technology (ICT) in Education

Many countries in Africa are now struggling with the changing political, social and economic environment. It is evident from developed countries that the modern successful industrial economy is technologically oriented (Ngemu, 2009). ICT has been noted to be a necessary step for developing countries to engage in globalization and the new economy (Clarke, 2011). Institutions such as education institutions also need to devise and implement strategies and policies that will facilitate the achievement of Education For All (EFA) and the Sustainable Development Goals (SDG's). These strategies and policies must embrace information and Communication Technology (ICT) as argued by Ngemu (2009). Hence there is a great need for institutions to have methods and framework for assessing their readiness and progress in adopting and embracing new technology. Further observation made by InfoDev (2013) cited by Ngemu (2009) highlights that ICT is increasingly perceived by developing national governments as the key to improving education and spurring social change and economic development. UNESCO places a strong emphasis on the benefit of ICT in education, and advocates ICT in providing simple tools for information searching, presentation, communication and interactive learning methods (UNESCO, 2012).

In Kenya, learning institutions are under increasing pressure to integrate ICT in teaching and learning given the knowledge and skills needed in the 21st century (MOEST Policy Draft, 2012). Therefore, "ICT-integration should support teaching and learning in the delivery of the various curricula to achieve improved education outcomes, to develop diversified skills needed for industrialization and a knowledge-based economy" (Quality Education and Training for Vision 2030, Kenya). A study

carried out by Kagwiria (2014) on the impact of ICT on education in Kenya noted that the ICT plan of the ministry of education recognizes a current deficit in terms of human resource capacity to lead and support the implementation of the plan. Findings of studies of innovation in educational contexts around the world show that many educational innovations ultimately fail because of too little effort or too few resources as emphasized by UNESCO (2012). School managers play a key role in ICT integration in education. Many teacher or student initiated ICT projects have been undermined by lack of support from the authority (Kagwiria, 2014). For ICT integration programs to be effective and sustainable, education administrators themselves must be competent in the use of technology, and they must have a broad understanding of the technical, curricular, administrative, financial, and social dimensions of ICT use in education.

2.4 Computer-Assisted Learning (CAL)

Computer Assisted Learning (CAL) also called E-Learning refers to learning through the Information and Communication Technologies, as well as computer networks and multimedia. Moore, Dickson-Deane, & Galen, (2011) defined e-learning as being broadly synonymous with instructional technology, information and communication technology (ICT) in education, Education Technology, learning technology, multimedia learning, technology-enhanced learning (TEL), computer-based instruction (CBI), computer managed instruction, computer-based training (CBT), computer-assisted instruction or computer-aided instruction (CAI), internet-based training (IBT), flexible learning, web-based training (WBT), online education, virtual education, virtual learning environments (VLE) (which are also called learning platforms), m-learning, and digital education. E-learning is typically employed as

common term for teaching and initiatives that offer learning material, course communications, and the delivery of course content electronically through technology mediation (Swan, 2003). In usage, all of these terms appear in articles and reviews, in that they refer to the use of modern tools of learning such as computers, digital technology, electronic media, networked digital devices and associated software and courseware with learning scenarios, worksheets and interactive exercises that facilitate learning. However, these alternative names individually emphasize a particular digitization approach, component or delivery method. E-Learning is an interdisciplinary sector of scientific research (Ewing *et al*, 2014). It involves, at the same time, both researchers from education science interested in pedagogical aspects as well as researchers in computer science interested in technologies which allow the delivery of E-learning (Fuccella, 2007). Skrzypek, Potyrala & Walosik (2011) noted that the development of ICT impact on their users and shapes contemporary culture, where they become a source of a variety of learning experiences. These experiences shape the attitudes of technological products to their customers, providing them with patterns of language, aesthetic, axiological and often imposing their own media authorities and the specific communication situation for themselves. Research has shown that media images of reality affect the same reality by defining and imposing its representation. Because of this media culture should become a starting point in the learning process and construct curricula (Ogonowska, 2010). The key feature of CAL is the use of computers in the teaching and learning. This helps to improve student's attitudes, self-efficacy and retention which are the precursors for quality education.

Wioletta, Katarzyna, & Alicja, (2011) acknowledged that the knowledge-based society is a partner in both information revolution and economic globalization. Education, science and technology have become a top priority in building the

knowledge-society. The growing importance of technical means which is present in the process of education makes it necessary to expand the knowledge and skills of using these aids. Technology plays a number of educational functions. Facilitation and speed of communication processes, in the sense of fast moving news and information, stimulate the development of man. They effectively promote the value systems, beliefs and attitudes, especially in children and adolescents. The CAL in education is a learner-centered model where greater responsibility is entrusted on the learner. This implies that in many environments, the traditional instructional means have been incorporated with the newer technologies. This approach, also called blended learning, is more suitable in those environments in which the pedagogical aspect prevails over the pure traditional methods of teaching such as lecture and discussion methods. Blended learning foresees that the frontal lessons are integrated with on-line lessons and with the availability for instructors and learners of synchronous (chat, videoconference) and asynchronous (e-mail) communication tools. Thus, the students will be able to think critically, which in turn will help them achieve success in their examinations and support professional development of learners and teachers in science subjects (Veselinovska, 2014).

However, many researches on the use of ICT in teaching and learning had been done with various outcomes being either positive or negative. Omollo, Indoshi, & Ayere, (2013) studied the attitudes of teachers and students towards use of information and communication technology in the implementation of Biology curriculum in secondary schools in Rachuonyo South district in Kenya. The study found out that teachers and students had positive attitudes towards ICT use in the implementation of Biology curriculum. The positive attitude toward technology by both teachers and learners is a pre-requisite in learning Biology. Computers also give learners an opportunity to

enjoy the doing specified activities in the learning process. Skrzypek, Potyrala, & Walosik (2011) noted that during workshops, computers offered some of the best opportunities of engaging students in learning hence it is necessary to use the media as tools for communicating, learning, acquisition, collection and processing of information. Yapici & Akbayin (2012) investigated the effect of blended learning model on high school students' Biology achievement and their attitudes towards the computer use. The research results revealed that the blended learning model contributed more to the students' Biology achievement than traditional teaching methods did and that the students' attitudes towards the use of computers in learning Biology developed significantly. In a number of studies including those of EL-Deghaidy and Nouby, (2008); Uluyol and Karadeniz, (2009); and Aladejena, (2009) similar findings were obtained. It can be stated that blended learning environment has positive effect on the students' attitudes and these opportunities increased the achievements of the students. Other forms of technology using computers have also been found to be of significant value in teaching Biology, for instance, Vaselinovska (2014) did a study on the use of interactive white board in the teaching of Biology. The study posits that classes beginning by using interactive methods in teaching and using ICT, Internet connection and whiteboard were more exciting and encouraging on students' reflective activities than classes beginning with lecturing. The study further argues that there is need to analyze, revise and modernize the conditions in teaching frames of our educational system. In the times of communication revolution it is necessary that ICT is the catalyst of reforms in education. Yusuf and Afolabi, (2010) confirm this when they did a study on the effects of computer assisted instruction on secondary school students' performance in Biology. They found out that the performance of students who were taught Biology using computer assisted

instructional packages indicated an increased performance than those taught with conventional classroom. These findings point out that computer assisted instructional packages are more superior to the traditional approaches of teaching science such as Biology. This is because the learner is no longer passive in the learning process. These studies are important since they demonstrate that blended learning is effective in education since students using CAL can structure their learning activities and actively learn. If CAL is well structured, it could lead to a high level of motivation that cannot be achieved in the case where traditional approaches of teaching are used in our classes. The findings of this study are in agreement with what other researchers in the area of CAL found out since the learners self-efficacy improved positively.

The need to analyze, revise and modernize the conditions in our education system has lately been closely connected with the tendencies to improve communication; hence it is necessary that ICT should be the catalyst of the reforms in education. It is important to teach specific approaches for using digital images effectively, including having students record observations about what they see and infer what will happen next (Bell *et all*, 2008). Teachers should model effective use of CAL, including providing advance organizers to help students comprehend what they see and how it is connected to the content they are learning and occasionally pausing to ask questions or to point out specific features concerning the topic being covered. The use of computer-assisted learning is intended to enable teachers to facilitate learning more effectively and enhance students' understanding of concepts which are expected to translate into expansion and retention of Knowledge and improved examination outcomes. This study investigated the impact of Computer Assisted Learning on student attitudes, self-efficacy and retention in Biology.

2.5 Self-Efficacy and Achievement

The concept of self-efficacy is defined as a qualification that plays an effective role in shaping behavior and individuals' perceptions of themselves in successfully completing necessary activities by planning these activities to achieve specific performance (Bandura, 1977; Zimmerman, 2000). Bandura, (1997) defined self-efficacy as one's perceived capabilities for learning or performing actions at designated levels. He notes that although self-efficacy is a type of cognition, theory and research support, it can affect other facets of development (e.g., social, emotional, behavioral) and that it is influenced by various personal, social, and contextual variables. According to Bandura, self-efficacy is the belief in one's capabilities to deal with different situations and to perform a certain task required to produce given attainments and this belief is dependent on individual's belief in his abilities. In this context, self-efficacy beliefs affect the individual's choice of activities, perseverance for difficulties, level of his efforts and performances (Ekici, 2012). This belief is also necessary for organizing a certain behavior and realizing that behavior to reach a certain goal (Azar, 2010). Pajares (1996) explained that individuals' beliefs about their abilities profoundly influence the ways in which they will behave. Their behavior influences performance attainment, their environment, and their self-beliefs, which, in turn, influence their subsequent behavior.

Students' self-beliefs help determine many choices throughout their academic career, such as how much time they will spend on a particular task in a course, the relative amount of effort they will expend to achieve complex tasks, and how persistent and resilient they will be when confronting obstacles (Pajares, 1996). Self-efficacy has been found to influence choice of whether to engage in a task, the effort expended in

performing it, and the persistence shown in accomplishing it (Compeau and Higgins, 1995). The greater people perceived their self-efficacy to be, the more active and longer they persist in their effort (Murphy et al., 1989). Clearly, understanding students' beliefs as related to learning science merits further examination. Self-efficacy belief depends on four inter-related sources and this belief occupies an important place in human life (Bandura, 1997). Bandura summarizes the sources as follows: a) Performance achievements or achieved works and reached goals: which is directly related to the individual's own experiences, the success of an individual is the indicator of future successes. b) Vicarious experiences or experiences of other people. Observing the achievements of other people bears the expectation for the individual's own success. c) Verbal persuasion or external support: The expressions of and advice from other people towards the successful realization of a behavior change encourage the individual and can contribute to changes in self-efficacy. d) Motivation processes or the emotional state: The mental and physical well-being of a person affects their potential for the expected behavior.

Learning process is continuous and as such learners require self-efficacy. Self-efficacy belief assists people in how much effort they will exert against difficult situations, how long they will exert efforts in facing difficulties (especially in the learning process) and how they will pull themselves together (Bandura, 1977 and Pajares, 1996). Bandura, (1997) and Schunk, (2001) also assert that Self-efficacy is hypothesized to affect individuals' task choices, effort, persistence, and achievement compared to learners who doubt their capabilities, those who feel self-efficacious about learning or performing a task competently are apt to participate more readily, work harder, persist longer when they encounter difficulties, and achieve higher levels of performances.

Self-efficacy is one of the key variables in the social cognitive theory. Self-efficacy is especially important in learning the subjects that are perceived to be difficult (such as Biology and other empirical sciences) given that students enter courses with varying levels of fear and anxiety. One would predict that students with higher self-efficacy in their ability to understand and apply scientific concepts to real-world situations would be more likely to engage in learning than students with low self-efficacy who may tend to avoid efforts to learn science (McMillan & Forsyth, 1991).

Researchers have conducted studies in order to measure self-efficacy which affects the behaviors and attitudes of teachers and the achievement of the students in various areas, and a large body of research has shown positive effect. Students whose Biology self-efficacy beliefs are at a high level participate eagerly in all the activities about Biology and those expectations which will be obtained in these activities are higher (Ekici, 2012). As a result, students whose self-efficacy is higher like taking challenging tasks, make the difficult duties seem easy by tackling them and behave eagerly than the students whose self-efficacy is low (Ekici, 2012). Sud & Schwarzer (2002) demonstrated that individuals whose self-efficacy beliefs are at a high level make much more effort to succeed in classroom tasks, do not give up when they meet negative situations. On the contrary, they are insistent and patient, they re-arrange themselves up in a short time in face of the difficulties and maintain their loyalties to their aims. Azar (2010) concluded that the main objective of recent reform studies in the field of Science Teaching is the preparation of individuals for the rapidly changing and developing era of science and technology and to enable them to become literate both scientifically and technologically. The success of these reform studies depends on the self-confidence of teachers reflecting the innovations as laid out by these programs to their classroom activities. In other words, it depends on the development

of an influential self-efficacy in the learning process (Czerniak, 1990; Cronin-Jones, 1991; Levit, 2001).

Self-efficacy has been shown to mediate a number of factors, such as academic achievement, perseverance, and self-regulated learning. In geosciences, students who had low self-efficacy but strong academic backgrounds received the same grades as those with high self-efficacy and weaker academic backgrounds (McConnell *et al*., 2010). Another factor that correlates with an increase in self-efficacy is perseverance where students who have higher self-efficacy are more likely to persist in the face of difficulties (Zimmerman, 2000 and Usher & Pajares, 2002). Sawtelle *et al*. (2012) noted this effect when studying gender differences in physics self-efficacy. Seymour and Hewitt (1997) also concluded that perseverance is particularly important for those students who were considering avoiding the sciences. Blue and Tirotta (2011) in their study with university students examined the effectiveness and limitations of the tools that they defined as 21st century tools (blogs, wikis, and interactive board). The results of their study revealed that motivation levels of all the participating students increased. That those who failed to use the 21st century technologies were unable to develop positive attitudes at all. As computer technologies become a crucial part of academic systems, self-efficacy still need research studies to keep investigating these issues. Moreover, various studies point out factors that affect levels of technology use such as experience, age, usage, anxiety, attitudes, and gender as noted by Torkzadeh and Koufterous, (1994).

However, while a large body of research showed positive effect of self-efficacy on academic performance, others did not. One study in Biology education suggested that efforts at improving self-efficacy to affect course performance were ineffective in an

introductory non-majors Biology course (Lawson *et al*., 2007). Also, Azar (2010) compared the levels of pre-service and in-service secondary school science teachers' self-efficacy beliefs relating to science teaching. Azar (2010), analyzed the change of these beliefs according to their demographic characteristics such as gender, the graduate school status, and teaching experience. He concluded that there were no significant difference between in-service and pre-service secondary school science teachers' personal self-efficacy beliefs. Moreover, the self-efficacy beliefs and outcome expectations did not change relating to their gender, teaching experience, but they changed relating to their graduate school status.

Self-efficacy also depends on students' intelligence and abilities. In general, high performing students feel more efficacious about performing well than do low performing students, but self-efficacy is not a direct reflection of students' intelligence and abilities. Collins (1982) identified high performing, average, and low performing students in mathematics. Within each level she found students with high and low mathematical self-efficacy. She tested students on mathematical achievement. Regardless of performance level, students with high self-efficacy demonstrated higher achievement and persistence to complete difficult problems. The research suggested strategies that teachers can use to help promote self-efficacy among learners. Individuals who develop a resilient sense of self-efficacy are well placed for learning.

Self-efficacy has been seen as a construct of perceived confidence in carrying out a given task (e.g., mastering biological content and processes) which will strongly predict acquisition of skills and subsequent behavior, such as motivation to pursue Biology education (Ebert-May, Brewer, & Allred, 1997; Ramey-Gassert, Shroyer, &

Staver, 1996). Students' self-efficacy towards Biology have a characteristic role in their feelings, thoughts and behaviors related to Biology. Because of these reasons, it should be regarded that self-efficacy in Biology and factors affecting self-efficacy have to be emphasized in the process of education. Because there are a few known studies that have examined computer assisted learning in promoting self-efficacy regarding the ability to learn Biology, this research contributes to the field by describing and providing a self-efficacy instrument that will specifically be developed to measure the effect of CAL on secondary school students' self-efficacy.

2.6 Effect of CAL on Self-Efficacy.

Many studies have been done on how self-efficacy can be promoted by CAL. Yu-Hsin, Ju-Tzu, & Deng-Jyi (2012) investigated the effect of multimedia computer assisted instruction and learning style on learning achievement using the high school curriculum entitled "molecules that dominate secret of life" from high school Biology. The results showed that when compared to traditional models of instruction, students using the multimedia computer assisted instruction model scored significantly better in learning achievement assessments. The study suggests that under the multimedia computer assisted instruction model teachers may utilize computers to present certain abstract concepts of the Biology curriculum and various 3D structures that are difficult to present in textbooks. Multimedia computer assisted instruction provides students with specific experiences in observation and simulation. In addition, the interaction of digital learning materials allows students to learn through intuitive and experimental methods, they repeatedly attempt to establish concept and models contained within course content. Therefore students are likely to obtain greater learning achievement and this promotes their self-efficacy.

In another study, Guzeller & Akin (2012) investigated the effect of web-based mathematics instruction on mathematics achievement, attitudes, anxiety and self-efficacy of 6th grade students in Turkey. The results indicated that students in the Web-based mathematics instruction developed positive mathematics attitudes and mathematical self-efficacy than students in the traditional mathematics instruction. Besides, it was found that students' mathematical self-efficacy were quite negative in the traditional mathematics instruction class at the end of study. It can be concluded that Web-based mathematics instruction improves students' confidence in mathematics problem solving, and increases positive attitude towards learning as it also gives students more practice. This helps students better their self-efficacy hence promotes achievement. Biology is a science subject just like mathematics, where it can be assumed that self-efficacy can also be improved by the use of CAL. Students can be presented with challenging problems which will give them more practice and hence provide profound opportunities for learning Biology.

One application of CAL is for teachers to learn the interests and preferences of their students and incorporate these interests into their teaching and learning instruction. This will boost the performance of the low achievers in science subjects. Awofala (2011) investigated the effect of personalized, computer-based instruction on students' achievement in solving two-step word problems. The study found out that personalized computer based instruction was effective in increasing students' performance to solve two-step word problems. It was a catalyst for low-ability student performance to solve arithmetic problems. Teachers of science should learn to incorporate computer-based instruction into their teaching to support students' learning and facilitate their performance.

2.7 Effect of CAL on Attitude towards Science

Attitude towards science can be defined as the feelings, beliefs and values held about an object that may be the endeavor of science, school science and the impact of science and technology on society. Attitude involves the tendency to evaluate something in either a positive way or in a negative way. Attitudes are acquired through experiencing our environment and it is learned in much the same way as skills and habits in our everyday endeavors. Many researchers have investigated the relationship between achievement and attitudes in science. For instance French & Russell (2006) noted a positive correlation between achievement in science and positive attitude towards science.

Other studies have been done on the effect of CAL instructional mode on different aspects of teaching and learning process. Omollo, Indoshi and Ayere (2012) investigated the attitude of teachers and students towards use of information and communication technology in the implementation of Biology curriculum. The study found that both teachers and students had positive attitude towards use of ICT in implementing Biology curriculum. This may lead to improvement of Biology curriculum to suit the needs of the learner and teacher by helping them tackle the areas of difficulty. Some other studies have indicated that CAL in science can improve learning and positively influence student attitude and self-esteem. Sharifah *et al*. (2001) demonstrated that CAL increased not only the students' performance but also their attitude towards science. This means that when CAL instructional mode is used in the preliminary introductory stage in teaching Biology for example, attitude towards science improves hence performance also improves. Veselinovska (2014) used the interactive whiteboard in teaching Biology in the preparation of pre-service

teachers. The results proved that classes beginning by using interactive methods in teaching; using ICT, internet and whiteboard were more exciting and encouraging on students' reflective activities than classes beginning with lecturing. This attracts more attention and motivation among students as compared to oral lecture which is monotonous to students especially the bright students. Obinna (2012) investigated the effect of CAL on secondary school students' achievement and interest in Biology. The evidence from the study revealed that students taught Biology using computer assisted instruction programme showed more interest than students taught using the expository method. The interest is basically due to the positive attitude towards the learning of Biology hence this leads to improved performance.

Prior involvement with computers can also attribute to a more positive attitude towards learning. Bove´e, Voogt, and Meelissen, (2005) investigated computer attitudes of primary and secondary students in South Africa. The study established a positive correlation between computer attitude and computer experience. Those students who had a chance of handling and manipulating computers in other set-ups other than classrooms showed more interest than those who had not come across such an experience before. This fact therefore demarcates learners brought up in settings with more technology in the form of computers, mobile phones, and T.V's among many, from those with little or no technology at all.

Pilli and Aksu (2013) employed a quasi-experimental research design to examine the impact of educational software for mathematics on 4th grade pupils' achievements in mathematics, the pupils' attitudes towards mathematics and computer-assisted teaching and learning as well as the retention of mathematical knowledge. They found that the educational software is an effective tool for teaching and learning

mathematics in the sense that pupils who used the software in the classrooms achieved higher test scores and had more positive attitudes towards mathematics.

As much as many studies found a positive correlation between use of CAL on many instructional approaches, Owusu, Monney, Appiah, and Wilmot (2010) however, found different results. Their study findings concluded that the use of CAI was not superior to the conventional approach. However, they argued that CAL had that ability to improve the performance of low achievers within a class. Moreover, they concluded that CAL had a positive effect on students who showed interest in learning with CAL. Thus, it can be said that CAL can provide new skills in using technology in the learning process for those students who show some interest. These students in the course of using technology will keep making new discoveries about the subject matter and in the process learning takes place. Lack of appropriate training on the use of technology may lead to disuse of computers for learning. Sorgo (2010) carried out a study on information and communication technologies (ICT) in Biology teaching in Slovenian secondary schools. The study found out that teachers had negative attitudes towards computer applications which they did not use. Teachers therefore need appropriate training on computer applications software so as to enable them use it for instructional purposes. Sorgo further pointed out that using CAL in education can be effective for increasing knowledge and achievement in Biology and attitudes towards Biology as well. This makes the computers effective learning tools in the classroom.

