IMPACT OF SELECTED INSTRUCTIONAL METHODS ON STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY IN SECONDARY SCHOOLS IN NANDI SOUTH SUB-COUNTY, KENYA

TECLA LAGAT

A THESIS SUBMITTED TO THE SCHOOL OF EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF EDUCATION IN EDUCATIONAL TECHNOLOGY

MOI UNIVERSITY
ELDORET

2019

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 Moi University.

…… ……

Lagat Tecla Date

EDU/PGCM/1028/12

Declaration by the Supervisors

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

…… ……

Prof Khaemba Ongeti Date

Department of Curriculum, Instruction and Educational Media

Moi University

…… ……

Prof Marcella Mwaka-Kyalo Date

Department of Curriculum, Instruction and Educational Media

Moi University

DEDICATION

I dedicate this work to my sweet daughter Stephanie Jebet and to my late Mum; Mary Lagat, who selflessly supported me morally during the difficult time, untiringly inspiring me on and for taking care of my daughter in my absence. I also dedicated this work to my loving Dad, Stanley Lagat, for his unwavering support towards this cause.

ACKNOWLEDGEMENTS

I am indebted to my supervisors, Prof Khaemba Ongeti and Prof Marcella Mwaka-Kyalo for their steadfast guidance during the development of this thesis. I wish to thank all my colleagues in Moi University for their insights and criticisms during the drafting of this thesis. I am greatly indebted to my respondents in Nandi South Sub-County who wilfully cooperated with me during the data collection process. I wish to thank most sincerely my family members for their moral and material support.

To God be the Glory.

ABSTRACT

With the introduction of computer into the educational system, it has been discovered that teaching could be done in a more flexible way through Computer-Assisted Instruction in order to make it more responsive to student's learning. It has been observed that poor performance in the sciences is caused by the poor quality of science teachers, poor pedagogical techniques and lack of suitable and adequate science equipment. The purpose of this study was to investigate the influence of computer-assisted instruction and conventional instruction on academic achievement of secondary school students in Biology in national examinations in Nandi south sub-County. The study sought to achieve the following objectives: to establish teachers' and students' attitude towards Computer-Assisted Instruction (CAI) and conventional Instruction (CI) in secondary schools in Nandi South sub-County.; to find out the influence of Computer-Assisted Instruction (CAI) on academic achievement of students in Biology in secondary schools in Nandi South sub-County; to find out the influence of Conventional Instruction (CI) on academic achievement of students in Biology in secondary schools in Nandi South sub-County; and, to establish the impact of a combined use of Computer-Assisted Instruction (CAI) and Conventional Instruction (CI) on academic achievement of students in Biology in secondary schools in Nandi South sub-County. The study was based on Cognitive Theory of Multimedia Learning which states that active learning occurs when a learner engages in three cognitive processes: selection, organization, and integration. The study adopted a descriptive research design approach. The target population for this study comprised all head teachers, students and teachers of Biology in all secondary schools in Nandi South sub-County. Eleven secondary schools were selected using simple random sampling technique while 11 head teachers and 24 teachers of Biology were selected using purposive sampling. Kathuri and Pals' formula was used to compute a sample of 368 students. The students were selected using simple random sampling technique. Questionnaire and interview schedule were the main data collection tools. Responses from all questionnaire items and interview schedule items were cross-checked to facilitate coding and processing for analysis. Responses from interview schedules were analysed descriptively. Chi-square correlation analysis was computed to investigate the relationship between attitude of teachers and students towards CAI and CI and academic achievement in Biology. Findings of the study were presented in form of cumulative frequency tables, percentages, charts and graphs. The study established that: majority of students preferred that Biology be taught entirely through CAI as opposed to CI; majority of teachers preferred CI over CAI claiming that CAI wastes time and is more complicated; and, a combined use of CAI and CI was found to be more effective than singly using CAI or CI. The study recommends that: in order to promote the use of CAI in teaching Biology, training should be given to both pre-service and in-service teachers for developing instructional materials for CAI; development of CAI material should be made part of teaching subjects and the student teachers should develop computer assisted instructional material for at least one unit of a particular class; and, the teacher educators should motivate the pre-service as well as the in-service teachers to develop positive attitude towards the application of CAI in the teaching-learning process.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