2.8 Effect of CAL on Retention

Teachers often encounter difficulties when teaching certain phenomena especially when dealing with abstract concepts. Computers first found their way into the classroom in the early 1960s (Morrell, 1992). Computer use in all its forms appears to

offer almost endless avenues for enrichment of the learner's academic experiences. For science education in particular, the computer appears to be a technological tool which when effectively integrated in instruction, would lead to improvement in student retention of knowledge. Computer assisted learning (CAL) combines text, sound, graphics, and animation to truly and graphically communicate those abstract phenomena that are imperceivable and difficult to be observed in real life. Advocates in favor of CAL have expressed that the use of educational technology in teaching and learning may help learners in putting greater focus on understanding the more difficult and complex concepts (Doerr & Zangor, 2000) as well as help them in developing a conceptual understanding of such concepts (Kebritchi, Hirumi & Bai, 2010). CAL when used properly in the classroom may provide support to the teacher in delivering the course material and help the pupil in mastering the required concepts more easily. Obinna (2012) investigated the effect of CAL on secondary school students' achievement and interest in Biology. The results from the study revealed that students taught Biology using computer assisted instruction programme performed significantly better than students taught using expository method. The trend of high performance by the treatment group could be attributed to better understanding of the contents hence higher retention rates. In a different study, Olga (2008) investigated the effects of computer-assisted instruction on the achievement, attitudes and retention of fourth grade mathematics course among primary pupils in Turkey. The study established that the computer-assisted instruction was effective on the students' retention scores in mathematics lesson specifically on the units: "multiplication of natural numbers" and "division of natural numbers. Yapici and Akbayin (2012) investigated the effect of blended learning model and found that the blended learning model contributed more to the students' Biology achievement than traditional

teaching methods did and that the students' attitudes towards the Internet developed significantly. This supports the use of computers in our classrooms since computers have an effect on long term achievement of learning concepts and retention of the subject content. In comparison with the traditional instruction methods based on texts and graphs alone, the computer assisted learning instruction can further motivate students using a lively approach hence active learning.

2.9 Critic of Related Studies

This chapter highlighted several studies conducted in the light of CAL. Research and anecdotal evidence has confirmed the effectiveness of CAL. Regardless of the challenges, CAL has been shown to be more effective than the conventional approaches of teaching. Studies that have conducted have shown that CAL improved academic achievement (Skrzypeck,Portyrala & Walosik, 2011; veselivovska, 2014; Yapici & Akbayin, 2012; Yusuf & Afolabi 2010). CAL programs are considered as a way to improve students learning outcomes. The debate is no longer on whether or not computers should be integrated into the educational system. Rather, the message of this literature review is on how the use of CAL in teaching and learning impacts the learners' learning academic achievement, attitudes and interests. Science teachers have employed several forms of CAL to help them enhance the learners' outcome. With significant amounts of resources being spent on hardware and software in the classrooms of schools in Kenya, there is an increasing call for accountability on the school administrators, the teachers and the learners on the use of these resources in improving students learning outcomes. Basically this boils down to answering the question whether the use of technology in schools, in general and in classrooms for

both teaching and/or learning, has enabled learners to realize better learning outcomes.

There was conflicting information in the literature review where different researchers came out with different results on the use of CAL on the teaching and learning process. A study conducted by Yusuf and Afolabi (2010) on effects of CAI on secondary school students performance in Biology showed that students who were taught Biology using CAI indicated a higher performance than those taught with conventional teaching approaches. On the contrary, Owusu, Monney, Appiah and Wilmot (2010) conducted a study on the effect of CAI on academic achievement. They established that CAI did not show superior academic achievement to conventional teaching approach. CAL has been shown to have an effect on students' attitudes learning Biology. Studies conducted by Omollo, Indoshi and Ayere (2013) showed that students' attitudes towards use of ICT in the implementation of Biology curriculum in secondary schools showed that students' had a positive attititude towards ICT use and in the implementation of Biology curriculum as a prerequisite for learning of Biology. Another study conducted by Pilli and Aksu (2013) employed quasi experimental design to examine impact of computer-assisted teaching on mathematics on fourth grade learners' attitudes towards mathematical knowledge. They found out that learners exposed CAT had more positive attitudes towards mathematics hence achieved higher test scores. These studies focused on students' attitudes and implementation of Biology curriculum (Omollo et al, 2013) and students attitudes and achievement in mathematics (Pilli and Aksu, 2013). These studies did not consider CAL and how it impacts on student academic achievement, attitudes and self-efficacy in Biology subject.

Studies of CAL and self-efficacy and students' achievement improved significantly. A research conducted by Ekici (2012) established that students' whose Biology self-efficacy beliefs were at a high level eagerly participated in all activities about Biology hence they tackled these activities with ease and succeeding in the learning process. In another study by McConnell et al (2010) established that positive self-efficacy improved academic achievement in geo-sciences. Findings from these studies indicated that positive self-efficacy improved students' academic achievement. It is against this backdrop that these study sort to explore the effect of CAL on secondary school students' attitudes, self-efficacy and retention in Biology subject. Moreover, most of the CAL studies reviewed were done in other parts of the world and hence the study wished to explore a Kenyan scenario in Mount Elgon sub-county.

Long term goals on industrialization as set by vision 2030 may remain theoretical if no action is taken to improve the quality of teaching science in the Kenyan secondary schools. Though most researchers recommend experimental method as the best approach of teaching science subjects such as Biology, inadequate teaching and learning resources have heavily set pressure on their use. This has been occasioned by the ever increasing population in our schools due to the government policy of free secondary education. Therefore the need to use CAL to compliment the conventional methods of teaching is indeed indisputable.

2.10 Summary of the Chapter

Literature was reviewed around the following sub-themes: ICT technologies, information communication and technology (ICT) in education, computer-assisted learning (CAL), self-efficacy and achievement, effect of CAL on self-efficacy, effect

of CAL on attitude towards science and effect of CAL on retention. The chapter ends with a critic of related studies.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction to the Chapter

This chapter discusses the philosophical underpinnings of the research design that was used in this study in relation to other philosophies; expound the research strategy including the research procedures and methods that the researcher used to meet the objectives of the study. It also introduces the research instruments that were developed and utilized in the pursuit of the research goals, and gives an account of the anticipated data analysis schemes. The chapter also explains how validity and reliability of the research instruments were determined. The chapter ends with a chapter summary.

3.2 Research Philosophy

A research philosophy is a belief in which data about a phenomenon should be gathered, analyzed and used. Crotty (1998) posited that a theoretical perspective is the philosophical stance behind the chosen methodology. This is the knowledge claimed by the researcher which affects the way the researcher seeks the truth. Creswell (2003) indicated that researchers start a proposal with certain assumptions about how they will learn and what they will learn during the inquiry. This study adopted pragmatic theoretical perspective. Pragmatism is derived from the work of Peirce, James, Mead and Dewey (Holmes, 1998). The pragmatist epistemology stands in contrast to prevailing positivist (objectivist) and anti-positivist (constructionist and subjectivist) views of scientific discovery (Martin, 1990, Freeman, 1998). Pragmatism proposes to reorient the assessment of theories around a third criterion; the theory's

capacity to solve human problems (Rallis and Rossman, 2010). Pragmatism not only appreciates there is reality that exists independently of the human mind but also appreciates that meaning of that reality is socially constructed. Pragmatism is not committed to any one system of philosophy and reality, but to facilitate human problem solving. To pragmatists, the problem is most important and researchers use all approaches to understand and solve the problem (Grossman and Wilson, 1990). Pragmatist philosopher John Dewey argues that science should overthrow the 'notion' which has ruled philosophy since the time of the Greeks that the functions of knowledge is to uncover the antecedently real, rather than, as is the case with practical judgment, to gain understanding which is necessary to deal with problems as they arise (Powell, 2001). Powell (2001) states that pragmatists maintain true proposition which facilitates faithful paths of human discovery, and should be retained, deployed and improved as long as it is profitable.

In this study, Mt Elgon sub-county has registered low grades in Biology subject for a considerable period of time as stated in the statement of the problem. Pragmatically, the interest of the researcher was to solve the low achievement in Biology using computer-assisted learning as an innovative teaching approach. The philosophy of this study was therefore to ensure the research facilitates the teaching strategy that would result in quality education that would reflect holistic and lifelong learning.

3.3 Research Methodology

Methodology is the strategy, plan of action, process or design lying behind the choice and use of particular methods and linking the choices and use of particular methods to the desired outcome (Crotty 1998). This study will employ mixed methods research methodology. Mixed methods research is where the researcher combines both

quantitative and qualitative research techniques, methods, approaches, concepts and languages into a single study (Creswell, 2003). Mixed methods allow researchers to use multiple approaches in answering research questions, rather than restricting or constraining researcher's choices (Johnson and Onwuegbuzie, 2004). Schofield and Anderson, (1998) and Martens, (2003) identified the following advantages with mixed methods; a) Qualitative research is conducted in natural settings rather than laboratory manipulation. The qualitative researcher often goes to the site (school) of the participant to conduct the research where curriculum is implemented. This enables the researcher to report on the ground. b) Utilizes the researcher as the chief "instrument" in both data-gathering and analysis. It also means that the researcher while observing reflexivity filters the data through a personal interpretive lens that is situated in a specific socio-political and historical moments. c) Emphasizes data which illuminates everyday pattern of action and meaning from the perspective of those being studied. Curriculum evaluation being a political process this will help to reduce illusions and rhetoric as the recommendations will be contextual. d) Tends to focus on social processes rather than primarily or exclusively on outcomes. Qualitative research is emergent rather than tightly pre-figured. It incorporates the emergent themes in the course of the study. This ability to accommodate mutation makes it important in this study because it appreciates there is reality that exists independently of the human mind and appreciating that the meaning of that reality is socially constructed and that is curriculum. e) Employs multiple data-gathering methods that are interactive and humanistic. They do not disturb the site more than it is necessary. f) Uses an inductive approach to data analysis, extracting it's concepts from the mass of a particular detail which constitutes a database. g) Qualitative studies express language and "voice" as it observes polytonality while reporting the findings.

Concurrent triangulation design was used in this study where the focus is on confirming, cross-validating or collaborating findings from a single study (Creswell, 2003). The qualitative and quantitative data were collected concurrently and equal weight was given to the two kinds of data. The pre-test and the post-test yielded quantitative data while on the other hand, the questionnaires yielded the qualitative data. The quantitative and qualitative data ware analyzed separately and integration took place when interpreting the findings.

3.4 Research Design

This is the plan, structure and strategy of investigation of the conceived problem in order to obtain possible solutions to research questions. Quasi experimental was used for this study. A quasi-experiment is an empirical study used to estimate the causal impact of an intervention on its target population. This design typically allows the researcher to control the assignment to the treatment condition, but using some criterion other than random assignment (Dinardo, 2008). Naturally occurring variables are measured within quasi-experiments (Morgan, 2000). Hence quasi-experimental design is used when randomization is impractical and they are easier to set up in their natural settings than experiments in a controlled laboratory set-up. Utilizing quasi-experimental designs minimizes threats to external validity as natural environments do not suffer the same problems of artificiality as compared to a well-controlled laboratory setting (DeRue, 2012). Since quasi-experiments are natural experiments, findings in one may be applied to other subjects and settings, allowing for some generalizations or extrapolation of the results to be made about population. The pre-test post-test design that was used in this study was the Two Group Control Group Design (Shuttleworth, 2009). The principle behind this design involved

randomly assigning respondents between two groups, a control group (A) and a test/experimental group (B). Both groups were pre-tested, and post-tested, the ultimate difference being that one group was administered the treatment as shown in Table 3.1;

Table 3.1 Showing Two Group Control Group Design

Control group (A)	Pre-test	No treatment	Post-test
Experimental group (B)	Pre-test	Treatment	Post-test

The researcher chose this design because it allowed her to compare the final post-test results between the two groups, giving an idea of the overall effect of the treatment. In this study the quasi-independent variable was the computer-assisted learning/treatment. This is the variable that is manipulated in order to test its effect on the retention of Biological knowledge on the experimental group (B). The control group (A) was not treated but subjected to the normal methods of learning. The results of both groups from the post-test were obtained so that the overall effect can be compared. Stratified sampling was used to separate the schools that were equipped with computers from those that were not equipped with computers. Out of the 27 schools in the sub-county, 6 were equipped with computers and 21 lacked computers. The researcher included all the 6 (100%) school equipped with computers to participate in the study, simple random sampling was used to select 6 (30%) other schools out of 21 schools without computers. In total 12 schools participated in the study. In total the study respondents were 946 in the 12 schools where 274 were randomly sampled to participate in the study. The researcher then used simple random sampling technique to assign equal number of respondents between the two groups;

137 respondents for the control group (A) and another 137 respondents for the experimental group (B), from each category making a total of 274 sample respondents. A pre-test was administered to all the participants to determine the cognitive levels of the learners. Treatment was administered to the experimental group who were taught by use of Computer-Assisted Learning Program (CALP) after the pre-test. The control group was taught using conventional forms of instruction such as lecture, discussion and question and answer methods which do not require the computer. A post-test was administered after a period of four weeks. The results obtained from the two tests were analyzed using a T-test inferential statistics to determine the effect of the treatment. The researcher inducted the Biology teachers who participated in the study on the computer software program known as computer-assisted learning programme (CALP) prepared by the researcher that was used to teach the experimental group.

3.5 Study Area

This study was carried out in Mount Elgon sub-county located in Bungoma County in the western part of Kenya, latitude $1^{o}11'26.9664"N$ and longitude $34^{o}25'11.3675"E$ as shown in appendix XIV. It borders Trans-nzoia County to the east, Bungoma west sub-county to the south and Uganda to the west. The local ethnic communities in this region practice subsistence farming as an occupation. The Mt. Elgon region has had a history of violence due to conflict over land rights issues. The last major clashes were 2003-2007, even prior to the Kenyan 2008 post-election violence. Most schools in the region have very limited budgets and facilities due to the lack of viable economic development in the area. The free secondary education (FSE) government funding is only sustains the running of these schools. Although an agriculturally rich locale, the

land clashes have negatively impacted the agricultural production. With a high number of widows and orphans in this region, many students get into difficulty of paying school fees. Girls often drop out of school early, some due to no school fees or lack of family support, but many due to early pregnancies and/or forced marriages (Barmao, 2015). For students in these impoverished regions, education is one way to combat the impact of poverty and begin to provide hope to both students and the community. The researcher carried out research in schools in this area because they had continually performed poorly in Biology in KCSE national examinations (KNEC, 2013), and intended to explore the possibility of improving the performance in national exams. Also Mt. Elgon is a rural setting where most students from the region do not access educational digital devices hence this study gave an insight into the importance of equipping the secondary schools with computers for learning. The study area had 27 secondary schools in total.

Many researches that have been carried out in the area have focused on the external problems facing the teaching learning process. For example, Moikut (2011) investigated the impact of land clashes on access to primary and secondary education in Chepyuk settlement scheme, Mt Elgon district. He noted that the clashes completely grounded teaching and learning in the region during the clashes. Nasongo & Muola (2011) also investigated the effect of inter-tribal post-election violence conflict trauma on academic performance among secondary school students in Mt. Elgon district. Their study recommended trauma counseling to be entrenched in the school system since they found out that a large percentage of students were largely affected. Barmao (2015) focused on the effect of early teenage pregnancy on dropout rates in Chepkurkur in Mt. Elgon. Mt Elgon has not had serious attention in terms of academic growth for a length of time both in pre and post-independence period. Since

all parts of the country should have equal growth in all dimensions, then they should be facilitated to do so. Hence this study will investigated the effect of CAL on secondary school students' attitudes, self-efficacy and retention in Biology. This will ensure that Mt Elgon like any other region in this country conforms to international goals of education for all (EFA). Currently research studies worldwide are not trying to answer the question whether or not to integrate computers in Biology education, most of them are focused on the answer of how to utilize computers to maximize the students' learning. Unfortunately there has not been any research on the integration of technology in Mt. Elgon. Mt. Elgon should not be left out of these new developments and changes in educational technologies. The region can be left out if nothing is done to alleviate the situation. It should be ensured that it gets quality education which can only be determined and guided by research hence the choice.

3.6 Target Population (Study Population)

Borg and Gall (1996) defined target population of study as all the members of a real or hypothetical set of people, events or objectives to which the researcher hopes to generalize the results of the research study. On the other hand, Best & Bell (2003) defined the target group of study as any group of individuals who have one or more characteristics in common that are of interest to the researcher in the study. The population which was under investigation comprised all forms three Biology students in secondary schools and teachers of biology of Mt. Elgon sub-county. The region under study had 27 secondary schools which had 946 students of Biology, from which a sample of 274 respondents were selected to participate in the study.

3.7 Sampling Techniques

This study employed both stratified sampling and simple random sampling techniques. In stratified sampling, researchers obtain stratified samples by dividing the population into groups called strata according to some characteristics that is important to the study, then sampling from each group, (Bluman, 2012). The samples within the strata were then randomly selected. The study area has a total of 27 secondary schools. Stratified sampling technique was used to select secondary schools which were equipped with computers for learning computer studies together with other subjects Biology included. The sub-county has six secondary schools that were equipped with computers for learning and 21 secondary schools did not have computers. The study included all the 6 secondary schools equipped with computers in the study. Simple random sampling was used to select six out of 21 schools without computers. This was done by writing the names of the 21 schools on different pieces of paper. The pieces of paper were mixed up in a container and then six pieces of papers were randomly picked. The names of the schools on these six pieces of paper were those that were used in the study. A total of 12 secondary schools participated in the study. At school level, the researcher used simple random sampling technique to select 274 respondents who participated in the study. The researcher assigned the subjects into two equal groups; 137 respondents for the control group (A) and another 137 respondents for the experimental group (B), making a total of 274 which was the sample size. Also, 12 Biology teachers in the secondary schools that participated in the study administered the teaching methodology as per the requirement of study. Teachers of Biology in schools with computers were interviewed on their views regarding CAL.

3.8 Sample size

Neuman (2000) argues that the main factor considered in determining the sample size is the need to keep it manageable enough. This enables the researcher to derive from it detailed data at an affordable cost in terms of time, finances and human resource. The study area (Mt. Elgon sub-county) has a total of 27 secondary schools. Stratified sampling technique was used to group secondary schools to those with computers and those schools without computers. Schools equipped with computers for learning were six in number and those without computers were 21. All the six schools (100%) with computers participated in the study. The 6 schools were few hence all were selected to participate in the study. Simple random sampling technique was used to select other six schools out of 21 schools without computers which participated in the study. A total of 12 schools were selected and participated in the study.

Out of the 12 schools, simple random sampling technique was used to select 274 respondents based on Krejcie & Morgan (1970) table for determining sample size for research activities from a target population of 946 form three Biology students, as shown in appendix XI. The respondents were form three students selected from the study population. Teachers of Biology that were interviewed were six, drawn from schools with computers. Their responses helped triangulate data obtained from the student questionnaires.

Table 3.2: Showing Sampling Frame

Category	No. of Schools	Schools Selected	Sample size
With Computers	6	6	137
Without Computers	21	6	137
TOTAL	**27**	**12**	**274**

Source: Researcher, 2016.

3.9 Variables of the Study

The study had independent, dependent and extraneous variables. The independent variable in this study was the computer-assisted learning. This is the variable that was manipulated and its outcome was measured on attitudes, self-efficacy and biological knowledge retention which were the dependent variables. There were other variables not being studied but may have affected the outcome of the study (intervening variables) include; Teacher computer literacy, Sources of power (energy), Computer malware and Computer software (program).

3.10 Treatment Procedure

CAL in this study entailed teaching learners in the experimental group by the use of CAL programme while the control group was taught by the conventional approaches of teaching. A test was used to test the retention of biological knowledge amongst the two groups hence determine the learners' achievement of biological knowledge. A questionnaire was then administered after the treatment to determine the learners' attitudes and self-efficacy. However, there are intervening variables that are likely to affect the outcome of the study. First is the teachers' approach of teaching which is largely affected by training. This largely depends on the teachers' preparedness on whether the teacher will employ lecture method or go for methods that involve the

learner in the learning process during the CAL lesson. Secondly students' socio-economic status would determine the interaction of the learners with the digital content. Lastly infrastructure in terms of electricity would actually determine the availability of the digital content in schools.

3.11 Data Collecting Instruments

Data was collected from primary sources. Primary sources basically include data from the questionnaires filled by respondents, interview schedules and the tests (pre-test and post-test).

3.11.1 Questionnaire

The main research instruments used were the questionnaires shown in appendix VII . Data was collected by use of closed ended questions in order to promote effective quantification and to enhance data analysis. The questionnaire is a convenient tool especially where there are a large number of respondents to be handled because it facilitates quick and easy derivation of information within a short time (Borg & Gall, 1989). The questionnaire consisted of items to answer the research questions. The respondents for the questionnaire were the Biology students. The researcher used self-administered questionnaire with the help of research assistants who were the Biology teachers in the sampled schools as it took a short time. The questionnaire for the students consisted of two parts; the first part had the items on attitude and the second part consisted of items on self-efficacy.

An attitude and self-efficacy questionnaire was designed to collect data for purposes of answering the research questions. The attitude questionnaire had eight statements while the self-efficacy questionnaire had twelve statements in the form of closed

ended questions to be responded to by the learners. The matrix questions were interpreted using the Likert scale with the keys assigned values. Numerical scores were assigned to five response options given to each item on the attitude scale. For positively stated items, the score values were assigned as follows:

Strongly Agree (SA) = 5,

Agree (A) = 4,

Undecided (UD) = 3,

Disagree (D) = 2 and

Strongly Disagree (SD) =1.

However, for the negatively stated items, the scoring was reversed and scores assigned as follows:

Strongly Agree (SA) = 1,

Agree (A) = 2,

Disagree (UD) = 3,

Disagree (D) = 4 and

Strongly Disagree SD = 5.

The data was then keyed into SPSS data editor for analyses.

3.11.2 Interview Schedules

Interview schedules shown in appendix X, were used for Biology teachers so as to make results obtained using the student's questionnaire more meaningful and establish reliability of what was stated by the respondents in the student's questionnaire. This method was appropriate because of its flexibility as it permitted issues to be probed and rejoinder questions to be added for clarification. This helped the researcher to meet the objectives and answer the research questions effectively. The researcher created a suitable friendly environment where the respondent would answer the questions freely.

3.11.3 Computer Assisted Learning Achievement Test (CALAT)

Test examination was also another main research instrument. Retention of Biological knowledge was tested or measured by the use of a Computer-assisted learning achievement test (CALAT). The test consisted of two sections; a pre-test and a post-test each comprising of short answer questions and structured questions as shown in appendix IX. The test was developed by the investigator and drawn from the form three syllabuses on the topic classification. The test was presented to the respondents by their teachers in their respective schools. The post-test was administered at the end of four weeks instruction. Four weeks period between the pre-test and post-test was to ensure that the effects of the pre-test did not interfere with the results of the post-test. Two groups of students were established where one group was the control group (A) and the other group was the experimental group (B). All the students were first pre-tested to determine their cognitive abilities. Then the experimental group was taught using the CAL (treatment) while the control group was taught by use of the conventional methods of teaching such as lecture method, discussion method and the

question and answer method which do not involve the use of a computer. A post-test examination was administered after a period of four weeks to test the learner's retention of the knowledge learned during the experimental period. The scores obtained from the two test examinations were subjected to statistical analysis by use of SPSS version 20 and Excel computer programme.

3.12 Piloting

A pilot study was conducted to determine the construct validity, quality of the individual questions and estimated reliability of the test. This was to ensure the research instruments fully addressed the objectives of the study. In addition, the aim of the pilot study was to validate the research instruments as well as rehearse related logistical arrangements of the main study. A pilot study was done in two schools in Trans-nzoia County which had similar settings as the schools in Mt. Elgon sub-county. The characteristics of the pilot group were similar to the population of the form three Biology students but did not form part of the sample selected for the study. The responses of the participants were checked against the research objectives. For a research instrument to be considered valid, the content selected and included in the questionnaire must be relevant to the variable being investigated (Kerlinger, 1978). Triangulation was also used as a way of reducing uncertainty of interpretation of results, as a form of cross-checking as recommended by Nkapa (1997). This helped improve the efficacy of the instruments.

The pilot study showed that the chances of getting questionnaires returned increased significantly when a teacher in the sampled schools was entrusted to take charge of the exercise. The response rate for the questionnaire was 100%.

3.13 Validity and Reliability of the Research Instrument

3.13.1 Validity of Research Instrument

Validity is an important key to effective research. Validity is a requirement for both quantitative and qualitative research. While earlier versions of validity were based on the view that it was essentially a demonstration that a particular instrument in fact measures what it purports to measure, more recently validity has taken many forms. For example, in qualitative data validity might be addressed through the honesty, depth, richness and scope of the data collected the participants approach, the extent of triangulation and the objectivity of the researcher (Winter, 2000). In quantitative data validity might be improved through careful sampling, appropriate instrumentation and appropriate statistical treatments of the data. It is impossible for research to be 100 percent valid; that is the optimism of perfection (Cohen, Manion & Morrison, 2004). Patton (2002) argues that validity is a quality attributed to propositions or measures to the degree to which they conform to established knowledge or truth. Validity therefore refers to the extent to which an instrument can measure what it was intended to measure and the extent to which an instrument poses the right questions in terms of accuracy. The instruments were rated in terms of how effectively they sampled the significant aspects of the purpose of the study. This study relied on face and content validity procedures to establish that the instruments will measure what they were intended to measure. The face and construct validity of the instrument were determined in two ways.

First, the researcher discussed the items in the instrument with the supervisors, peers and lecturers in the research content area at the University of Eldoret. The purpose was to rid the instruments of unclear direction, vocabulary and sentence structures

that might have been too difficult, poorly constructed items, improper arrangements of items and ambiguous test items inappropriate for the outcomes being measured. Advice given, suggestions, clarifications and other inputs helped the researcher to revise and make changes in the items in the instruments.

Secondly, a pilot study was conducted to determine the construct validity, quality of the individual questions and estimated reliability of the test. This was to ensure the research instruments fully addressed the objectives of the study. The response rate for the questionnaire was 100%. The students' feedback helped improve the quality of the questionnaires in terms of content coverage in addition to content validity.

3.13.2 Reliability of Research Instrument

Reliability is a measure of the degree to which a research instrument yields consistent results after repeated trials (Neuman, 2000). Reliability is a quality attributed to proposition or measures to the degree to which they produce consistent results. An attitude scale is considered reliable, for example to the degree to which the same respondents, or very similar respondents, acquire the same or very similar score upon repeated testing. According to Creswell (2003), the reliability of an instrument is the measure of the degree to which a research instrument yields consistent results or data after repeated trials. In order to measure the consistency of the results from the research, a pilot study was carried out where the test–re-test method was used. The questionnaire was administered twice within an interval of two weeks. This established the extent to which the questionnaire elicited the same responses every time it was administered. The reliability of students' questionnaire was determined by use of Cronbach's alpha formula for internal consistency of the instruments and a Cronbachs' alpha of 0.762 was obtained. The value obtained indicates a high degree

of reliability of items in the instrument. Gay (1987) recommended $\alpha \geq 0.7$ threshold to be accepted in a study.

3.14 Administration of Research Tools/Instruments (Data Collection)

The researcher obtained research authorization from the National Commission for Science, Technology and Innovation (NACOSTI), through the University of Eldoret office of post graduate studies before proceeding to collect data in the field. A research permit to carry out research in the selected schools was availed. The researcher then proceeded to the county commissioner's office and county director of education in Bungoma for research authorization letters. The researcher then purposively selected the schools that participated in the study, for the purpose of selecting population sample. The researcher then wrote a letter to the various school principals of the schools selected for the study to request their students and teachers take part in the study. The researcher administered students' questionnaires directly to the respondents to clarify the purpose of the study, besides seeking further clarification from teachers regarding some of the responses by the use of interview schedules. The test was administered by the Biology teachers in the various schools that were sampled for the study. The test consisted of a pre-test and a post-test that was developed by the researcher and administered to all the sampled respondents in the study. Treatment was given to the experimental group; the researcher inducted all the Biology teachers in the selected schools participating in the study on how to administer the treatment to the experimental group. The researcher also developed a computer-assisted learning programme (CALP) through a power-point computer software, which was used to teach the experimental group. The control group was taught by conventional methods such as lecture method, discussion method and the

question and answer method which did not involve the use of a computer. The pre-test and post-test were given at intervals of four weeks and the scores obtained were recorded for analysis. The post-test was administered after four weeks to test for the retention of the Biological knowledge.

3.15 Data Processing

The raw data was collected, compiled and analyzed using the statistical package for social scientists (SPSS) version 20 and Microsoft Excel statistical package. Quantitative data was analyzed using descriptive statistics: frequency counts, percentages, means, standard deviations and the relevant graphical representations to analyze data obtained from questionnaires. On the other hand qualitative data was analyzed using inferential statistics (t-test), to test for retention of knowledge in pre-test and post-test examinations.

3.16 Ethical Considerations of Study

Knowledge acquired through research should uphold human dignity. The major ethical issues of concern and of the researcher's responsibility in this study included; informed consent as approved by the school principal, privacy, confidentiality and anonymity of the respondent. The researcher informed the participants of the purpose of the research and that participation in the research was voluntary as expressed by Bera (2004). The informants or respondents were assured that their views would be kept confidential during and after the study and that their identity would remain anonymous. The researcher also ensured that the informant did not disclose his or her name anywhere in the course of the study. Any situation that would intimidate or embarrass the participants was avoided, for example, students' scores in the pre and

post-test were not disclosed as it could demoralize both students who scored low marks as well as their teachers. The researcher also assured the respondents of the accessibility of the research outcome in case there was any who was interested. The researcher also avoided plagiarism and carried out research as stipulated.

3.17 Summary of the Chapter

This chapter started by explaining the research philosophy, the pragmatist approach that guided the study. A mixed method design which comprises of qualitative and quantitative approaches was the methodology employed in the study. The quasi-experimental design which employed the two group control group design was applied. The study area was in Mt. Elgon sub-county in Bungoma County. The study targeted the 946 Biology students and all the teachers of Biology in the county. The sampling techniques employed included stratified and simple random sampling techniques. The study sample size used was 274 students and six teachers. The independent variable in the study was CAL while attitudes, self-efficacy and retention were dependent variables. Data was collected by use of questionnaires, interview schedules and a test examination. The instruments used to collect data in the study were discussed with the supervisors and piloted to determine their validity and reliability. Finally data collection procedures, data analysis and research ethical issues were pinpointed in this chapter.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION OF THE FINDINGS

4.1 Introduction to the Chapter

This chapter presents the analysis of the data collected, interpretation and discussions of the findings based on and in view of the stated research objectives. Data collected was analyzed using both descriptive and inferential statistics. For descriptive statistics, frequencies and percentages were used to present the study findings, and for inferential statistics independent samples t-Test were used to test hypotheses at α=0.05 level of significance.

The analysis examines the following research questions:

1. What is the difference in retention of biological knowledge between learners taught by Computer Assisted Learning (CAL) and those taught by traditional approaches of teaching?
2. To what extent does computer-assisted learning (CAL) influence secondary school students' attitudes towards biological knowledge?
3. What is the influence of computer-assisted learning (CAL) on secondary school students' self-efficacy?

In order to effectively deal with each research question, the analysis of the data findings are presented under different headings according to research objectives and related research questions.

4.2 Demographic characteristics of the respondents

4.3 Computer-assisted learning and students retention of biological knowledge

4.4 Computer-assisted learning on students attitudes towards biological knowledge

4.5 Computer-assisted learning on students self-efficacy in Biology

4.2 Demographic Characteristics of the Respondents

4.2.1 Gender

The data analyzed in table 4.1 indicates the frequency and percentage distribution of students' gender, frequencies and percentage distribution of the study participants.

The study sample comprised of 274 (N=274) respondents. They were further divided into two groups, 137 respondents for the control and 137 experimental groups. The table 4.1 shows the frequencies and percentages of the respondents' gender.

Table 4.1: Frequency distribution of Gender (Male / Female)

Gender	Frequency	Percent
Female	106	38.7
Male	168	61.3
Total	274	100.0

Source: Researcher, 2016

The data in Table 4.1 indicated that a total of 274 respondents sampled participated in the study. The respondents that were sampled out in this study comprised of 168 males (61.3%) and 106 females (38.7%) students. A total of 274 (100%) respondents

from the sampled secondary schools completed and returned the questionnaires. In this study there were more males (168) than females (106) who participated in the study as shown in Figure 4.1. This could be attributed to the simple random sampling technique used where the researcher did not have a direct influence on the selection of the study respondents. The information in table 4.1 was drawn on a pie chart as shown in figure 4.1:

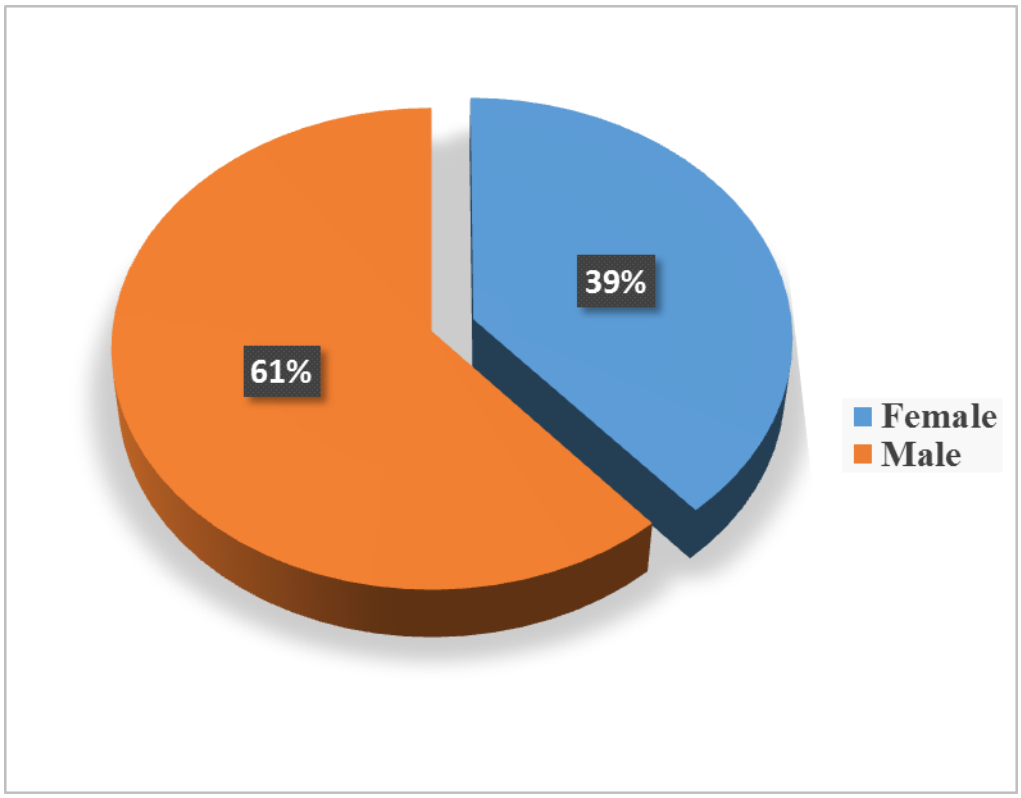


Figure 4.1: Frequency distribution of Gender

Source: Researcher, 2016.

The figure 4.1 show the percentage of males (61%) and females (39%) who participated in the study. From the Figure 4.1, there were more boys in the sample than girls since the sample was selected by simple random sampling technique.

4.2.2 Familiarity with Computer applications

The study was designed to establish the level of computer literacy skills among the respondents. The questionnaire used comprised a Likert scale in which the respondents were required to indicate their level of familiarity with computer applications that were indicated. The respondents were supposed to put a tick on the response that best explained their belief. The responses were; Not at all, Small extent and Large extent. Table 4.2 gives a summary of their responses.

Table 4.2: Students' familiarity with Computer Applications

	Application	Not at all	Small Extent	Large Extent	Total
1	Word processing (Ms. Word)	182(66.4%)	78(28.5%)	14(5.1%)	274(100%)
2	Databases (Ms. Access)	243(88.7%)	21(7.7%)	8(3.6%)	274(100%)
3	Spread sheets (Ms. Excel)	230(83.9%)	28(10.2%)	16(5.8%)	274(100%)
4	Presentation (PowerPoint)	229(83.6%)	39(14.2%)	6(2.2%)	274(100%)
5	Web browser (internet explorer, Mozilla Firefox, Opera)	123(44.9%)	80(29.2%)	69(25.9%)	274(100%)

Table 4.2 shows that a majority of the respondents were not familiar with most computer applications. For instance, 182 (66.4%) were not familiar with word processing which is considered the basic package with only 14 (5.1%) who said they were comfortable to handle it. This indicates that the respondents may not have been introduced to computer usage before. However, a good percentage 69 (25.9%) seemed to be more conversant with the Web browser applications possibly due to the applications used in the mobile phones they handle in their day to day life.

4.3 Computer-assisted Learning and Retention of Biological Knowledge

The first objective sought to investigate the effect of computer-assisted learning on students' retention of biological knowledge in the teaching and learning process. The respondents who participated in this study were 274 form three secondary school students drawn from 12 secondary schools in Mt. Elgon sub-county. The procedure for testing the respondents consisted of three stages;

1. Pre-testing to assess the learners' cognitive abilities
2. Experimental treatment and
3. Post-testing to assess the change in the learners' achievement in biological knowledge.

The instrument used for the study comprised a Biology achievement test (CALAT). The content used for testing the subjects was drawn from form three syllabus on the topic classification. The pre-test and post-test consisted of two sections each; short answer questions and structured questions constructed by the researcher. The post-test was administered four weeks after the instruction period. The respondents were divided into two groups; the control group (A) and the Experimental group (B). The experimental group which comprised of 137 respondents was drawn from secondary schools in the region that were equipped with computers. The control group also comprised 137 respondents that were drawn from the same region but from schools without computers.

4.3.1 Pre-test Scores

The researcher administered a pre-test to both groups at the beginning of the research period. The results obtained were as follows:

Table 4.3: Student's Mean and Standard Deviation in Pre-test

	Type of Group	N	Mean	SD
Pre-test Score	Control Group	137	50.09	11.532
	Experimental Group	137	49.09	11.414

Table 4.3 shows the means and standard deviations of the control and the experimental group during the pre-test. The mean score recorded by the control group during the pre-test was 50.09% while that of the experimental group was 49.09%. This means scores had a mean difference of 1.00. This information was drawn on box plots as shown in Figure 4.2.

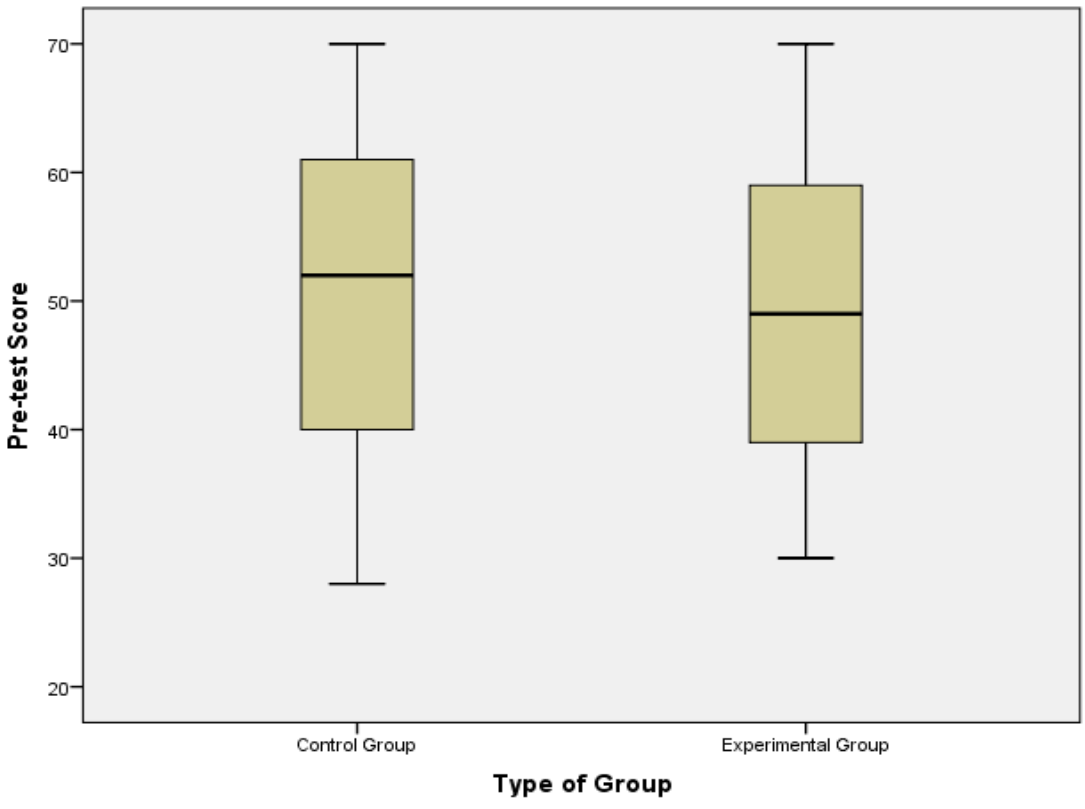


Figure 4.2: Pre-test Scores (%)

Figure 4.2 contains boxplots which help to visualize the distribution of scores for both the experimental and control groups. The thick black line in the middle of the

boxplots represents the means. The lower and upper boundaries of each box represent the 1st and 3rd quartiles respectively. The extreme lower and upper ends represent the least and highest scores respectively. From figure 4.1 it can be seen that the distribution of the scores in the box plots of the control (50.09%) and experimental (49.09%) groups was almost the same.

The researcher further subjected the pre-test scores of the control and experimental groups to a t-test to determine the equality of their means. The results were as presented in table 4.4 as follows;

Table 4.4: T-test for Equality of means in Pre-test

	t-test for Equality of Means						
	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Pre-test Scores	0.721	272	0.471	1.000	1.386	-1.729	3.729

Table 4.4 contains the results of a t-test that was comparing the mean scores of the pre-test between the control and experimental groups. The p-value that was obtained is 0.471. Since the p-value is greater than 0.05, it was inferred that there was no significant difference in the means of the control and experimental groups. It was therefore concluded that students were of equal ability which was a necessary condition for the research to have proceeded.

4.3.2 Post-test Scores

After pre-testing the learners, the researcher administered treatment to the experimental group who were taught by the use of Computer-assisted learning while

the control group were taught using the conventional methods such as lecture, discussion and the question and answer method for a period of four weeks. At the end of the treatment period a post-test was conducted to the same respondents to test for the retention of knowledge. The results are illustrated in Table 4.5.

Table 4.5: Students' means and standard deviation in Post-test

Type of Group	N	Mean	SD
Control group	137	53.30	9.916
Experimental Group	137	66.64	9.855

Table 4.5 contains the means and standard deviations of the scores during the post-test for both the experimental and control groups. The mean score of the control group was 53.30% while that of the experimental group was 66.64%. It was observed that both post-test means in the control and experimental groups improved from the previous pre-test means as shown in Table 4.6.

Table 4.6: Pre-test Post-test Mean Deviations

Type of Group	Pre-test Mean	Post-test Mean	Mean Deviation
Control group	50.09	53.30	+3.21
Experimental Group	49.09	66.64	+17.55

Table 4.6 showing the mean deviation

The information presented in Table 4.6 can be interpreted that both CAL and the conventional methods of teaching had an effect on the overall mean achievement of the learners. In this study it was observed that the means of both the control and experimental groups improved. The experimental group improved because of the treatment given. The control group improved possibly due to the fact that the respondents were aware that they were participating in a study and their teachers

could have improved in the content delivery. Worth noting is that the improvement in the experimental group is higher than the control group. This information was further drawn in box plots as shown in Figure 4.3.