ICAI	Individualized Computer-Assisted Instruction
ICT	Information Communications Technology
CAI	Computer-Assisted Instruction
CAL	Computer-Assisted Learning
CAIM	Computer-Assisted Instruction Material
CBI	Computer-Based Instruction
CI	Conventional Instruction
CCAI	Cooperative Computer Assisted Instruction
CRT	Criterion Reference Test
CTML	Cognitive Theory of Multimedia Learning
KCSE	Kenya Certificate of Secondary Education
RSPM	Raven's Standard Progressive Matrices

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter presents the background to the study, statement of the problem, objectives and hypotheses of the study, justification of the study, significance of the study, scope and limitations, theoretical framework and conceptual framework and finally, operational definition of terms.

1.2 Background to the Study

In spite of the importance and popularity of Biology among secondary school students in Kenya, performance of this subject in national examinations has generally been average (Ahmed, 2008). The desire to establish the causes of the low performance in Biology has been the focus of researchers for some time now. It has been observed that poor performance in the sciences is caused by the poor quality of science teachers, poor pedagogical techniques, overcrowded classrooms, and lack of suitable and adequate science equipment (Abdullahi, 2009). However, Ahmed (2008) underscores methods of instruction as key in determining students' achievement in Biology. Computer-Assisted Instruction (CAI) is one teaching approach that is considered effective in the teaching of Biology. However, research evidence on whether teaching of Biology using Computer-Assisted Instruction is more effective than using Conventional Instruction remains scanty.

CAI is an educational method that uses computers as a medium that facilitates teaching and learning. This educational method has been formed by combining computer technology and learning principles by oneself (Hancer & Tüzeman, 2008). In CAI,

students are led through a lesson by a step-by-step strategy, being directly informed about their own progress and with the teacher's adjustment to every student. In this way, every pupil learns independently, individually and at their own speed (Pejić, 2006).

CAI allows learners to be able to take increasingly more responsibility to choose, control, and evaluate their own learning activities, which can be pursued at any time, at any place, through any means, at any age. Simply put, learners can decide what they want to learn and in what order (Pilli, 2008). Further, CAI is visually attractive, since it presents concepts using demonstrations that are made attractive by animation, colour and sound. In addition, CAI captures and holds learners' attention by providing opportunities for competition, with the learners' previous performance as the opponent (Mahmood, 2006).

CAI also eliminates misconceptions by providing immediate feedback, since immediate feedback prevents incorrect learning concepts. In Computer-Assisted Instruction, rote learning is minimized and meaningful learning can occur (Renshaw & Taylor, 2000). Many science teachers, educators, and researchers have proposed to employ CAI in the teaching of Biology. However, as pointed out by Hancer and Tüzeman (2008), not all biological contents are appropriate for implementing CAI. There are some content that require the application of CI. This has been confirmed by many studies that examine the effectiveness CI and CAI in the implementation of various biological contents.

Çepni *et al*. (2006) investigated the effects of Computer-Assisted Instruction Material (CAIM) related to the topic 'Photosynthesis' on students' cognitive domain levels (knowledge, comprehension and application). The results of the research showed that the

overall success of students in the CAIM group in the overall achievement test was significantly higher in comparison to the success of students from the CI group. Analysing the success of students on individual cognitive domains, students from the CAIM group achieved significantly better results compared to the pupils from the control (CI) group.

Yusuf and Afolabi (2010) investigated the effects of Individualized Computer Assisted Instruction (ICAI) and Cooperative Computer Assisted Instruction (CCAI) on secondary school students' performance in biology compared to Conventional Instruction (CI) in the topics covering Food chain, food web, energy flow, nutrient, movement, and pyramid of numbers. It was found that the performance of students exposed to CAI either individually or cooperatively was significantly better than the performance of their counterparts exposed to CI. Comparing the efficiency of ICAI and CCAI, significantly higher achievement of students was accomplished with CCAI method. During the implementation of the teaching unit, eyesight and sense, Katircioglu and Kazanci (2003) monitored the effectiveness of the group performing individual work with a programmed multimedia presentation and the group with teacher's help in addition to slide show compared to the control (CI) group. The results of this study showed that pupils of experimental groups achieved significantly greater success than the pupils from the control group.