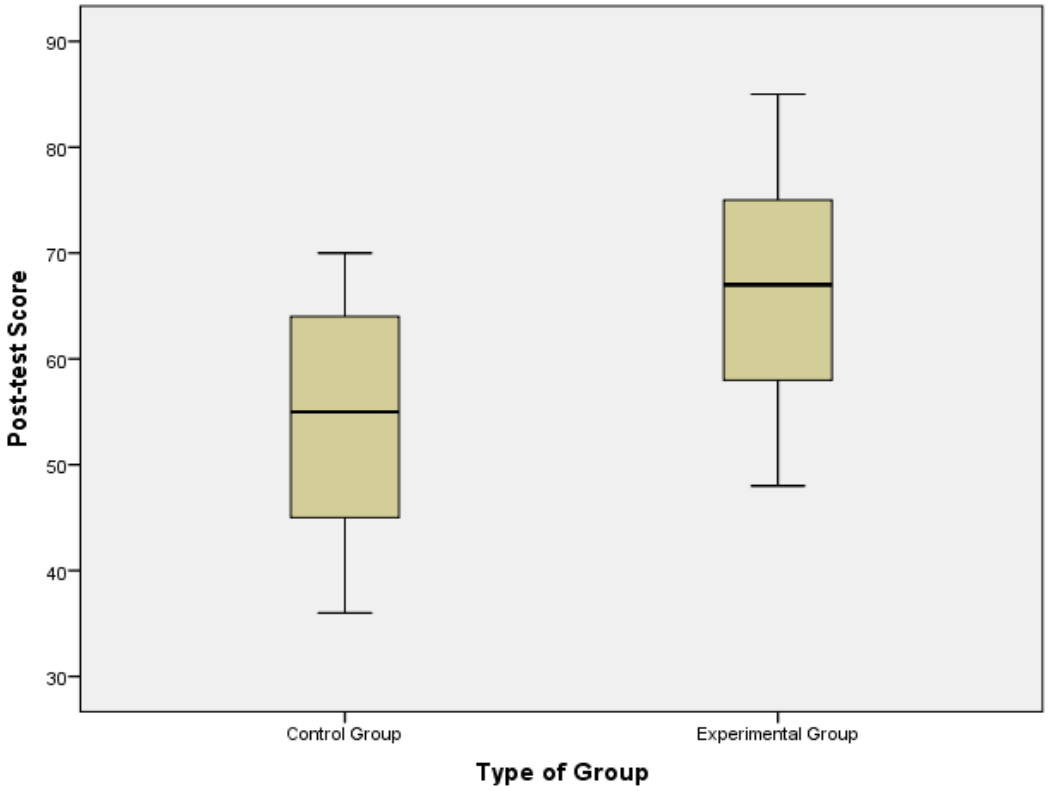


Figure 4.3: Post-test Score (%)

Figure 4.3 contains boxplots which indicate the distribution of scores for both the control and experimental groups. In relation to figure 4.2 we can visualize that there is a difference in the control group and experimental group scores. For instance, the mean of the experimental (66.64%) group is far higher than that of the control group (53.30%).

4.3.3 Hypothesis Testing

The first hypothesis (HO_1) of the study stated that: There is no significant difference in the retention of biological knowledge between learners taught by computer-assisted learning and those taught using conventional approaches of teaching. This was done by conducting a t-test on the post-test scores. The results are shown in Table 4.7

Table 4.7: t-test for equality of means in Post-test

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Post-test Score	-10.33	272	.000	-12.336	1.194	-14.487	-9.984

Table 4.7 contains results of a t-test that was carried out after a post-test had been administered to the respondents. The p-value that was obtained was 0.000. Since, the p-value was less than alpha at 0.05, the null hypothesis was rejected. Hence, it was concluded that there was sufficient evidence to reject the null hypothesis since there was a significant difference in the retention of knowledge between learners taught by computer-assisted learning and those taught using conventional methods. Moreover, the mean score of the experimental group was higher than that of the control group. This implies that CAL (treatment) was more effective as compared to the conventional methods of teaching.

Table 4.8: Comparing pre-test and post-test means for the experimental group

		Mean	N	Std. Deviation
Experimental Group	Post-test Score	66.64	137	9.855
	Pre-test Score	49.09	137	11.414

Table 4.8 contains the means and standard deviations for the experimental group comparing pre and post test scores. The post-test mean score was 66.64 while that of the pre-test was 49.09. A t-test was carried out to establish whether the mean scores were different. The results were as shown in Table 4.9.

Table 4.9: t-test comparing pre-test and post-test means for the experimental group

Experimental Group	Paired Differences					t	df	Sig. (2-tailed)
	Mean	SD	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Post-test Score - Pre-test Score	17.540	16.291	1.392	14.788	20.293	12.602	136	0.000

Table 4.9 contains the results of a t-test carried out to establish the difference in means for the experimental group comparing the pre-test and post-tests scores. The p-value that was obtained was 0.000. Since the p-value was less than 0.05, it indicates that the pre-test and post-test means were different. The post-test mean was greater than the pre-test mean. The overall mean deviation for the experimental group (+17.55) was far much greater than the overall mean deviation for the control group (+3.21) as depicted in Table 4.10.

Table 4.10: Pre-test Post-test Mean Deviations

Type of Group	Pre-test Mean	Post-test Mean	Mean Deviation
Control group	50.09	53.30	+3.21
Experimental Group	49.09	66.64	+17.55

Table 4.10 showing the mean deviation

The results in Table 4.10 led to a conclusion that computer-assisted learning was more effective in improving the students' retention of biological knowledge and consequently their scores as compared to the ones obtained using the conventional methods in the teaching of Biology.

4.3.4 Discussion of the Findings

The results of this study are in agreement with what other researchers in the area of computer-assisted learning found out. The experimental group significantly outperformed the control group in a study where computer-assisted learning was used in the instruction of fluid flow physics, (Kapting'ei, 2008). In addition, Mubichakani (2013) found out that computer-based learning in Mathematics improved achievement and motivation among boys and girls in probability topic. He then postulated that at secondary school level learners developed greater understanding of many of the Mathematical concepts due to the interactive nature of computer-based learning. Obondo (2013) investigated the effect of video in teaching of landforms in Geography on attitude and academic achievement in secondary schools in Homabay district. He concluded that learners taught landforms using video registered greater achievement as compared to their counterparts who were taught by conventional methods of teaching. On the other hand CAL has also been found to improve mastery of concepts in Biology. According to Chebotip (2013) who investigated the effect of CAL on

mastery of the concepts in the topic mutations among learners in secondary schools, established that there was greater mastery of concepts which resulted to greater achievement among the learners taught by computer-assisted learning. Therefore this study has endeavored to establish that CAL is effective in the improving learner's achievement in Biology. The findings of this study supports Mayers' cognitive theory of multimedia learning (CTML) used in the conceptual frame. The theory states that people learn more deeply from words and pictures than from words alone (Mayer, 2001). This study enlightens teachers of Biology to utilize CAL in the teaching and learning of Biology to improve achievement.

However, the findings of this study are in disagreement with what other researchers in this field found out. Smith & Hardman (2014) carried out a study on the impact of computer immersion on performance of school leavers Senior Certificate mathematics by comparing performance between two groups: a control and an experimental group. Their findings indicated that there was no significant difference between the final Senior Certificate mathematics results of the schools with the computers and those without. This suggests that there were other variables which strongly contributed to the performance of school leavers Senior Certificate mathematics other than the computer immersion. Owusu *et al.* (2010) also found CAI not superior to the conventional approach of teaching when they investigated the effects of CAI on performance of senior high school Biology students in Ghana. This implies that the use of computers in the teaching learning process should not wholesomely replace the teacher. Kevogo, Toili and Mutsotso (2013), investigated the relationship between secondary school students' competence in computer use and performance in Biology. They found no relationship between competence use and performance in Biology. This also suggests that competence in computer use is not an indicator of performance

in Biology. Therefore, CAL should be used as a teacher support resource for better and greater benefit to be achieved in the teaching learning process.

4.4. Computer-assisted Learning on Students' Attitude towards Biology

The second study objective was to establish the influence of computer-assisted learning on students' attitudes towards biological knowledge. The question to be answered in this section was; to what extent does computer-assisted learning (CAL) influence secondary school students' attitudes towards biological knowledge? A questionnaire was designed to collect data for purposes of answering this question. The questionnaire was in the form of closed ended questions to be responded to by the learners.

Students were asked to respond to statements which could indicate their attitudes. The eight attitude statements used were as shown in Table 4.11. The study respondents ticked the appropriate choice that best explained their feeling towards each statement. For purposes of data analysis the five categories of responses namely; strongly agree (SA), agree (A), Undecided (U), disagree (D), and strongly disagree (SD) were collapsed into three categories, A, U, and D. The data was then keyed into SPSS data editor for analyses and the responses to the statements were as follows:

Table 4.11: Summary of Frequencies and Percentages of Students' attitudes towards CAL

N = 137, F = Frequency, % = Percentage

No.	STATEMENT	TYPE OF RESPONSE		
		AGREE	UNDECIDED	DISAGREE
		F (%)	F (%)	F (%)
1	CAL has improved my curiosity towards Biology	107(78.1)	3(2.2)	27(19.7)
2	I look forward to my Biology lesson at the Computer Laboratory.	122(89.1)	11(8.0)	4(2.9)
3	CAL has improved my understanding of Biological concepts.	108(78.8)	7(5.1)	22(16.1)
4	I ask questions that demonstrates the understanding of biological concepts during CAL lessons.	95(69.3)	28(20.4)	14(10.2)
5	I understand the explanations from my Biology teacher that accompany the power point presentations.	120(87.6)	15(10.9)	2(1.5)
6	The power point presentations are too difficult to understand	18(13.1)	12(8.8)	107(78.1)
7	The animations and simulations are just like normal videos for me.	13(9.5)	98(71.5)	26(19.0)
8	CAL has not improved my attitude and motivation towards learning Biology.	12(8.8)	17(12.4)	108(78.8)

Source: Researcher 2016

Based on the responses given in Table 4.11 the overall students' attitude was positive. It was observed that 107 (78.1%) respondents agreed that CAL improved their curiosity towards Biology subject. This could be attributed to the enhanced understanding of the biological concepts presented via CAL. This view is supported when 108 (78.8%) respondents concurred that CAL had improved their understanding of biological knowledge. This suggests that the learners were able to conceptualize and acquire in-depth understanding of the content that was presented through CAL. This in turn builds on the cognitive abilities of the learners and improves their thinking skills. This is further supported when 122 (89.1%) of the respondents looked forward to CAL Biology lessons in the computer laboratories. This was reinforced

when most of the teachers interviewed confirmed that their students felt confident when they used computers in the teaching learning process, which in turn made Biology subject interesting to the learners. However, 27 (19.7%) respondents did not find a change in their curiosity towards the subject and 3 (2.2%) did not know what this was all about.

In terms of improving the learners understanding, 120 (87.6%) of the respondents agreed that CAL had improved their understanding of the explanations from their Biology teacher that accompanied the Power point presentations. This good response could be due to the fact that CAL employed both computer presentations as well as explanations from the teacher. Difficult concepts taught in the topic "classification" were accompanied by pictures, animations and simulations which could have made the content easily understood. For example, content on invertebrates whose majority of the phyla are marine organisms could well be understood when explained with pictures, animations and simulations for learners in areas not endowed with marine ecology. The teacher has an opportunity to get appropriate pictures which are true representation of the organisms. This gave them a clear picture of their characteristics such as their habitat, feeding, growth, and reproduction. This was confirmed when most teachers interviewed said that CAL positively improved retention of biological knowledge hence their achievement in Biology subject. Furthermore, they confirmed that CAL helped them to teach more effectively. Since learners were able to use their senses of hearing (ears) and sight (eyes), these facilitated in-depth knowledge acquisition as proposed by Mayer (2001). This promoted the learners retention of the knowledge which led to their improved performance as seen in objective one, hence their positive attitude.

The difficulty of subject content presented on Power point also had varied responses from the learners. The study noted that 18(13.1%) agreed that Power point presentations were too difficult to understand while 12(8.8%) were undecided. This could be mainly because the content on Power point was in short summarized form where some of the respondents could not comprehend. However a majority 107(78.1) said power point presentation could easily be understood as they accompanied a teachers explanation.

Finally, 26 (19%) respondents viewed animations and simulations to be just like normal videos to them while 98 (71.5) said they were not like normal videos. The content covered in the topic “classification” entails grouping organism into their taxonomic units. The pictures, animations and simulations of different organism could have been confused for the animals and plants shown in nature films and videos. There is need therefore for the teacher to assist students to distinguish the classroom content from normal videos. The means and standard deviations were calculated and presented in Table 4.12

Table 4.12: Summary of Means and Standard Deviations of Students' Attitudes towards CAL

Attribute	Minimum	Maximum	Mean	SD
1. CAL has improved my curiosity towards learning Biology.	1	5	3.99	1.323
2. I look forward to my Biology lesson at the Computer Laboratory	1	5	4.33	.924
3. CAL has improved my understanding of Biological concepts	1	5	4.23	.949
4. I ask questions that demonstrate the understanding of biological concepts during CAL lessons.	1	5	3.87	1.316
5. I understand the explanations from my Biology teacher that accompany the power point presentations	1	5	4.44	1.035
6. The power point presentations are too difficult to understand	1	5	3.98	1.060
7. The animations and simulations are just like normal videos to me	1	5	3.95	1.059
8. CAL has not improved my attitude and motivation towards learning Biology.	1	5	3.91	.903
Average			**4.088**	1.0711

Source: Researcher, 2016

The means and standard deviations in Table 4.12 were further presented and can be seen in Figure 4.2. The statements in the figures have been replaced by the serial numbers 1-8.

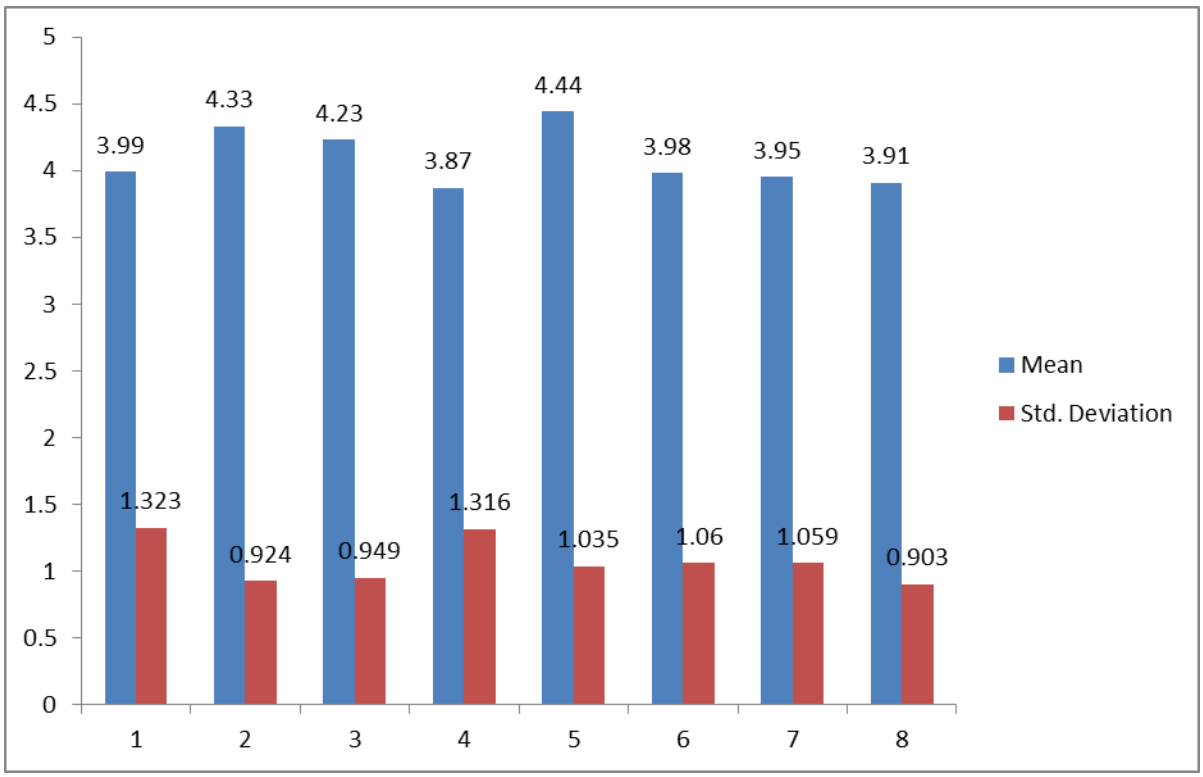


Figure 4.4 Mean and Standard Deviation for Learners' Attitudes

Source: Researcher, 2016

Table 4.12 shows that the overall mean attitude was 4.088 on a scale ranging from 1(strongly disagree) to 5(strongly agree) and a standard deviation of 1.0711. This average mean and standard deviation was above average hence this implies that Biology students had a positive attitude towards computer-assisted learning. The highest mean 4.44 was registered under the statement "*I understand the explanations from my Biology teacher that accompany the power point presentations".* This is a clear indication that learners appreciate the use of computer-assisted learning since

they understand extra content from the computer programme prepared for them in addition to the teachers' explanations. Most of the teachers interviewed confirmed that using CAL enhanced their students' attitudes towards Biology subject. The positive attitude therefore means in-depth and better learning which yields to acquisition and retention of more biological knowledge hence improvement in the post-test scores. This is reinforced by Turkmen, (1996) who said that computer-assisted learning aids teachers to teach what they already want to teach but better, in other words teaching more easily and in greater depth. Most teachers interviewed noted that CAL helped them to teach more effectively.

4.4.1 Discussion of the Findings

Attitude as an aspect has caused considerable concern in education (Samikwo, 2012). Attitude is the inner feelings of an individual towards something or somebody (Wabuke & Samikwo, 2012). This is because attitudes affect achievement and achievement affects attitudes. Owiti, (2001) in his study found that attitude influences performance and performance influences attitude and that positive attitudes in students help to improve achievement. The kind of attitude one holds in a learning situation therefore is of great significance. This implies that those who have positive attitudes are viewed as people who achieve highly while those holding negative attitudes are low achievers. Positive attitude activates the thinking, feeling and reacting components on an individual, hence influences the performance (Wabuke, 2012).

In this study use of CAL in the learning process has been shown to develop a positive attitude among learners during Biology lesson. Hence this study found a positive attitude towards Biology which could be linked to improved achievement in the post-

test. This positive attitude can be linked to the improvement in the Biology post-test results. Other studies conducted with the use of computer as tool for instruction which found similar findings include; Jeetkaur & Sharma (2013), Obondo (2012), Owusu (2010), Serin (2011) and Turkmen (1996), who reinforced this fact when they found out that computer-assisted learning enhanced students' attitude in Biology subject. Positive attitude cultivates students' ambitions and morale of what they want to do irrespective of a difficult subject, hence makes students to work hard with minimum supervision. CAL can also be said to provide new learning skills in using technology in the learning process. The learner uses multiple senses; hearing and sight in the learning process. Due to these reason therefore the need of computer-assisted learning to improve learning attitude in Biology is indisputable. This supports Mayers' cognitive theory of multimedia learning (CTML) which says that people learn more deeply from words and pictures than from words alone (Mayer, 2001). The pictures in this study were in the CAL package and the teachers' explanations reinforced the knowledge learned. The learners see the pictures accompanying the teacher's explanations which enhance deeper learning. This was realized through the improved achievement in the post-test results.

Other researchers working in the field of CAL found different results. The students' attitude taught by CAL and those instructed by traditional approaches of 10^{th} grade students of Diyarbakir Melik Ahmet secondary school in Turkey did not emerge as statistically different (Efe, Oral, Efe, & Sunkur, 2011).

4.5 Computer-assisted Learning (CAL) and Students' Self-efficacy in Biology

The third study objective was to find out the influence of computer-assisted learning on students' self-efficacy in Biology. The research question stated; what is the

influence of computer-assisted learning (CAL) on secondary school students' self-efficacy? A questionnaire was designed to collect data for purposes of answering this question. The questionnaire was in the form of closed ended questions to be responded to by the learners.

Students were asked to respond to statements which could indicate their self-efficacy. The twelve self-efficacy statements used were as shown in Table 4.13. The study respondents ticked the appropriate choice that best explained their belief towards each statement. For purposes of data analysis the five categories of responses namely; strongly agree (SA), agree (A), Undecided (U), disagree (D), and strongly disagree (SD) were collapsed into three categories, A, U, and D.

The data was then keyed into SPSS data editor for analyses and the responses to the statements were as follows:

Table 4.13: Summary of Frequencies and Percentages of Students' Self-efficacy towards CAL

N = 137, F = Frequency, % = Percentage

		TYPE OF RESPONSE		
No.	**STATEMENT**	**AGREE**	**UNDECIDED**	**DISAGREE**
		F (%)	**F (%)**	**F (%)**
1	I like going to the computer lab for Biology CAL lessons.	127(92.7)	1(0.7)	9(6.6)
2	I enjoy watching and listening to CAL Programme.	124(90.5)	1(0.7)	12(8.8)
3	I am able to take well organized notes during Biology CAL lessons.	78 (56.9)	12(8.8)	47(34.3)
4	I participate in the CALP biology class by answering the teacher's questions.	100(73.0)	11(8.0)	26(19.0)
5	I can relate the CALP content to the material in Biology textbooks.	64(46.7)	20(14.6)	53(38.7)
6	I enjoy explaining and teaching other students about the CALP course content.	75(54.7)	22(16.1)	40(29.2)
7	Apart from CALP notes, I also read extra information from other reference books.	90(65.7)	33(24.1)	14(10.2)
8	I study and revise the CAL lesson notes presented by my teacher in class.	98(71.5)	23(16.8)	16(11.7)
9	I pay close attention to what the teacher says during CALP classes.	124(90.5)	3(2.2)	10(7.3)
10	I finish my homework well after CALP lessons every day.	123(89.8)	3(2.2)	11(8.0)
11	After learning with CALP, I have more confidence in dealing with Biology concepts.	125(91.2)	2(1.5)	10(7.3)
12	I seek help from my teacher when I get stuck in CAL Biology tasks.	94(68.8)	5(3.6)	38(27.7)

Source: Researcher, 2016

The overall self-efficacy as shown in 4.13 was good. From the Table 4.13 the responses for the learners self-efficacy showed that, 127 (92.7%) students liked going to the computer laboratory for CAL lessons in Biology while only 9(6.6%) disagreed.