Efe and Efe (2011) examined the effectiveness of CAI compared to CI in the implementation of teaching a topic on cell biology in the first grade of secondary school. Students who were taught by CAI software which contained a large number of simulations were more successful in solving problems in six cognitive domains. The authors emphasized

that pupils should be enabled to learn the contents by using this type of software given that they use visualization in order to easily understand the structure of cells, the function of various cell organelles, cell division, transport of oxygen, food and water through the cell membrane, active and passive transport and membrane potential (Efe & Efe, 2011). In addition, according to Hancer and Tüzeman (2008), CAI is more efficient than CI concerning the increase of academic achievement of students in the realization of lessons: Digestion and Excretion Systems (Pektas *et al*., 2006), Floral Plants (Akcay *et al*., 2005), Increase and Inheritance of Lives (Yoldas, 2011), Reproduction of Plants and Animals (Soyibo & Hudson, 2007). On the other hand, there are studies in Biology teaching which demonstrated higher effectiveness of traditional teaching in comparison to CAL in the realization of lessons. Such studies include, cell division (Owusu *et al*., 2010), Photosynthesis and Introduction to Genetics (Morrell, 2012), Enzymes (Güler & Saglam, 2009).

CAI application in Biology teaching has not been fully explored. Possible reasons for that include the lack of computer equipment in Biology cabinets, inadequate published educational software, and insufficient training of teachers of Biology for using computers in teaching (Drakulić i sar, 2011; Terzić i Miljanović, 2009a). Grujičić and Miljanović (2005) and Terzić and Miljanović (2009b) examined the effectiveness of cooperatively applied multimedia application in the teaching of Biology in the instructions of *Angiosperms* in the fifth grade of primary school, and *Biology of the Development of Animals* in the third grade of secondary school, respectively. The results of their research showed that the use of computers in the teaching of Biology was much more efficient than traditional teaching in terms of quality, durability and applicability of knowledge.

In a review of empirical studies on CAI, Cotton (2007) concluded, among others, that the use of CAI as a supplement to conventional instruction produces higher achievement than the use of conventional instruction alone, research is inconclusive regarding the comparative effectiveness of conventional instruction alone and CAI alone, and that computer-based education (CAI and other computer applications) produce higher achievement than conventional instruction alone. In addition, students learn instructional contents faster with CAI than with conventional instruction alone, they retain what they have learned better with CAI than with conventional instruction alone, and CAI activities appear to be at least as cost effective as and sometimes more computer assisted instruction has been found to enhance students' performance than the conventional instructional method in counsellor education (Karper, Robinson & Casado-Kehoe, 2005). Similarly, college students taught statistics using lecture-plus-CAI obtained higher averages on midterm and final exams than students taught using lecture method only (Basturk, 2005).

CAI is insufficiently applied in the teaching of Biology in Kenya's educational system, a reason that could explain the dismal performance in the subject in majority of secondary schools in Nandi South sub-County as illustrated in Table 1.1.

Table 1.1: Mean Performance of Secondary Schools in Nandi South in Biology in KCSE (2009-2013)

Year	Mean Aggregate Points	Mean Grade

2009	4.963	D+
2010	3.813	D-
2011	4.811	D+
2012	5.032	D+
2013	4.956	D+

Source: Nandi South sub-County Education Office (2013)

1.3 Statement of the Problem

The overall performance in Biology of secondary schools in Kenya and particularly in Nandi South sub-County has been below average over the years (Nandi South Sub-County Education Office, 2013). This low performance of students in the KCSE Biology examinations has raised serious concerns among educational researchers, parents and other stakeholders. The teaching of Biology, being a vital science subject, has always been key to the academic achievement of students.

How teachers incorporate innovative pedagogical skills in their instruction has a lot of influence on their classroom practices and the subsequent students' achievement in Biology. The review of literature has shown that inadequate studies have been conducted in Nandi South sub-county to determine the relationship between computer-assisted instruction and students' academic achievement in Biology. Although Kenya expects increased utilization of computers in education from primary school to secondary school, the potential impact of computer-assisted instruction is not fully documented. Does the use of computer instruction make a difference in students' achievement in Biology? This research found out it necessary to investigate the influence of selected instructional methods on academic achievement of students in secondary schools in Nandi South Sub-County.

1.4 Purpose of the Study

The purpose of this study was to investigate the influence of selected instructional methods on academic achievement of students in secondary schools in Nandi South Sub-County.

1.5 Objectives of the Study

This study sought to achieve the following objectives:

i) To establish teachers' and students' attitude towards Computer-Assisted Instruction (CAI) and conventional Instruction (CI) in the instruction of Biology in secondary schools in Nandi South Sub-County
ii) To find out the influence of Computer-Assisted Instruction (CAI) on academic achievement of students in Biology in secondary schools in Nandi South Sub-County
iii) To find out the influence of Conventional Instruction (CI) on academic achievement of students in Biology in secondary schools in Nandi South Sub-County
iv) To establish the impact of a combined use of Computer-Assisted Instruction (CAI) and Conventional Instruction (CI) on academic achievement of students in Biology in secondary schools in Nandi South Sub-County

1.6 Hypotheses of the Study

The following hypotheses were tested:

H_{O1}: There is no significant difference between attitude of teachers and students towards adoption of Computer-Assisted Instruction in Biology in secondary schools in Nandi South sub-County.

H_{O2}: There is no significant influence of Computer-Assisted Instruction (CAI) on academic achievement of students in Biology in secondary schools in Nandi South sub-County.

H_{O3}: There is no significant influence of Conventional Instruction (CI) on academic achievement of students in Biology in secondary schools in Nandi South sub-County.

H_{O4}: There is no significant difference between Computer-Assisted Instruction (CAI) and Conventional Instruction (CI) on academic achievement of students in Biology in secondary schools in Nandi South sub-County.

1.7 Justification of the Study

The significance of pedagogical integration of ICT and particularly Computer-Assisted Instruction (CAI) in Kenya and globally cannot be overemphasized. It is becoming increasingly apparent that all aspects of students' academic achievement stories are greatly influenced by how their teachers integrate Information and Communication Technologies (ICTs) in curriculum instruction (Achuonye, 2006).

In an effort to keep up with these new developments, the Kenyan Government, through its key ministries of Education, Science and Technology and Information and Communication Technology, has developed several policy and strategy documents to

guide the integration of ICT in education (National ICT Policy, 2006; Sessional Paper No. 1 of 2005 and Kenya Education Sector Support Programme, 2005-2010).

These efforts are also out of the realization that there are many initiatives being championed by various government agencies, private sector, non-government organizations and even individuals, that are not well coordinated, are disjointed, lack focus and sometimes duplicate each other. In the last decade, the Government of Kenya has invested numerous resources in ICT infrastructure including the digitization of educational materials through the Kenya Institute of Education (KIE) and The National ICT Integration and Innovation Centre (NI3C).

The e-content being developed for schools at primary and secondary levels is expected to increase access and improve the quality of education in the country. While this is a laudable initiative, the required penetration in schools both in breadth and depth is yet to be realized. The existing literature on Computer-Assisted Instruction technology integration in the teaching of science subjects, particularly Biology in secondary schools in Kenya appears to indicate limited knowledge on the quantity and quality of research in this area. Many scholars and practitioners have raised this as a major research need (Omwenga, 2003; Keiyoro, 2011; Gikonyo, 2012). Computers have been generally heralded as being an effective teaching methodology (Christmann & Badgett, 2010). However, this "heralding" still lacks adequate research. Coffland (2009), in discussing the status of technology use in mathematics education, noted there is ample justification for research into how computers are used in education. In their focus on the status of research on the efficacy of CAI, Christmann and Badgett (2008) also suggest a need for further

research by arguing that, "despite the accolades heralding CAI as the effective teaching methodology, there is still no documented evidence verifying its perceived superiority over Conventional Instruction.

1.8 Significance of the Study

The results from the study will help shed light on the state of computer-assisted instruction integration in the Biology curriculum and therefore provide vital information to education planners. This information will be vital in policy formulation on how to equip teachers of Biology with technical pedagogical skills.