This good response could be attributed to the students' perceptions of CAL lessons in addition to the change of class venue. CAL approach of teaching was perceived by learners to be different from the normal conventional methods of teaching. CAL as an instructional method combines presentation of the content by use of computer software packages such as power-point with explanations from the teacher. This makes the students to be eager to go and learn Biology in the computer laboratory. The computer laboratory also offers a venue different from the normal classroom environment for learning. This definitely makes them want to go to the computer laboratory for the Biology CAL lessons and this forms the basis of their self-efficacy. Bandura (1977, 1988) supports this when he considered self-efficacy to be an important determinant of whether an individual will expend effort on a task and even persist in the face of difficulty. Students were willing to go to the computer laboratory irrespective of whether the CAL content was challenging.

CAL also calls for multivariate sense response. Apart from just listening, learners were also required use their sight to see the Biology lesson content that was projected on the screen. In support of this 124 (90.5%) students enjoyed watching and listening to CAL Programme, 12 (8.8%) disagreed while only 1 (0.7%) student was undecided. In addition, 124 (90.5%) said they paid close attention to what the teacher says during the CAL lessons while 10 (7.3%) disagreed. The topic "classification" whose content was used in the study cuts across all living organisms. The CAL lesson content used involved the use of pictures in three dimensions in addition to the power-point presentations. These give the teacher a platform to describe the characteristics which are visible to the learners. Therefore this captures the learners' attention which motivates them to enjoy learning hence their self-efficacy. This enables the learners build confidence to handle difficult tasks, 125(91.2%) learners agreed they had more

confidence in dealing with biological concepts which is the first positive step towards achievement. The confidence enabled learners to seek clarity where they needed help, 94(68.8%) learners seeked help from their teacher when they got stuck in CAL Biology tasks. This fact enabled the teacher to clarify and reinforce sections of the lesson deemed not clear. Most teachers interviewed noted that CAL had considerable potential to allow students to improve on their self-efficacy. Efficacy expectations are beliefs that a person strives to successfully completing the course of action that will lead to success, Bandura (1988). The students who were exposed to CAL developed a positive self-efficacy towards biology which in turn led to the improved performance in the post-test.

However, a majority of the learners could not connect the CAL program content with what is presented in Biology text books. The study found out that 64(46.7%) could relate the CAL programme content with what was presented in Biology text books, 20(14.6) were undecided while 53(38.7%) disagreed. This means that learners perceived the CAL content just like normal content viewed in televisions and videos sourced from elsewhere. There is need therefore to include CAL content in the Biology text books in the form of boxed power point slides.

The researcher went further to calculate the means and standard deviations from the responses from table 4.13 and were presented in Table 4.14

Table 4.14: Summary of means and Standard Deviations of Students' self-efficacy scores towards CAL

Attribute	Minimum	Maximum	Mean	SD
1. I like going to the computer lab for CALP lessons in Biology	1	5	4.39	.885
2. I enjoy watching and listening to CAL programme	1	5	4.45	.962
3. I am able to take well organized notes during Biology CAL lessons	1	5	4.37	1.071
4. I participate in the CALP biology class by answering the teacher's questions	1	5	3.96	1.288
5. I can relate the CALP content to the material in Biology textbooks	1	5	3.22	1.469
6. I enjoy explaining and teaching other students about the CALP course content	1	5	3.93	1.086
7. Apart from CALP notes, I also read extra information from other reference books	1	5	3.66	.980
8. I study and revise the CAL lesson notes presented by my teacher in class	1	5	3.86	1.072
9. I pay close attention to what the teacher says during CALP lessons	1	5	4.44	.954
10. I finish my homework well after CALP lessons everyday	1	5	4.45	.999
11. After learning with CALP, I have more confidence in dealing with Biology concepts	1	5	4.51	.900
12. I seek help from my teacher when I get stuck in CAL biology tasks.	1	5	4.35	.978
Average			**4.133**	**1.061**

Source: Researcher, 2016

The above Table can be presented visually as follows;

The means and standard deviations in Table 4.14 were further presented and can be seen in Figure 4.3. The statements in the figures have been replaced by the serial numbers 1-12.

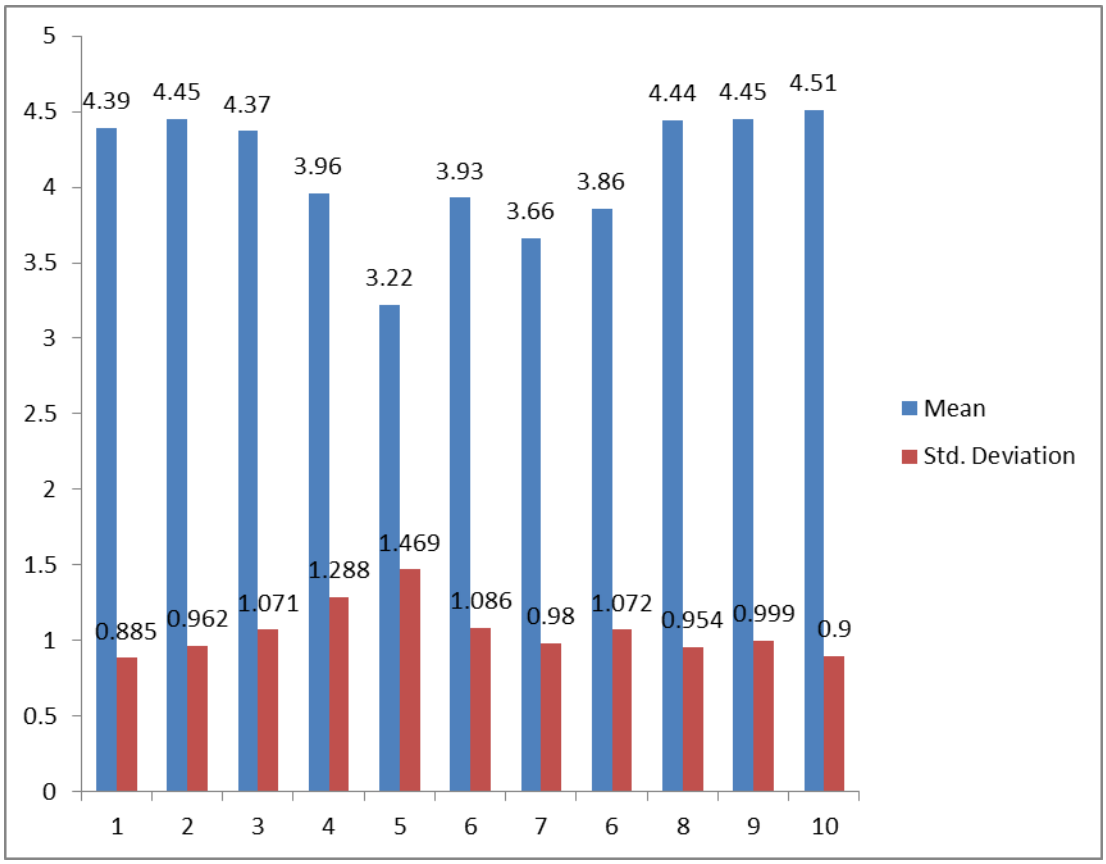


Figure 4.5: Showing students overall mean self-efficacies.

Source: Researcher, 2016

Table 4.14 shows that the overall mean self-efficacy was 4.133 on a scale ranging from 1(strongly disagree) to 5(strongly agree) and a standard deviation of 1.061. This average mean was above average (above 3.0) hence this implies that Biology students had a positive self-efficacy towards computer-assisted learning. The highest mean 4.51 was registered under the statement "*After learning with CALP, I have more confidence in dealing with Biology concepts*" meaning that learners appreciate the

confidence they acquire after going through a CAL programme in dealing with biological knowledge. Confidence is an important element for learners who are motivated. Serin (2011) concurs with this when he found out that CAL motivates students and develops curiosity, gets them to take an active part in the learning process and boosts their confidence. On the other hand the lowest mean of 3.22 was registered under the statement "*I can relate the CALP content to the material in Biology textbooks".* Indeed this suggests that the learners get carried away by the CAL content that they could not identify which part of the Biology Syllabus it must have come from. There is need therefore to include CAL computer slides in the textbooks used to implement the Biology curriculum.

Discussion of the Findings

This study found a positive self-efficacy in the students in the experimental group that were exposed to CAL. The results of this study are in agreement with those of other researchers in this field. Kocakaya & Gonen (2010) investigated the effects of CAI learning on second grade physics students' self-efficacy perceptions. They found out that, students' self-efficacy perceptions on physics increased after treatment with CAI. Serin (2011) carried out a study on the effects of computer-based instruction on self-efficacy of science and technology students and found out that there was a positive self-efficacy in the experimental group that received computer-based science and technology instruction. However, the findings of this study are not in agreement with Hevedanli (2015) who carried out a study on the influence of web-aided learning on secondary school students self-efficacy beliefs in Biology and found no difference in students' self-efficacy in Biology.

Individuals' beliefs about their abilities make up their sense of self-efficacy. Students set individual goals that become their personal standards for evaluating their performance. It's these individual set goals that becomes the driving force or the expended effort to attain them. Efficacy expectations are beliefs that a person is capable of successfully completing the course of action that will lead to success (Bandura, 1988). Goal attainment and commitment of effort is then geared towards self-satisfaction, a means by which people avoid discontentment associated with below standard performance. Bandura (1977, 1988) considers self-efficacy beliefs to be important determinants of whether individuals will expend effort on a task and persist in the face of difficulty. Bandura in his social learning theory offers explanations for the differences in the amounts of effort students expend on school tasks which actually yield their self-efficacy, that students make personal interpretations of their accomplishments and set goals based upon these interpretations. Pintrich *et al* (1991) on the other hand view the differences in effort expenditure in relationship with ability and task difficulty as explaining differences in student achievement. They postulated that the more able students persisted even in more difficult tasks as compared to the less able students who easily gave up during difficult tasks. Therefore this study recommends that CAL be used to teach Biology at secondary school so as to improve the students' self-efficacy.

4.6 Summary of the Chapter

This chapter has presented the findings of the study. The data collected was analyzed by both descriptive and inferential statistics by the use of SPSS version 20 computer programme and EXCEL computer software. Presentation of the findings was based on the objectives of the study. Data was presented in the form of tables, charts and figures. Interpretation and discussion of data followed so as to give meaning to data that was collected.

CHAPTER FIVE

SUMMARY OF THE FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The main purpose of this study was to investigate the effect of computer-assisted learning on secondary school students' achievement in Biology. This chapter presents a summary of the findings as presented in chapter four. It draws conclusions from the research findings, gives recommendations based on the findings. The chapter ends with suggestions for further research.

5.2 Summary of the Study

5.2.1 CAL and Retention of Biological Knowledge

The first objective of the study was to investigate the effect of computer-assisted learning on students' retention of biological knowledge. In response to the question as to whether there was a difference in retention of biological knowledge between students' using CAL and those taught using traditional methods, the research findings established that students taught Biology by computer-assisted learning performed significantly better than students taught using conventional approaches of teaching such as lecture, discussion and question and answer methods which did not involve the use of a computer.

The superiority of the use of computer-assisted learning could possibly be explained by the multivariate nature of the method which employs use of the computer software in addition to the accompanied teachers' explanations. Hence this employed various

stimuli where learners used various senses in response in the course of the teaching and learning process as opposed to traditional methods of learning which utilizes fewer stimuli in the course of learning. As a result this increased the learners' retention of biological knowledge hence achievement in Biology subject. The computer-assisted learning in this study entailed the use of presentation of concepts with pictorial illustrations and animations which are quite appealing to the learners. Obinna (2012) asserted that pictorial illustrations were considered effective in enhancing achievement in science for both concrete operational and formal students. Therefore use of computer-assisted learning in teaching created multisensory channels for learning which enhances retention of knowledge learned. Ratner (2008) argues that this situation usually enhances learning since students tend to learn better when more of the senses are involved than when one sense is involved.

The findings of this study are in agreement with what other researchers in the area of computer-assisted learning found out. Kapting'ei, (2008) noted that the experimental group significantly outperformed the control group in a study where computer-assisted learning was used in the instruction of fluid flow physics. In addition, Mubichakani (2013) found out that computer-based learning in Mathematics improved achievement and motivation among boys and girls in the probability topic. Obondo (2013) on the other hand investigated the effect of video in teaching of landforms in Geography on attitude and academic achievement. He concluded that learners taught landforms using video registered greater achievement as compared to their counterparts who were taught by conventional methods of teaching. Therefore this study has endeavored to establish that CAL is effective in the improving learner's achievement in Biology.

5.2.2 CAL and Attitudes towards Biological Knowledge

The second objective of the study was to establish the influence of computer-assisted learning on students' attitudes towards biological knowledge. In response to the research question as to the extent to which computer-assisted learning (CAL) influenced secondary school students' attitudes towards biological knowledge, the research findings established that CAL influenced students' attitudes positively towards learning of Biology. Students in the experimental group taught by use of CAL had a positive attitude towards learning of Biology. Attitude influences performance and performance on the other hand influences attitude. The positive attitude among the respondents in the experimental group could be attributed to the improved achievement as evidenced in the post-test results. The respondents' positive attitude towards Biology was linked to their improved performance in the post-test.

These findings are in agreement with Jeetkaur & Sharma (2013), Obondo (2012), Owusu (2010), Serin (2011) and Turkmen (1996), who found out that computer-assisted learning enhanced students' attitude in Biology subject. Positive attitude cultivates students' ambitions and morale of what they want to do irrespective of a difficult subject, hence makes students to work hard with minimum supervision. CAL can also be said to provide new learning skills in using technology in the learning process. The learner uses multiple senses; hearing and sight in the learning process. Due to these reason therefore the need of computer-assisted learning to improve learning attitude in Biology is indisputable. This supports Mayers' cognitive theory of multimedia learning (CTML) which says that people learn more deeply from words and pictures than from words alone (Mayer, 2001). The pictures in this study were in the CAL package and the teachers' explanations reinforced the knowledge learned.

The learners see the pictures accompanying the teacher's explanations which enhance deeper learning. This was realized through the improved achievement in the post-test results.

5.2.3 CAL and Self-efficacy in Biology

The third objective of the study was to find out the influence of computer-assisted learning on students' self-efficacy in Biology. In response to the question as to whether there is any influence of computer-assisted learning (CAL) on secondary school students' self-efficacy, the research findings established that CAL positively improved learners' self-efficacy in Biology.

Students' self-efficacy help determine many choices throughout their academic career, such as how much time they will spend on a particular task, the relative amount of effort they will expend to achieve complex tasks, and how persistent and resilient they will be when confronting obstacles (Pajares, 1996). Learning process is continuous and as such learners require self-efficacy. Self-efficacy belief assists people in how much effort they will exert against difficult situations, how long they will exert efforts in facing difficulties especially in the learning process and how they will pull themselves together (Bandura, 1977 and Pajares, 1996).

The findings of this study are in agreement with those of other researchers in this field. Yu-Hsin, Ju-Tzu, & Deng-Jyi (2012) investigated the effect of multimedia computer assisted instruction and learning style on learning achievement. The results showed that when compared to traditional models of instruction, students using the multimedia computer assisted instruction model scored significantly better in learning achievement assessments. Guzeller & Akin (2012) investigated the effect of web-

based mathematics instruction on mathematics achievement and self-efficacy. The results indicated that students in the Web-based mathematics instruction developed positive mathematics self-efficacy than students in the traditional mathematics instruction. Besides, it was found that students' mathematical self-efficacy were quite negative in the traditional mathematics instruction class at the end of study.

These studies suggests that under the CAL instruction teachers may utilize computers to present certain abstract concepts of the Biology curriculum and various 3D structures that are difficult to present in textbooks. CAL provides students with specific experiences in observation and simulation. In addition, the interaction of digital learning materials allows students to learn through intuitive and experimental methods, they repeatedly attempt to establish concepts and models contained within the Biology course content. Therefore students are likely to obtain greater learning achievement and this promotes their self-efficacy.

5.3 Conclusion

From the results of this study, first, it can be concluded that CAL is a superior approach in the teaching and learning of Biology as compared to the conventional approaches of teaching such as lecture, discussion, question and answer methods which do not require the use of a computer. CAL has the ability to improve the academic achievement of learners in Biology.

Secondly the research findings established that CAL influenced students' attitudes positively towards learning of Biology. Students in the experimental group taught by use of CAL developed positive attitude towards learning of Biology. Attitude influences performance and performance on the other hand influences attitude. The

positive attitude among the respondents in the experimental group could be attributed to the improved achievement as evidenced in the post-test results.

Lastly the research findings established that CAL positively improved learners' self-efficacy in Biology. Hence as Kenya moves towards the age of digital technology, increase in the growth of new technologies will provide new opportunities for delivering instruction in the course of teaching and learning process because of the positive influence they have on students.

It can be concluded that CAL in Biology instruction improves students' confidence, enhances positive attitude and promotes positive self-efficacy towards learning hence there is improved achievement.

5.4 Recommendations

In reference to this study, it was concluded that computer-assisted learning programme has the potential to improve achievement, attitudes and self-efficacy in the learners. Based on the study findings and conclusions reached, the following recommendations were made:

1) Digital content be included in the current text books published by various publishing companies. This should be made in line with the e-learning content prepared by the MOEST for teaching and learning in schools. For instance, power-point slides bearing key components of the topic being presented could be included in the student text books. This will create a link of what is contained in the text books to the digital content presented via digital platforms.
2) Apart from the government initiative to equip schools with computers, other non-governmental agencies should be encouraged to equip schools with computers

and new technological software for increased and easy access by both teachers and students to use. The government should also encourage schools to have partnerships with various non-governmental organizations with the goal of equipping schools with the relevant digital content to be used in the teaching and learning process.

In addition, there is room and capacity of incorporating other more recent technologies such as interactive technologies. For instance, the digital Smart board can be used to improve the effectiveness of CAL technique. Hence schools should be encouraged to install digital Smart boards for interactive forms of learning such cooperative learning to take place. This will enable learners to share their experiences during the teaching and learning process.

3) Teacher training colleges and universities should train and equip fresh new teachers with the necessary skills and knowledge to properly integrate computers in their daily classroom processes. This fact is reinforced by Mwangi (2014) who found out that 65% of the teachers never used ICTs to teach their subjects. This will ensure that teachers are computer literate and are abreast in the digital applications required in their classrooms. Also, this will expose teachers to practical examples of integrating CAL for instructional based teaching/learning. In addition, the government should in-service the serving teachers with free and compulsory computer training to enable them to manage the new upcoming technologies in their classrooms.
4) School electrification programme be continued to reach all secondary schools in the country especially those seated deep in the rural remote areas, this will ensure there is necessary infrastructure to power the computers and to run the e-learning programs in schools.

5.5 Suggestions for Further Studies

Kenya's education system needs a constant review by scholars drawn from the field of education. Therefore, there is need for other researchers to investigate the areas which were not looked into by this research. Scholars working in this area of study should try and investigate the following:

1) This study was limited to one region, that is, Mt Elgon Sub-County. Therefore a study extended to larger regions is needed to see if the findings of this study can be generalized to all schools as they get equipped with computers. Such researches will enable scholars establish if there is a relationship between digital technologies such as CAL and technology in education policies.
2) There is extensive use of digital media, for instance phones outside school by both teachers and students on a wide variety of platforms such as social media. Studies can be undertaken with broadened scope that includes such platforms used out of school for the purpose of teaching and learning.
3) Subsequent studies are recommended in the same region to explore in depth the constraints on CAL implementation on all the subjects within the secondary school curriculum in Kenya. That could include cross-sectional and longitudinal studies which were beyond the scope of this study.
4) The research findings of this study were limited to Biology subject among secondary schools in Mt Elgon sub-county. Ideally, it would have been appropriate if several researchers investigating all subjects offered in the Kenyan curriculum collaborated in such a research project.
5) Similar studies in the same region using recent interactive technologies such as Smart boards and Bulletin boards should be undertaken.

6) Investigate the integration of recent technologies in colleges and universities in teacher preparation programme.

REFERENCES

Ajaja, P. (2013). Which strategy best suits biology teaching? Lecturing, concept mapping, cooperative learning or learning cycle? *Electronic Journal of Science Education* (Southwestern University). Vol. 17, No.1 (2013). Retrieved from http://ejse.southwestern.edu.

Aladejana, F. (2008). Blended Learning and Improved Biology Teaching in the Nigerian Secondary Schools. *Proceedings of the World Congress on Engineering and Computer Science 2008 WCECS 2008,* October 22 - 24, 2008, San Francisco, USA.

Awofala A. O. A. (2011). Effect of Personalized, Computer-Based Instruction on Students' Achievement in Solving Two-Step Word Problems. *International Journal of Mathematics Trends and Technology- Volume2 Issue2- 2011*. ISSN: 2231-5373. http://www.internationaljournalssrg.org.

Ayoo, O. (2009). Reflections on the Digital Divide and its Implications for the Internationalization of Higher Education in a Developing Region: The Case of East Africa Higher Education Policy, 22, (303–318). *International Association of Universities* 0952-8733/09. www.palgrave-journals.com/hep/

Azar, A. (2010). In-service and pre-service secondary science teachers' self-efficacy beliefs about Science Teaching. *Educational Research and Reviews.* Department of Secondary Science and Mathematics, Zonguldak Karaelmas University, Zonguldak, Turkey. Vol. 5(4), pp. 175-188, April, 2010. http://www.academicjournals.org/ERR2

Baggott La Velle, L., Wishart, J., McFarlane, R. B., & John, P. (2007). Technological and learning with ICT within the subject culture of secondary school science. *Research in Science & Technological Education*, 25(3), 339–349.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191-215.

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

Banju, M. K. (2014). Factors Influencing Implementaion of Laptop Project in Public Primary Schools in Kenya. A case of Nairobi County. Masters Thesis. Universty of Nairobi. Kenya

Barmao, C. (2015). Effect of Early Pregnancy among Teenage Pregnancy on Dropout Rates. PhD Thesis. Moi University. Kenya.

Basturk, R. (2005). The Effectiveness of Computer-Assisted Instruction in Teaching Introductory Statistics. *Educational Technology & Society*, 8 (2), 170-178.

Bell, R. L., Gess-Newsome, J., & Luft, J. (Eds.) (2008). Technology in the Secondary Science Classroom. Arlington, VA: NSTA Press.

Bera, K. (2004). *Revised Ethical guidelines for Educational Research.* Retrieved from http://www.bera.ac.uk/files/2008/09/Ethical 1.pdf

Best, R. & Bell, L. (2003). A bibliography of articles on technology in science education. *Contemporary Issues in Technology and Teacher Education, 2(4),* 427-447.

Biott, C. (1999). *Collaborative Learning in Staffrooms and Classrooms*. David Fulton Publishers.

Blue, E. & Tirotta, K. (2011). Cloud Computing and Interactive White Boards in Teacher Preparation. *Teach Trends*, 55(3):31-39

Bluman, A. G., (2012). *Elementary Statistics*, A Step by Step Approach. McGraw-Hill Companies, Inc. 1221. New York.

Borg, W. R., & Gall, M. D. (1989). *Educational Research*: An introduction (5th ed.). New York: Longman.

Bove'e, C., Voogt, J. & Meelissen, M. (2005). Computer Attitudes of Primary and Secondary Students in South Africa. *Science Direct*. www.sciencedirect.com

Bransford, J. D., Brown, A. L. & Cocking, R. R. (2002). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press. http://www.nap.edu/openbook.php?record_id=6160

Burns, M., & Bodrogini, P. W. (2011). "The wisdom of practice": Web 2.0 as a cognitive and community-building tool in Indonesia. In M. Thomas (Ed.), *Digital education: Opportunities for social collaboration* (pp. 167–193). Basingstoke, UK: Palgrave-MacMillan.

Chebotip, N. (2013). Effect of CAL on the Mastery of the concept of Mutations among Secondary school students in Kenya. A case study of Kerotet Girls' secondary school, Uasin Gishu County. *Unpublished M.Phil. Thesis.* Moi University. Kenya.

Clarke, M. (2011). *Understanding the Policy Implementations of ICT for Development*. In Steyn, J. & Johanson, G. (Eds.) ICTs and Sustainable Solutions for the Digital Divide: Theory and Perspective. Hershey, New York: IGI Global

Cohen, L., Manion, L. & Morrison, K. R. B. (2004). *Research Methods in Education* (6thed). London: Routledge.

Collins, M. A. J. (1982). Improved learning with computerized tests. *The American Biology Teacher*, 46(3):188–191.

Compeau, D., & Higgins, C. (1995). Computer Self-Efficacy: Development of a Measure and Initial Test. MIS Quarterly, 19.

Cotton, K. (1991). Computer-assisted instruction. School improvement series: research you can use. Retrieved 20/05/2014. Available from. www.nwrel.org/scpd/sirs/5/cu10.html.

Cotton, K. (1997). *Computer-assisted instruction*. North West Regional Educational Laboratory. http://www.borg.com/~rparkany/PromOriginal/ETAP778/CAI.html

Creswell. J. W. (2003). *Research Design, Quantitative, Qualitative, and Mixed method approaches.* (2nded). London. Sage Publications.

Cronin-Jones, L. L. (1991). Science teacher beliefs and their influence on curriculum implementation: Two case studies. *J. Res. Sci. Teaching* 28:235-250.

Crotty, M. (1998). *The Foundations of Social Research.* Meaning and Perspective in research process. Allen & Uwinpty Ltd. St. Leonards 2065: Australia.

Crovello, T. J. (1985). Computers and Biology Education, *New Trends in Biology Teaching*, v5, UNESCO.

Czerniak, C. M. (1990). A study of self-efficacy anxiety and science knowledge in pre-service elementary teachers. *Paper presented at the Meeting of the National Association for Research in Science Teaching*, Atlanta GA.

Davy, I. (2011). *Learners Without Boarders*: A Curriculum for Global Citizenship. Cardiff UK.

DeRue, Scott, (September, 2012). "A Quasi Experimental Study of After-Event Reviews". *Journal of Applied Psychology* 97 (5): 681–689. doi:10.1037/a0028244.

Dinardo, J. (2008). "The New Palgrave Dictionary of Economics". pp. 856–859. doi:10.1057/9780230226203.1162. ISBN 978-0-333-78676-5

Doerr, H. M., & Zangor, R. (2000). Creating meaning for and with the graphing calculator. *Educational Studies in Mathematics*, 41(2), 143-163.

Donner, J. (June, 2010). *The changing role of mobile phones in development: Some examples*. [PPT presentation]. Retrieved from http://research.microsoft.com/en-us/events/indiasummerschool2010/donner-mobs_society-june15.pdf.

Ebert-May, D., Brewer, C., & Sylvester, A. (1997). What we say is not what we do: Effective Evaluation of Faculty Professional Development Programs. *Bioscience 2011; 61:550-558.*

El-Deghaidy, H. & Nouby, A. (2008). Effectiveness of a Blended E-Learning Cooperative Approach in an Egyptian Teacher Education Programme. *Computers & Education*, 51, 988–1006.

Economist, (2010). Struggling for control: The race to organize television. *Economist*, 67–68. London, UK: Author.

Ekici, G. (2012). Responsibility perception scale of teachers' for student achievement: The adaptation into Turkish, validity and reliability study. *Journal of Contemporary Education Academic,* 1(2), 23–35.

European Commission, (2000). Communication from the Commission-e-Learning - *Designing tomorrow's education*. COM. 318 final.

Ewing, Javier; Chevrolier, Nicholas; Leenderste, Matthijs; Quigless, Maryanna; Verghese, & Thomas. (2014). *ICT Competitiveness in Africa*. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/19025 License: CC BY 3.0 IGO.

Farrell, G., & Isaacs, S. (2007). *Survey of ICT and education in Africa: A summary report based on 53 country surveys*. Washington, DC: World Bank. Retrieved from http://www.infodev.org/en/Publication.354.html

Freeman, M. B. (1998*).* Science Technology and Mathematics: The Problem of Developing Critical Human Capital in Africa*: International Journal of Science Education, 18 (3) 267 – 284.*

Friedler, K. Merin P. & Tamir S. (1992). Acting as we feel: When and how attitudes guide behaviour. In S.shavitt & T.C. Brck (Eds.) Persuasion. Boston: Allyn & Bacon.

Fuccella, V. (2007). Methods and Tools for Computer Assisted Learning and Assessment. PhD Thesis. University of Turkey.

Gaible, E., & Burns, M. (2007). *Using technology to train teachers: Appropriate uses of ICTs for professional development* [PDF document]. Washington, DC: World Bank. Retrieved from http://www.infodev.org/en/Publication.13.html

Gay, L. R. (1987). *Educational Research: Competencies for Analysis and Application*. (3rd Ed.). Melbourne: Merrill Publishing Company.

Gonen, S., Kocakaya, S., & Inan, C. (2006). The Effect of the Computer Assisted Teaching and 7e Model of the Constructivist Learning Methods on the Achievements and Attitudes of High School Students. *The Turkish Online Journal of Educational Technology* (TOJET) October 2006 ISSN: 1303-6521 volume 5 Issue 4 Article 11

Government of Kenya, (2007). *Kenya Vision 2030*. The Popular Version. Nairobi. Government Printer.

Grossman, P. & Willson P. (1990). *The making of a teacher*. New York: Teachers College Press.

Guzeller, C. O., & Akın, A. (2012). The Effect of Web-Based Mathematics Instruction on Mathematics Achievement, Attitudes, Anxiety and Self-Efficacy of 6th Grade Students. *International Journal of Academic Research in Progressive Education and Development.* Vol. 1, No. 2 ISSN: 2226-6348

Harris, B. W. (August, 2013). Distance Education Report –2011/2012 http://californiacommunitycolleges.cccco.edu/Portals/0/reportsTB/REPORT_ Distance Education2013_090313. pdf. Retrieved on 26/08/2014.

Hevedanli, M. (2015). Influence of Web-Aided Cooperative Learning Environment on Motivation and Self-efficacy Beliefs in Biology. *Academic Journals. Education Research Reviews.* Vol.10(5) pp.556-565. http://www.academicjournals.org/ERR

Holmes, B. (1998). *Cross-cultural differences of use of information technology in Education*: A comparative study of the use of computers in Japanese and British classrooms. Unpublished Ph.D. dissertation, Wolfson college, University of Cambridge.

Horn, M. B., & Staker, H. (2011). *The rise of K–12 blended learning* [PDF document]. Retrieved from http://www.innosightinstitute.org/innosight/wp-content/uploads/2011/01/The-Rise-of-K-12-Blended-Learning.pdf

Issenberg, S. B., Mcgaghıe, W. C., Petrusa, E. R., Gordon, D. L. & Scarlese, R. S. (2005). Features and Uses of High-Fidelity Medical Simulations that Lead to Effective Learning: a BEME Systematic Review, *Medical Teacher*, 27(1), 10-28.

Jeetkaur, R. & Sharma, S. (2013). Managing Students' Attitude Towards Science Through Computer Assisted Instruction. *International Indexed & Refereed Journal*. ISSN 0975 – 3486, RNI – RAJBIL – 2009 – 30097, Vol. – IV, Issue – 40.

Johnson, R., & Onwuegbuzie, L. (2004). Educational research: Quantitative, qualitative, and mixed approaches (2nd ed.). Boston, MA: Pearson Education.

Jonassen, D. H., Carr, C., & Yueh, H. (1998). Computers as Mindtools for Engaging Learners in Critical Thinking. *Tech Trends.* Columbus, OH: Prentice-Hall.

Kagwiria, G. (2014). Accessibility and Utilization of ICTs among Secondary School Teachers in Kenya. Retrieved from www.com. mleu.co.ke

Kapting'ei, P. (2008). Computer Assisted Learning in the Instruction of Fluid Flow in Physics. A case Study of Wareng and Uasin Gishu High Schools. Unpublished M.Phil. Thesis. Moi University. Kenya.

Kebritchi, M. Hirumi, Z. & Bai, K. (2010). Slovak High School Students' Attitudes to ICT using in Biology Lesson. *Computers in Human Behavior*, *25*(3), 743-748.

Kenya National Examination Council (KNEC), (2005). *Kenya Certificate of Secondary Education Report*. Nairobi: Kenya National Examination Council.

Kerlinger, F. (1978). *Foundations of Behavioral Research* (3rd edition). New Delhi, Surjeet Publishers.

Kevogo, N. Toili, W. W. & Mutsoso, S. (2013). Relationship between Secondary School Students' Competence in Computer Use and Performance in Biology. Asian Academic Research Journal of Social Science and Humanities (AARJSSH). Vol. 1 Issue 17. ISSN:2278-859X

Klopfer, E., Osterweil S., & Salen, K. (2009). *Moving learning games forward: Obstacles, opportunities and openness* [PDF document]. Retrieved from http://education.mit.edu/papers/MovingLearningGamesForward_EdArcade.pdf

Kocakaya, S. & Gonen, S. (2010). The Effects of Computer-assisted Instruction Designed According to 7E Model of Constructivist Learning on Physics Students Teachers' Achievement, Concept Learning, Self-efficacy Perceptions and Attitudes. *Turkish Online Journal of Distance Education (TOJDE)*. ISSN 1302-6488. Vol. 11 No. 3. Article 12.

Kozma, R. (2014). Technology in service of development: *Personal statement*. Retrieved from http://robertkozma.com/.

Krejcie, R. V. & Morgan, D. W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement.*

Latchem, C., & Jung, I. (2010). *Distance and blended learning in Asia*. New York, NY: Routledge.

Lawson, A. E., Banks, D. L., & Logvin, M. (2007). Self-efficacy, Reasoning Ability, and Achievement in College Biology. *J Res Sci Teach*;44:706-724.

Leedy, P.D. & Ormrod, J. E. (2010). *Practical Research: Planning and Design*, Ninth Edition. NYC: Merril.

Lutfullah, T. (1998). Computer Assisted Biology Education, *Journal of Computers in Mathematics and Science Teaching*, v11, UNESCO

Mayer, R. E. (2001). *Multi-media Learning* (2nd Ed). Cambridge University Press. 32 Avenue of the Americas, New York, NY 10013-2473, USA. www.cambridge.org/9780521735353.

Martens, C. (2003). Integration of ICT in science teaching: A study performed in Azores. *Recent Research Developments in learning Technologies*.

Martin, K. (1990). *What Factors Support or Prevent Teachers from using ICT in their Classrooms?* Paper presented at the British Educational Research Association Annual Conference.

Mc Connel, L. & Murray, J. (2010) A Study on the Effective Use and Integration of Technology into the Primary Curriculum. Saint Xavier University, Chicago.

McMillan, J. H., & Forsyth, D. R. (1991). What theories of motivation say about why learners learn. *In R. Menges & M. Svinicki* (Eds.), College teaching: From theory to practice. San Francisco, CA: Jossey-Bass.

Mikre, F. (2011). The Roles of Information Communication Technologies in Education. Review Article with Emphasis to the Computer and Internet. *Ethiopian Journal of Education & Science*.

Ministry of Education, (2005). Kenya Education Sector Support Programme (2005-2010); Delivering Quality Education and Training to all Kenyans.

Ministry of Information & Communications, (2006). National Information & Communications Technology (ICT) Policy. http://www.ist.africa.org/home/files/Kenya_ICTPolicy_2006.pdf

Ministry of State for Planning, National Development and Vision 2030. Retrieved 18 August 2012.

MoEST, (2012). Sessional Paper No. 1 of 2005 on a Policy Framework for Education, Training and Research: *Meeting the Challenges of Education, Training and Research in the 21st Century.* Nairobi: Government Printers.

Moikut, S. N. (2011). Impact of Land Clashes on Access to Primary and Secondary Education: A Case of Chepyuk Settlement Scheme, Mount Elgon District, Kenya. MED Thesis. Kenyatta University.

Moore, J. L., Dickson-Deane, C. & Galyen, K. (2011). "E-Learning, Online Learning, and Distance Learning Environments: Are they the same?". *The Internet and Higher Education.*

Morgan, G. A. (2000). *Quasi-Experimental Designs*. *Journal of the American Academy of Child & Adolescent Psychiatry* 39 (6). pp. 794–796. doi:10.1097/00004583-200006000-00020

Morrell, P. D. (1992). The Effects of Computer-assisted Instruction and Students. Achievement in High School Biology. *School Science and Mathematics*, 92(4), 177–181.

Mwangi, I. M. (2014). Access and Pedagogical Integration of Information and Communication Technology in Secondary Schools in Nairobi and Kiambu Counties: The Case of Computers for Schools Kenya. PhD Thesis. Kenyatta University.

Mubichakani, J. (2013). *Influence of Computer Based Learning in Mathematics on Learners' Motivation and Achievement Level.* M.Phil. Thesis. Moi University. Kenya.

Mubichakani, M. J. & Koros, C. S. (2014). Bridging Gender Disparities in Mathematics Achievement Through Computer Based Learning. *Journal of Education and Practices.* ISSN 2222 – 1735. Vol. 5, No. 6. 2014.

Murphy, P., Anzalone, S., Bosch A. and Moulton, J. (1989). Enhancing Learning Opportunities in Africa: Distance Education and Information and Communication Technologies for Learning. Washington DC: The World Bank.

Mutua, W. (July, 2013). Kenya's Laptops for children Initiative. (Twitter: @openAcademyNBO)

Mwirigi, C. (2011). How Teachers influence the Performance of Biology in High School. http//Eunea Articles.com. Retrieved on 13th Dec 2014. 10:44 PM.

Naone, E. (2010). Media moves online. *MIT Technology Review*, 60–61.

Nasongo, B. M. & Muola, J. M. (2011). The Effect of Inter-tribal Post Election Violence Conflict Trauma on Academic Performance among Secondary School Students in Mt. Elgon District, Kenya. African Research Review. An International *Multidisciplinary Journal, Ethiopia.* ISSN 2070--0083 (Online).

Neuman, F. (2000). *Qualitative Research and Evaluation Methods* (3rd Edition). London: Oakland Publishers. California.

Ngemu, V. V. (2009). *ICT –Readiness for E-Library: Case study of Institution of Higher Learning.* School of Computing and Informatics. Retrieved on 20th January 2016. Available at http://sci.uonbi.ac.ke

Ngesu, M. L., Gunga, S.,Wachira, L. & Kaluku, N. E. (2014). Some Determinants of Students Performance in Biology in K.C.S.E :A Case of Central Division of Machakos District. *International Journal of Innovative Research Studies.* Vol 3(1) www.ijirs.com

Nkapa, B.W. (1997). *Conducting Educational Research*. New York: Harcourt Brace Jonavovich Inc.

Nyaga, N. S. (2014). Challenges Facing Effective Information and Communications Technology (ICT) Implementation in Selected Public Secondary Schools in Nakuru North District Nakuru County. Master's Thesis. Kenyatta University. Kenya.

Obinna, O. M. (2012). Effect of Computer Assisted Instructional Packages on Secondary School Students Achievement and Interest in Biology. M.PHIL. Thesis. Nnamdi Azikiwe University. Awka.

Obondo, G. (2013). The Effect of Video in Teaching of Landforms in Geography on Attitude and Academic Achievement in Secondary schools in Homabay District, Kenya. Unpublished M.Phil. Thesis. Moi University. Kenya.

Ogonowska,A.,(2010).http://www.womkat.edu.pl/files/kwartalnik/19/Ogonowska.doc (retrevied 19.07.2014).

Olga P. (2008). The Effects of Computer-Assisted Instruction on the Achievement, Attitudes and Retention of Fourth Grade Mathematics Course. PHD Thesis. Middle East Technical University. Turkish Republic of Northern Cyprus.

Omollo, O., Indoshi, C. & Ayere, A. (2013). Attitude of Teachers and Students Towards Use of Information and Communication Technology in the Implementation of Biology Curriculum in Selected Secondary Schools. *Research Journal in Organizational Psychology & Educational Studies* 2(3) 76-83. (ISSN: 2276-8475)

Orodho, J. A. (2004). *Techniques of Writing Research Proposal and Reports in Education and social Sciences*. Nairobi. Masola Publishers.

Owusu, K. A., Monney, K. A., Appiah, J. Y., & Wilmot, E. M. (2010). Effects of computer-assisted instruction on performance of senior high school biology students in Ghana. *Computers and Education*. www.elsevier.com

Pajares, F. (1996). Self-Efficacy Beliefs in Achievement Settings. *Review of Educational Research.* 66: 543-578.

Parry, M. (July, 2010). Outsourced ed: Colleges hire companies to build their online courses. *Chronicle of Higher Education*. Retrieved from http://chronicle.com/article/Outsourced-Ed-Colleges-Hire/66309

Partnership for 21st Century Skills-The P21 Framework. Jenkins, H. (2009). Confronting the Challenges of Participatory Culture; Media Education for the 21st Century (*The John. D. and Catherine T. MacArthur Foundation Reports on Digital Media and Learning*). Cambridge, MA:MIT Press.

Patton, M. Q. (1990). *Qualitative Evaluation and Research Methods*. (2nd Ed).London: Saga Publications.

PBS & Grunwald Associates, (2010). ICT, Constructivist Teaching and 21st Century Learning.

Pilli, O. & Aksu, M. (2013). The effects of computer-assisted instruction on the achievement, attitudes and retention of fourth grade mathematics students in North Cyprus. *Computers & Education*, 62, 62-71.

Pintrich, P. R., Smith, D.A.F., Garcia, T., & McKeachie, W.J. (1991). A Manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ), Report Number NCRIPTAL-91-B-004. Ann Arbor, MI: *National Center for Research to Improve Postsecondary Teaching and Learning.* (ERIC Document Reproduction Service No. ED 338 122).

Powell, T. C. (2001). Competitive advantage: logical and philosophical considerations, Strategic Management Journal, 22(9), pp.875-88.

PricewaterhouseCoopers (2010). *A survey of ICT for education in India and South Asia* [PDF document]. Washington DC: World Bank. Retrieved from http://www.infodev.org/en/Project.103.html

Rallis, B. & Rossman, G. B. (2003). Numbers and Words: Combining Quantitative and Qualitative Methods in a single Large scale Evaluation Study. *Evaluation Review*, 9, 627-43.

Ramey-Gassert, G. Shroyer, P.& Staver, G. (1996) Teachers' computer anxiety: implications for professional development, Education and Information Technologies, 2 (1), pp. 17-30.

Ratner, W. (2008). *A General Guide to Writing Research Proposal and Report: A Handbook for Beginning Researchers, (2nd ed.).*

Russel, B. W. (2006). *Conducting Educational Research*. New York: Harcourt Brace Jonavovich Inc.

Salaway, G., Caruso, J. B., & Nelson, M. R. (2008). The ECAR study of undergraduate students and information technology. *In Research study*, Vol. 2 Boulder, CO, EDUCASE: Centre for Applied Research. Available from. http://www.educausd.edu/ecar.

Samikwo, D. (2013). Factors which Influence Academic Performance in Biology in Kenya: A Perspective for Global Competitiveness. *The International Journal of Current Research. (IJCR.)*Vol. 5, Issue, 12, pp.4296-4300, December, 2013. Available online at *http://www.journalcra.com*

Sawtelle, V. Brewe, E. & Kramer, L.H. (2012). Exploring the Relationship Between Self-efficacy and Retention in Introductory Physics. *J Res Sci Teach*;49:1096-1121.

Schunk, R. L. (2001). Integrating technologies throughout our schools. *Phi Delta Kappan, 82,* 620–624.

Serin, O. (2011). The Effect of Computer-Based Instruction on the Achievement and Problem Solving Skills of the Science and technology Students. *The Turkish Online Journal of Educational Technology. Vol.10, Issue 1.*

Sessional Paper, (2012). Reforming Education and Training in Kenya. A Policy Framework for Education and Training. *Ministry of Education and Ministry of Higher Education, Science Technology.* Republic of Kenya.

Seymour, E. & Hewitt, N.M. (1997). Talking About Leaving: Why Undergraduates Leave the Sciences. *Boulder,* CO: Westview.

Sharifah, L. Stephen C. Downey, S. & Sime, D. (2001). Interplay: Play, learning and ICT in pre-school education. Retrieved from on 7 March, 2011 from www.ioe.stir.ac.uk/.

Shofield, S. & Anderson, G. (1998). E-learning: A Comparison between Expected and Observed attitudes of Normative and Dropout Adolescents. *Education Media International*, *39*(1), 47-54.

Shuttleworth, M. (Nov 3, 2009). Pretest-Posttest Designs. Retrieved Jan 14, 2015 from Explorable.com: https://explorable.com/pretest-posttest-designs

Simon, M. K. (2011). Dissertation and scholarly research: Recipes for success (2011 Ed.). Seattle, WA, Dissertation Success, LLC. www.dissertationrecipes.com

Skrzypek,W., Potyrala, K. & Walosik, A. (2011) Formation Of Biology Students' Social Skills With Use Of Ict Tools. *Western Anatolia Journal of Educational Sciences* (WAJES), DokuzEylul University Institute, Izmir, Turkey. ISSN 1308-8971.

Smith, S. G. & Hardman, J. (2014). The Impact of Computer and Mathematics Software Usage on Performance of School Leavers in the Cape Province of South Africa. *International Journal of Education and Development Using Information and Communication Technology (IJEDICT). Vol.10,Issue 1, pp. 22-40.*

Snyman, M. (2010). South African students study math via cell phone. *Wireless Week*. Retrieved from http://www.wirelessweek.com/News/2010/09/South-African-Students-Study-Math-Cell-Phone-Devices-Mobile-Content/

Sorgo, A. (2010). Information and Communication Technologies (ICT) in Biology Teaching in Slovenian Secondary Schools. *Eurasia Journal of Mathematics, Science & Technology Education.* University of Maribor, Maribor, SLOVENIA.

Souter, David; Adam, Lishan; Butcher, Neil; Sibthorpe, Claire; Tusubira, Tusu. (2014). ICTs for Education in Africa. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/19024 License: CC BY 3.0 IGO.

Squire, K. (2006). From content to context: Video games as designed experience. *Educational Researcher 35*(8), 19–29.

Sud, B. and Schwarzer, L. (2002). *Multiple intelligences and student achievement.* Alexandria, V.A Association for supervision and curriculum development.

Swan, K. (2003). Learning effectiveness online: What the research tells us. Elements of Quality Online Education, Practice and Direction, 4, 13-47.

Tabin, H. J. & Fraser, B. J. (1995). Improving Science Education. National Society for the Study of Education (NSSE). Illinois.

Tabin, K., and Fraser, B. J. (1987). Exemplary practice in Science and Mathematics Education, Perth, Cartin, Western Australia.

Tella, A., Tella, A., Toyobo, O. M., Adika, L. O., &Adeyinka, A. A. (2007). An Assessment of Secondary School Teachers Uses of ICTs: Implications for Further Development of ICT's Use in Nigerian Secondary Schools. *Online Submission*, *6*(3).

The World Bank Group, (2013). http://go.worldbank.org/5WOSIRFA70

Tollefson, N. (2000). Classroom Application of Cognitive Theories of Motivation. *Educational Psychology Review.* Vol. 12, No.1, 2000.

Torkzadeh, G., and Koufterous, X. (1994). Factorial Validity of a Computer Self-Efficacy Scale and the Impact of Computer Training. Education and Psychological Measurement, 54(3).

Turkmen, H. (1996). Perception of Biology Teacher, Classroom Teaching Behavior and Students Achievement in Sudanese Secondary Schools. Unpublished Phd Thesis. University of Hull. UK.

Uluyol, A. Karadeniz B. (2009). Factors Affecting Teachers' use of Information and Communication Technology. International Journal of Instruction, 2(1).

UNESCO. (2012). *ICT in Primary Education - Analytical Survey. Volume 1, Exploring the origins, settings and initiatives.* Moscow: UNESCO

Usher, E. L., & Pajares, F. (2008). Sources of self-efficacy in school: critical review of the literature and future directions. *Rev Educ Res*;78:751-796.

Usher, K. & Pajares, F. (2002). Overview of Social Cognitive Theory and of Self-Efficacy. *Review of Educational Research.* Retrieved January 11 2004 from http://wwwemoryedu/EDUCATION/mfp/effhtml

Van Rooy, W. S. (2012). Using information and communication technology (ICT) to the maximum: learning and teaching biology with limited digital technologies. *Research in Science & Technological Education*, 30:1, 65-80

Veselinovska, S. S. (2014). Use the Interactive Whiteboard in Teaching Biology. *Technics and Informatics in Education.* 5th International Conference, Faculty of Technical Sciences Čačak, 30−31th May 2014. UDK:37.015.2-004.9

Wabuke, M. J. & Samikwo, D. (2013). How Students Characteristics Influence the Performance in Biology Subject in Secondary Schools in Eldoret Municipality, Kenya. *African Journal of Education, Science and Technology* 1(2); pp. 122-127. ISSN: 2309-9240

Watson, J. Murin, A. Vashaw, L. Gemin, B. & Rapp. C. (2010). *Keeping pace with K–12 online learning: An annual review of policy and practice* [PDF document]. Retrieved August 27, 2014: http://kpk12.com/

Wells, J. & Lewis, L. (2006). Internet access in U.S. Public Schools and Classrooms: 1994–2005 (NCES 2007–2007). *U.S. department of Education*. Washington. DC: National Centre for Education Statistics.

Winter, G. (2000). A Comparative Discussion of the notion of 'validity' in Qualitative and Quantitative Research. *The Qualitative Report,* 4 (3–4), March. www.nova.edu/sss/QR/QR4–3/winter.html.

Wioletta, S. Katarzyna P. & Alicja W. (2011). Formation of Biology Students' Social Skills with Use of ICT Tools. *Western Anatolia Journal of Educational Sciences* (WAJES), DokuzEylul University Institute, Izmir, Turkey ISSN 1308-8971.

Yapici, U. & Akbayin, H. (April, 2012). The Effect of Blended Learning Model on High School Students' Biology Achievement and on their Attitudes towards the Internet. *The Turkish Online Journal of Educational Technology (TOJET)* volume II Issue 2.

Yonazi, E. Kelly, T., Halewood, N. & Blackman, C. (2012). "eTransform Africa: The Transformational Use of ICTs in Africa." www.eTransformAfrica.org.

Yu-Hsin Cheng, Ju-Tzu Cheng, & Deng-Jyi Chen. (2012). the Effect of Multimedia Computer Assisted Instruction and Learning Style on Learning Achievement. *WSEAS TRANSACTIONS on INFORMATION SCIENCE and APPLICATIONS.* 1(9), E-ISSN: 2224-3402.

Yusuf M. O. & Afolabi K. (2010). Effects of CAI on Secondary School Student's Performance in Biology. *The Turkish Online Journal of Educational Technology.* Ilorin. Nigeria.

Zimmerman, B. (2000). Self-efficacy: an essential motive to learn. *Contemporary Education Psychology*; 25:82-91.

APPENDICES

APPENDIX I: Letter of Information to the Head Teacher/ Principal.

University of Eldoret,

P. O. Box 1125-30100,

ELDORET

1st May 2016

Dear Sir/ Madam,

RE: RESEARCH DATA COLLECTION

I am a Post graduate student in the school of education, University of Eldoret. I am pursuing a Doctorate degree in Education Science. Your school has been selected to participate in my study. The main objective of this study is to examine the effect of Computer-Assisted Learning on secondary school students learning of Biology in secondary schools. Collection of the data will be through a pre-test and a post-test together with questionnaires. The form three students with their Biology teachers will be involved in the study. The information obtained shall be exclusively confidential and will be used for the research purpose of this study only.

I therefore wish to kindly request you of my (research assistants) visit to your school between May to June 2016. You may contact the researcher for more information about the study and to communicate the findings of the study.

Thank you in advance for accepting to participate.

Yours faithfully,

SAMIKWO C. DINAH - EDU/DPHIL.SE/1003/12

APPENDIX II: Consent Letter to the Participant.

University of Eldoret,

P. O. Box 1125-30100,

ELDORET

1st May 2016

Dear Participant,

I am a Post graduate student in the school of education, University of Eldoret. I am pursuing a Doctorate degree in Education Science. For this reason I would kindly appreciate if you spare a few minutes to fill the questionnaire provided. The main objective of this study is to examine the effect of Computer-Assisted Learning on secondary school students learning of Biology in secondary schools.

You are requested to provide sincere and accurate responses to all the items in the research questionnaire to the best of your knowledge. The information you give will be kept confidential and will only be used for academic purpose. Please do not write your name. You may contact the researcher for more information about the study and to communicate the findings of the study.

Thank you in advance for accepting to participate.

Yours faithfully

SAMIKWO C. DINAH - EDU/DPHIL.SE/1003/12

APPENDIX III: NACOSTI RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MS. DINAH CHESAMI SAMIKWO
of UNIVERSITY OF ELDORET, 8205-30100
eldoret, has been permitted to conduct
research in Bungoma County
on the topic: EFFECT OF COMPUTER-ASSISTED LEARNING ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN BIOLOGY IN KENYA. A CASE OF SELECTED SCHOOLS IN MT-ELGON, BUNGOMA COUNTY.
for the period ending:
3rd May,2017

Permit No : NACOSTI/P/16/60092/10244
Date Of Issue : 4th May,2016
Fee Recieved :Ksh 2000

Applicant's Signature

Director General
National Commission for Science, Technology & Innovation

CONDITIONS

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

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 8998

CONDITIONS: see back page

APPENDIX IV: LETTER OF RESEARCH AUTHORIZATION NACOSTI

NATIONAL COMMISSION FOR SCIENCE,
TECHNOLOGY AND INNOVATION

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

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

Ref. No. **NACOSTI/P/16/60092/10244**

Date: **4th May, 2016**

Dinah Chesami Samikwo
University of Eldoret
P.O. Box 1125-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effect of computer assisted learning on secondary school students'achievement in biology in Kenya. A case of selected schools in Mt. Elgon, Bungoma County,"*** I am pleased to inform you that you have been authorized to undertake research in **Bungoma County** for the period ending **3rd May, 2017.**

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

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

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

Copy to:

The County Commissioner
Bungoma County.

The County Director of Education
Bungoma County.

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

APPENDIX V: LETTER FROM COUNTY DIRECTOR OF EDUCATION

REPUBLIC OF KENYA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
State Department of Education – Bungoma County

When Replying please quote
e-mail: bungomacde@gmail.com

Ref No: BCE/DE/19 VOL I/209

County Director of Education
P.O. Box 1620-50200
BUNGOMA
Dates: 17th May, 2016

The Sub - County Directors of Education
MT. ELGON SUB - COUNTY

RE: AUTHORITY TO CARRY OUT RESEARCH – DINAH CHESAMI SAMIKWO – PERMIT NO: NACOSTI/P/16/60092/10244

The bearer of this letter Dinah Chesami Samikwo is a student of University of Eldoret. She has been authorized to carry out research on ***"Effect of computer assisted learning on secondary school students' achievement in biology in Kenya. A case of selected schools in Mt. Elgon, Bungoma County," the*** research period runs up to **3rd May, 2017.**

Kindly accord her the necessary assistance.

CHRISTINE OWINO
FOR: COUNTY DIRECTOR OF BUNGOMA
BUNGOMA COUNTY.

APPENDIX VI: LETTER FROM COUNTY COMMISSIONER

REPUBLIC OF KENYA

OFFICE OF THE PRESIDENT

MINISTRY OF INTERIOR AND COORDINATION OF NATIONAL GOVERNMENT

Telephone: 055- 30326
FAX: 055-30326
E-mail: bungoma@yahoo.com
When replying please Quote

REF:ADM/15/13/232

County Commissioner's Office
Bungoma County
P.O. Box 550 - 50200
BUNGOMA

17th May,2016

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION

The bearer of this letter Dinah Chesami Samikwo , has sought an authority to carry out research on "***Effect of Computer assisted learning on Secondary school students achievement in Biology in Kenya***" In Mt. Elgon Sub County, Bungoma County for a period ending 3rd May, 2017.

Authority is hereby granted for the specific period and any assistance accorded to her in this pursuit would be highly appreciated.

COUNTY COMMISSIONER BUNGOMA

P.N. Njeru
For: County Commissioner,
BUNGOMA COUNTY.

APPENDIX VII: STUDENTS QUESTIONNAIRE

This is NOT an Examination. There is no right or wrong answers. The purpose of this questionnaire is to help me fulfill part of my study requirements at the University of Eldoret where I am undertaking a PHD degree in Science Education. The responses will be used for purely academic purposes. You are kindly requested to participate and respond to the items in this questionnaire in the best way possible. The data obtained will be treated with utmost confidentiality and will be used for the purpose of the study only. Put a tick (√) in the appropriate box. Do not write your name anywhere on this questionnaire. Please answer all questions to the best of your knowledge and ability.

SECTION 1: Background Information

1. Gender

   Male ☐

   Female ☐

2. To what extent are you familiar with the following computer applications?

   Indicate your level of agreement with the following statements.

   1 – Not at all **2 – Small extent** **3 – Large extent**

	Application	**1**	**2**	**3**
1	Word processing (Ms. Word)			
2	Databases (Ms. Access)			
3	Spread sheets (Ms. Excel)			
4	Presentation (PowerPoint)			
5	Web browser (internet explorer, Mozilla Firefox)			

3. Do you feel confident using the computer on your own?

Yes ☐ No ☐

SECTION 2: Influence of CAL on student Attitude Towards Biological knowledge

The use of CAL in schools has played an important role in the learning of Biology. Indicate your level of agreement with the following statements.

SA- Strongly Agree A-Agree U-Undecided D- Disagree SD-Strongly Disagree

NO	STATEMENT	SA	A	U	D	SD
1	CAL has improved my curiosity towards learning Biology.					
2	I look forward to my Biology lesson at the Computer Laboratory.					
3	CAL has improved my understanding of Biological concepts.					
4	I ask questions that demonstrates the understanding of biological concepts during CAL lessons.					
5	I understand the explanations from my Biology teacher that accompany the power point presentations.					
6	The power point presentations are too difficult to understand					
7	The animations and simulations are just like normal videos for me.					
8	CAL has not improved my attitude and motivation towards learning Biology.					

SECTION 4: SCALE ITEMS FOR SELF-EFFICACY TOWARDS CAL IN BIOLOGY LEARNING.

Indicate your level of agreement with the following statements.

SA - Strongly agree A- Agree U- Undecided D- Disagree SD - Strongly disagree

	SCALE ITEMS	SA	A	U	D	SD
1	I like going to the computer lab for CALP lessons in Biology.					
2	I enjoy watching and listening to CALP.					
3	I am able to take well organized notes during Biology CALP lessons.					
4	I participate in the CALP biology class by answering the teacher's questions.					
5	I can relate the CALP content to the material in Biology textbooks.					
6	I enjoy explaining and teaching other students about the CALP course content.					
7	Apart from CALP notes, I also read extra information from other reference books.					
8	I study hard and revise the CALP lesson presented by my teacher in class.					
9	I pay close attention to what the teacher says during CALP classes.					
10	I finish my homework well during CALP lessons every day.					
11	After learning with CALP, I have more confidence in dealing with Biology lessons.					
12	I seek help from my teacher when I get stuck in CAL biology tasks.					

APPENDIX VIII: INSTRUCTION FOR TEACHERS AND SAMPLE LESSON PLANS TO BE USED FOR (CAL) PACKAGE.

The Biology teacher should begin each lesson with a brief introduction and an overview of the topic Classification. After introduction, insert the Computer-assisted Learning Programme (CALP) provided which contains Biology components on the topic classification. When the CALP has been inserted into the computer, the topic as contained in the CALP will be displayed on the computer screen. The teacher will then use Power-point computer software to project the contents onto a large screen for visibility to all the learners in the class. The CALP contains already stored slides which contain detailed explanations, pictures and activities that relate to the topic classification which has been selected. The teacher then guides the learners through the study by explaining and answering the questions asked in class. Also evaluate the students using the multiple choice questions contained in the package. This is to ensure that students understand the lesson properly.

The teacher should following sample lesson plans:

TEACHER'S MANUAL (LESSON PLAN) FOR COMPUTER ASSISTED LEARNING PROGRAMME ON CLASSIFICATION IN BIOLOGY

INSTRUCTIONS

i) Use the following module in teaching the classification topic.

ii) Provide the learners with objectives of the lesson and levels of performance before the lesson.

iii) Monitor student's work providing corrective feedback as necessary and assess the performance of different groups in determining whether the classes are ready for the next instruction.

LESSON 1

TOPIC: CLASSIFICATON

Subtopic: Binomial Nomenclature

Objective: By the end of the lesson the learners should be able to:

i) Define the term binomial nomenclature

ii) State the general principles of classification

iii) Classify the human being using the taxa of classification

INTRODUCTION (5MIN)

The teacher introduces the lesson by reviewing previous lesson

Teacher leads the class in review of meaning of and the importance of classification

Teacher provides the learners with objective of the lesson and levels of performance.

LESSON DEVELOPMENT (30 MINUTES)

Teacher explains the term binomial nomenclature

Teacher and learners discuss the following:-

- The general principles of classification
- Classification of the human being into various taxonomic levels (after learners have done the classification a power point slide is projected to show the expected way of how scientific classification of human being is done)

-Learners follow instructions given in the power point slides to classify a domestic cat and weaver bird.

-Learners take brief notes

-Teacher monitor students work, providing corrective feedback as necessary, and assess the performance of the group.

CONCLUSION (5 min)

Teacher summarises the lesson

Teacher gives assignment which the learners have to hand in later

Teachers marks the assignment before next lesson. He/she reteaches the concepts which the learners did not understand.

LESSON 2 and 3

TOPIC: Classification

Subtopic: General characteristics of the Kingdoms

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

i) Name the kingdoms of classification

ii) State the characteristics of the kingdoms used in classification

INTRODUCTION (10MIN)

The teacher introduces the lesson by reviewing the previous lesson by way of question and answer method.

–The teacher provides the objectives of lesson and level of performance.

–Teacher discusses the procedure of the lessons, the different parts of the lesson and student's responsibility during each activity.

–Teacher encourages every learner to participate in performing each learning activity.

–Teacher advices learners to make accurate observations of the power point slides and communicate them using acceptable scientific language.

–Learners proceed to their working groups.

LESSON DEVELOPMENT (50mins)

–Teacher explains the learning activity/activities. That is, learners observe the power

point slides showing a variety of organisms and use observable features of the organism to place the organisms into their respective kingdoms).

–Teacher moves from group to group monitoring student's work providing corrective feedback as necessary and assess performance of the groups in determining whether the class is ready for the next instruction.

–Teacher encourages every learner to participate in performing each learning activity.

–Teacher advices learners to make accurate observations of the power point slides and communicate them using acceptable scientific language.

–Learners proceed to their working groups.

–Teachers moves to discussion when all learners have performed the activities.

DISCUSSION (15MIN)

–The teacher and learners discuss the result/observations on the learning activities.

–This is done by way of question and answer method. The teacher guides the learners through the discussion to arrive at accurate observations and inferences.

–Learners take down brief notes.

–Teacher gives learners the summary of characteristics of kingdoms of classification using power point presentation.

CONCLUSIONS (5 MINS)

The teacher summaries on the subtopic and give assignments to be done and handed later Teacher marks assignment before next lesson

LESSON 4

Topic: Classification

Subtopic: Phylum Arthropoda

OBJECTIVES: By the end of the lesson the learners should be able to:

i. State the general characteristics of phylum Arthropoda.

ii. Name the classes of phylum Arthropoda

iii. State the characteristics of organisms of the classes in phylum Arthropoda.

INTRODUCTION: (5MINS)

–The teacher introduce the lesson by reviewing the previous lesson by question and answer method.

–Teacher provides objectives of the lesson to the learners and the level of performance required.

–Teacher discusses the procedures of the lesson the different parts of the lesson and student's responsibility during each activity.

–Teacher encourages every learner to participate in performing each learning activity.

–Teacher advices learners to make accurate observations of the power point slides and communicate them using acceptable scientific language.

–Learners proceed to their working groups.

LESSON DEVELOPMENT (25 MINS)

–The teacher guides the learners in carrying out the lesson activity (observation of power point slides with photographs of organisms of phylum Arthropoda).

–Teacher monitor student's work providing corrective feeds back as necessary and assesses performance of the group in determining whether the classes ready for the next instruction.

DISCUSSION/CONCLUSION (10 MIN).

–The teacher and learners discuss the results /observations of the learning activity.

–Teacher guides the learners through discussion to make sure that misconceptions are corrected and learners' record correct information.

–Learners take down brief notes.

–Teacher summarizes the lesson and gives an assignment to be done and handed later.

–Teacher marks the assignment before the next lesson and clarifies the information that was not understood.

APPENDIX IX: PRE-TEST AND POST-TEST ITEMS

Computer Assisted Learning Achievement Test (CALAT)
Pre-Test Item Time: 1 Hour

1. Gender

Male ☐ Female ☐

2. Name of School _____

Instructions.

Answer the questions with sincerity. Cheating is strictly not allowed.

Do not write your name on this paper.

Answer the questions in the spaces provided.

Questions

1. Place the following list of taxonomic categories in their correct sequence in ascending order: genus; phylum; family; species; order; class. (1 mk)

2. The scientific name of the cat is *Felis catus* classify the cat into; (3mks)

   i) Kingdom……

   ii) Genus……

   iii) Species……

3. A student in form three caught an organism which had the following characteristics

i) Body divided into two parts.

ii) Simple eyes.

iii) Eight legs.

Classify the organism up to the class level. (3 mks)

a) Name the body covering found in members of phylum Arthropoda. (1 mk)

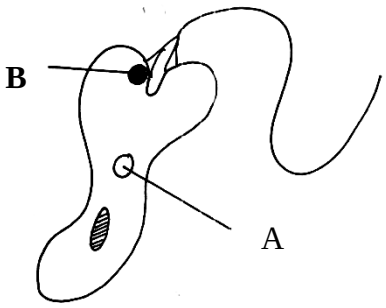
b) State three uses of the structure you have identified in (a) above for the survival of arthropods. (3 mks)

5. State two characteristics that are used to classify:-

a) Arthropods into classes (2 mks)

b) Insects into orders (2 mks)

6. Study the organism shown below and answer the questions that follow.



(a) Name the organism drawn above. (1mk)

……

(b) Identify the part labeled (2mks)

A……..

B……..

(c) In which two ways is the organism adapted to its movement in water. (2mks)

(i)……..

(ii)…….....

(d) Name the kingdom to which this organism belongs. (1mk)

……

(e) (i) State the function of the part labeled B. (1mk)

……

(ii) State two ways in which the organism resembles an animal and a maize plant . (2mk)

7. Insecta is the most abundant members of a single class of the kingdom Animalia. Discuss the various factors that have contributed to the great success of Arthropods. (20 mks)

Post-Test Items Time: 1 Hour

1. Gender

Male ☐ Female ☐

2. Name of School

_____

Instructions

Answer the questions with sincerity. Cheating is strictly not allowed.

Do not write your name on this paper.

Answer the questions in the spaces provided in this paper.

1. (a) What is meant by the term binomial nomenclature? (1 mk)

_____

(b) Give three reasons why classification is important. (3 mks)

_____

(c) Living organisms are classified into five Kingdoms. Name any them. (5 mks)

(d) The scientific name of black jack plant is BIDENS PILOSA.

(i) Write the scientific name given above following the accepted system of naming. (1 mk)

_____

(ii) Name the particular taxonomic units represented by the two terms. (2 mks)

_____

(iii) A species has many features in common. State the most common feature of a species in any group. (1mk)

2. which taxonomic group (taxon) contains:

(a) The largest number of individuals.

_____ (2 mark)

(b) Individuals with most similarities.

_____ (2mark)

3. An animal has an exoskeleton, 8 jointed legs, segmented body and two body parts. Name the phylum and class to which the animal belongs. (2 marks)

Phylum _____

Class _____

Write down two functions of exoskeleton in the phylum Arthropoda. (2 marks)

_____

_____

_____

2. Below is a list of organisms, which belong to classes Insecta, Diplopoda, Chilopoda and Arachnida; Tick, Centipede, Praying mantis, Tsetse fly, Millipede and Spider. Place the organisms in their respective classes in the table below. Give reason in each case. (6 marks)

Classes	**Organisms**	**Reasons**
Insecta		
Diplopoda		
Chilopoda		
Arachnida		

3. State three external differences between Chilopoda and diplopoda. (6 marks)
4. (a) State three characteristics of class Aves

(3mks)

……

……

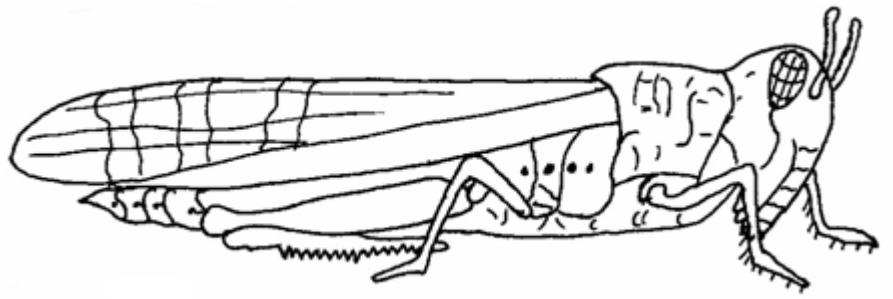
……

(b) Name the phylum to which a tick belongs

(1mk)

……

5. The diagram **below** represents a member of the animal phylum.



(a) (i) Name the phylum to which the specimen belongs. (1 mark)

_____

(ii) State **three** characteristics found in the members of this phylum. (3 marks)

_____

_____

_____

(b) (i) Name the class to which the specimen belongs. (1 mark)

_____

(ii) Using the diagram, state **four** observable characteristics found in the members represented by the drawing of the organism above. (4 marks)

_____

_____

_____

_____

(c) (i) Name the type of growth exhibited by members of the phylum named **a(i) above**. (1 mark)

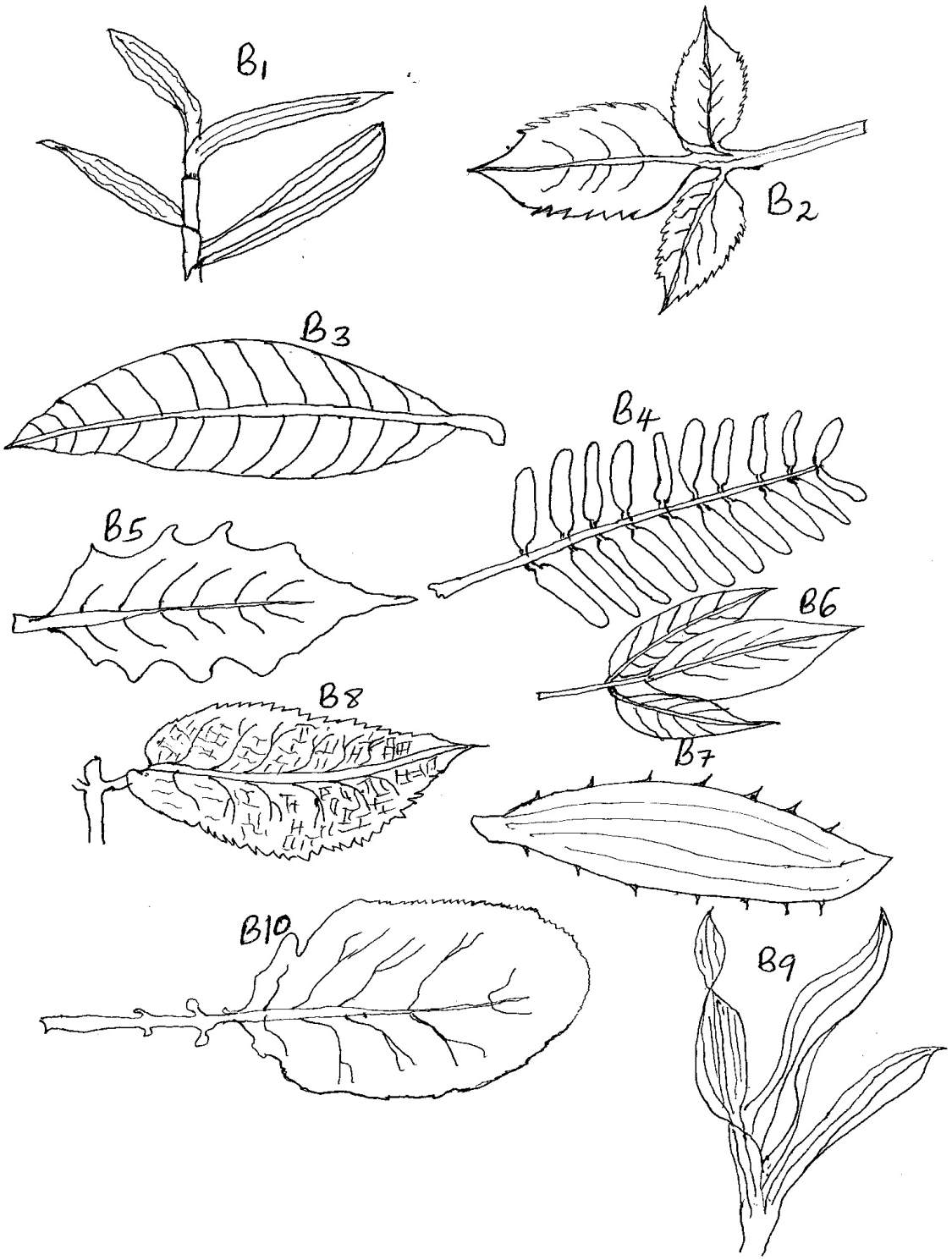
_____

(ii) What causes the type of growth named in **c(i) above**. (1 mark)

_____

_____

6. **Below** is a dichotomous key which can be used to identify specimens **B1 B2**, **B3 B4**, **B5**, **B6**, **B7**, **B8**, **B9**, **B10**.



Dichotomous

1. (a) Leaf parallel veined ----------go to 2
   (b) Leaf network veined ----------go to 4

2. (a) Leaf straight ----------Tradescantia
   (b) Leaf wavy ----------go to 3

3. (a) Leaf with thorns on margin ----------sisal
   (b) Leaf smooth on the margin ----------maize

4. (a) Leaf simple ----------go to 5
   (b) Leaf compound ----------go to 8

5. (a) Leaf margin entire ----------mango
   (b) Leaf margin serrated ----------go to 6

6. (a) Leaf texture rough ----------go to 7
   (b) Leaf texture smooth ----------Brassica spp.

7. (a) Leaf blade lanceolate ----------solanum spp.
   (b) Leaf blade broad ----------Lantana camara

8. (a) Leaf trifoliate ----------go to 9
   (b) Leaf Bipinnate ----------Acacia spp.

9. (a) Leaflet margin serrated ----------Bidens pilosa
   (b) Leaflet margin entire ----------pigeon pea

(i) Identify the specimen in the drawings using the key and outline the step followed to identify each specimen.

(10 marks)

Specimen	Identity	Step followed
B1	_____	_____
B4	_____	_____
B7	_____	_____
B8	_____	_____
B9	_____	_____

(ii) (a) To which class does specimen **B10** belong? (1 mark)

_____

(b) Give **two** reasons for your answer in **(iia) above**.
(2 marks)

_____

_____

_____

_____

APPENDIX X: INTERVIEW GUIDE FOR BIOLOGY TEACHERS

1. Do your students feel confident using the computer-assisted learning on their own?
2. What is the effect of CAL on students' attitudes and towards Biology subject?
3. In your opinion, how do you compare CAL and conventional methods of teaching and learning in terms of learners' interests?
4. In your opinion, how do you compare CAL and conventional methods of teaching and learning in terms of the learners' self-efficacy?
5. Does using computer-assisted learning to teach fit your teaching style?
6. Does CAL have considerable potential to allow students to improve their self-efficacy?
7. How does CAL affect students achievement in Biology subject?
8. Does CAL help you to teach more effectively? If yes, explain how?
9. How do you use CAL to make Biology subject interesting to your learners in the teaching and learning process.

APPENDIX XI: KREJCIE AND MORGAN TABLE

Krejcie and Morgan, Table for Determining Sample Size from a Given Population

Table X: Recommended Sample Size from a Given Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	373
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	225	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Key: “N” is the population size “S” is the sample size

Proportionate sample members= $\frac{\text{Total population x sample size}}{\text{Total population}}$

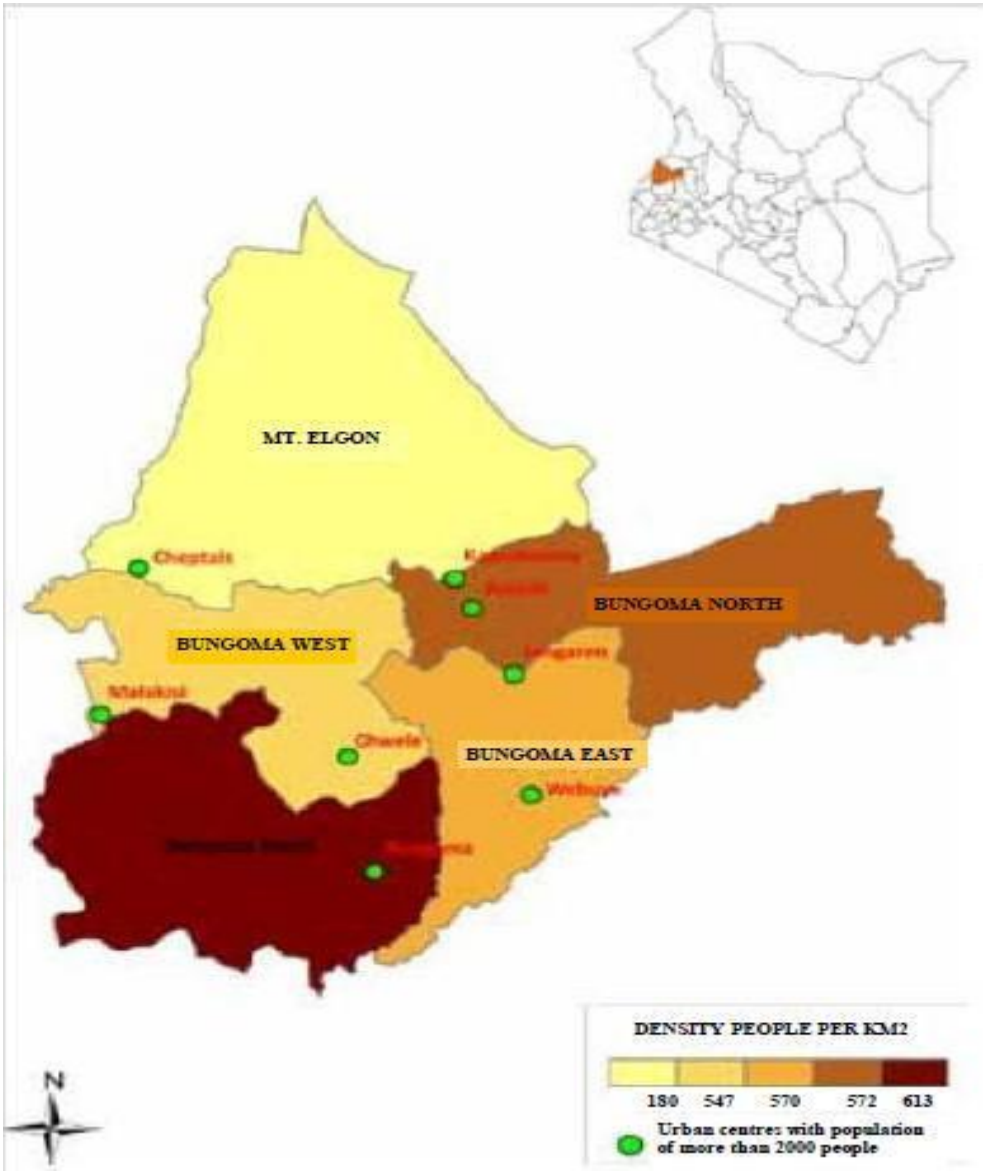
APPENDIX XII: MT. ELGON SUB COUNTY BIOLOGY MEAN SCORES

SCHOOL	2010	2011	2012	2013	2014
1	4.346	5.482	4.841	4.981	5.071
2	5.125	5.212	5.415	5.678	4.990
3	4.215	3.458	4.222	4.123	4.193
4	3.121	3.212	3.150	3.211	3.235
5	3.581	3.678	3.150	3.812	5.085
6	2.815	2.856	3.212	2.850	2.701
7	3.885	4.711	3.231	4.957	6.427
8	1.760	2.940	4.382	3.160	3.854
9	3.212	3.481	2.321	3.012	2.911
10	6.500	6.054	3.567	6.348	5.880
11	2.527	2.235	6.606	3.140	5.550
12	3.400	4.678	2.720	3.854	4.606

Source: Mt. Elgon sub county director of education examination office (2014)

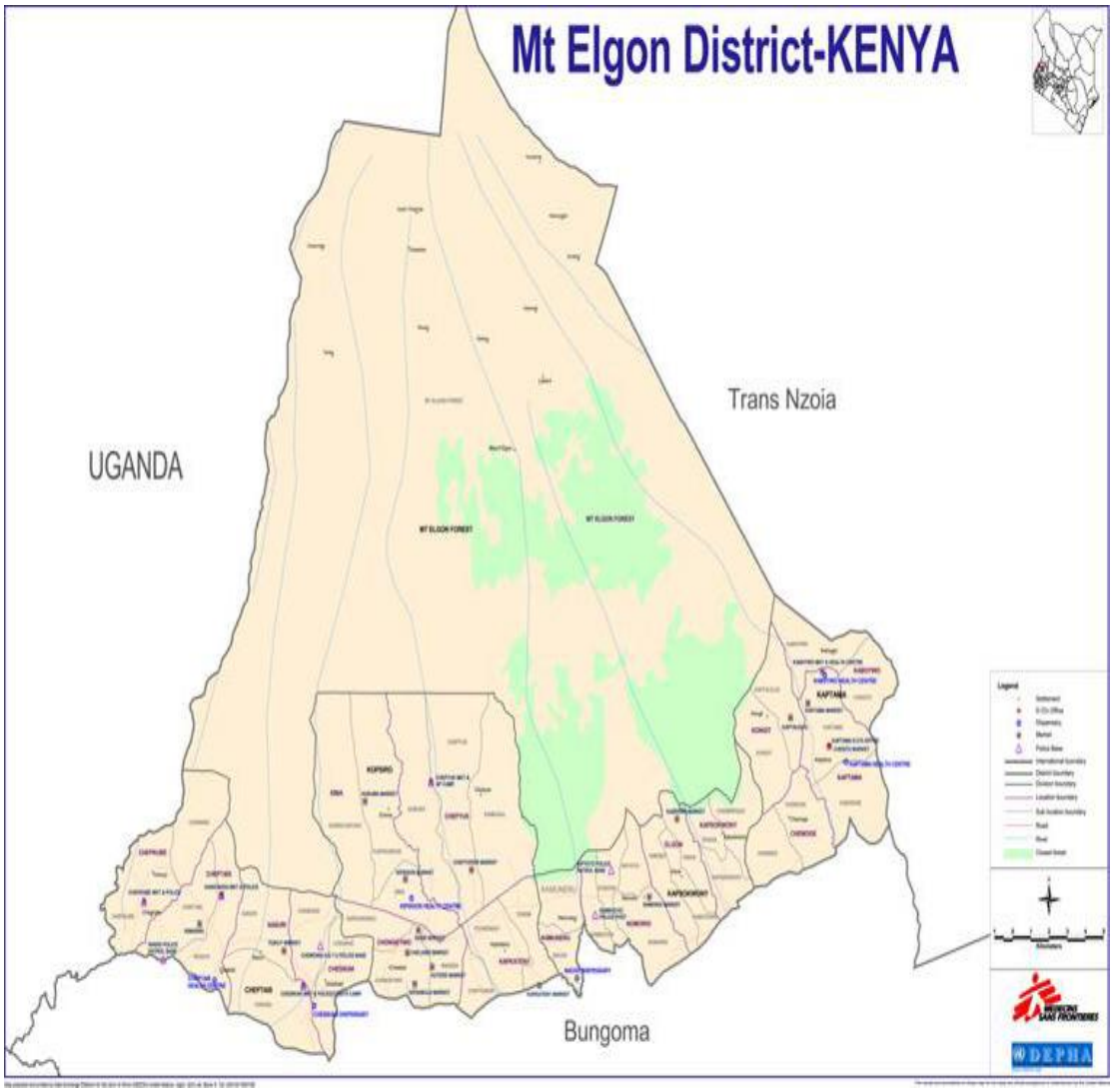
Table showing the mean score for Biology in Mt. Elgon Sub-County from the year 2010 – 2014 for 12 schools.

APPENDIX XIII: MAP SHOWING BUNGOMA COUNTY



Source: Google Maps www.hrw.org

APPENDIX XIV: MAP SHOWING MT. ELGON SUB- COUNTY



Source: Google Maps www.hrw.org

APPENDIX XV: LIST OF SCHOOLS IN MT ELGON SUB-COUNTY

SR	SCHOOL	CATEGORY	STATUS WITH COMPUTERS
1.	CHEPKUBE SA	Boys Boarding	Not Equipped
2.	ACK CHEPKUBE SEC	Mixed	Not Equipped
3.	CHEPTAIS BOYS	Boys Boarding	Equipped
4.	KIPSIS SEC	Mixed	Not Equipped
5.	TOROSO GIRLS	Girls Boarding	Equipped
6.	KIM GIRLS	Girl Boarding	Not Equipped
7.	CHESIKAKI SEC	Mixed	Not Equipped
8.	KIMABOLE SEC	Mixed	Not Equipped
9.	CHELEBEI SEC	Mixed	Not Equipped
10.	KAPKATENY SEC	Mixed	Not Equipped
11.	CHEPYUK SEC	Mixed	Not Equipped
12.	KAPKIRUOK SEC	Mixed	Not Equipped
13.	KAMNERU SEC	Mixed	Not Equipped
14.	KIMOBO SEC	Mixed Day/ Boarding	Equipped
15.	KIBUK GIRLS SEC	Girls Boarding	Equipped
16.	KAPSOKWONY BOYS	Boys Boarding	Equipped
17.	KAPTOLA SEC	Mixed	Not Equipped
18.	CHEMOGE SEC	Mixed	Not Equipped
19.	KIPCHIRIA SEC	Mixed	Not Equipped
20.	KONGIT SEC	Mixed	Not Equipped
21.	MOI KAPTAMA BOYS SECONDARY	Boys Boarding	Equipped
22.	MOI KAPTAMA GIRLS SECONDARY	Girls Boarding	Not Equipped
23.	CHESITO SEC	Mixed	Not Equipped
24.	KABOYWO SEC	Mixed	Not Equipped
25.	SENDERA SEC	Mixed	Not Equipped
26.	BISHOP OKIRING SEC	Mixed	Not Equipped
27.	ST. MARKS KIPCHIRIA	Mixed	Not Equipped