Besides, the findings of this study will be useful to the Ministry of Education in re-evaluating the current provision of computer teachers who are charged with the task of ensuring that ICT is put to use in secondary schools, countrywide. The Ministry will also use the findings of this study to invent appropriate measures that can counter current challenges to Computer-Assisted Instruction (CAI) in the Biology curriculum. As the direct consumers, students stand to benefit once any necessary remedies are instituted to improve computer-assisted instruction in the teaching and learning of Biology. The findings of this study will create awareness on the importance of integrating computer-assisted instruction (CAI) in the teaching of Biology in secondary school curriculum.

This study will form a basis of further research in areas related to computer-assisted instruction (CAI). The findings of this study will shed more light on the appropriateness of either incorporating CAI or CI in the teaching of Biology in secondary schools.

1.9 Scope and Limitations of the Study

1.9.1 Scope

This study was limited to the application Computer-Assisted Instruction and Conventional Instruction (CI) and students' academic achievement in Biology. The study only covered secondary schools in Nandi South Sub-County. The study narrowed down to the head teachers, teachers of Biology and students who were the main respondents.

1.9.2 Limitations

The researcher encountered a number of limitations. First, some respondents were not willing to respond to questionnaires provided for fear of victimization. Although the researcher assured the respondents of confidentiality, those unwilling to participate were allowed to opt out. Second, the issue of the influence of Computer-Assisted Instruction on students' academic achievement in Biology raised concerns of head teachers and teachers' commitment and proficiency.

1.10 Theoretical Perspective

This study was based on Cognitive Theory of Multimedia Learning (Mayer, 2005). Mayer suggests that active learning occurs when a learner engages in three cognitive processes: selection, organization, and integration. The learner selects relevant words for verbal processing and selects relevant images for visual processing. Based on Miller's finding stated earlier, people are able to process chunked information. During that time, learners must select relevant words and/or images to be stored in verbal and/or visual memory systems to overcome the limitations of memory.

The learner organizes words into coherent verbal models and organizes images into the coherent visual models. The more we think about and organize information in meaningful ways, the more we repeat information in our working memory, and the more likely we are to remember it. Notice that our minds organize new information in different ways. Some information may be arranged sequentially, hierarchically, or randomly according to the nature of information, some may be organized based primarily on an individual's knowledge and previous experience.

Mayer's research has shown that learners learn better when corresponding verbal and visual information are held together because it makes learning more meaningful. Ideally, verbal and visual information are linked and assist each other; therefore, when receiving verbal information and images simultaneously, the learner processes different modes of information all at once.

Mayer (2005) indicates that for effective learning to occur, these three cognitive processes need to be integrated. Mayer asserts that people learn more deeply from words and pictures than from words alone, which is referred to as the multimedia principle (Mayer, 2005a). Multimedia researchers generally define multimedia as the combination of text and pictures; and suggest that multimedia learning occurs when we build mental representations from these words and pictures (Mayer, 2005b). The words can be spoken or written, and the pictures can be any form of graphical imagery including illustrations, photos, animation, or video.

Multimedia instructional design attempts to use cognitive research to combine words and pictures in ways that maximize learning effectiveness. The cognitive theory of multimedia learning (CTML) centres on the idea that learners attempt to build meaningful connections between words and pictures and that they learn more deeply than they could have with words or pictures alone (Mayer, 2005).

According to CTML, one of the principle aims of multimedia instruction is to encourage the learner to build a coherent mental representation from the presented material. The learner's task is to make sense of the presented material as an active participant, ultimately constructing new knowledge. According to Mayer (2005), CTML is based on three assumptions: the dual-channel assumption, the limited capacity assumption, and the active processing assumption. The dual-channel assumption is that working memory has auditory and visual channels based on Baddeley's (1986) theory of working memory and Paivio (1986), Clark and Paivio's (1991) dual coding theory. Second, the limited capacity assumption is based on cognitive load theory of Sweller (1988, 1994) and states that each subsystem of working memory has a limited capacity. The third assumption is the active processing assumption which suggests that people construct knowledge in meaningful ways when they pay attention to the relevant material, organize it into a coherent mental structure, and integrate it with their prior knowledge. Figure 1.1 presents the schematic illustration of the cognitive theory of multimedia learning.

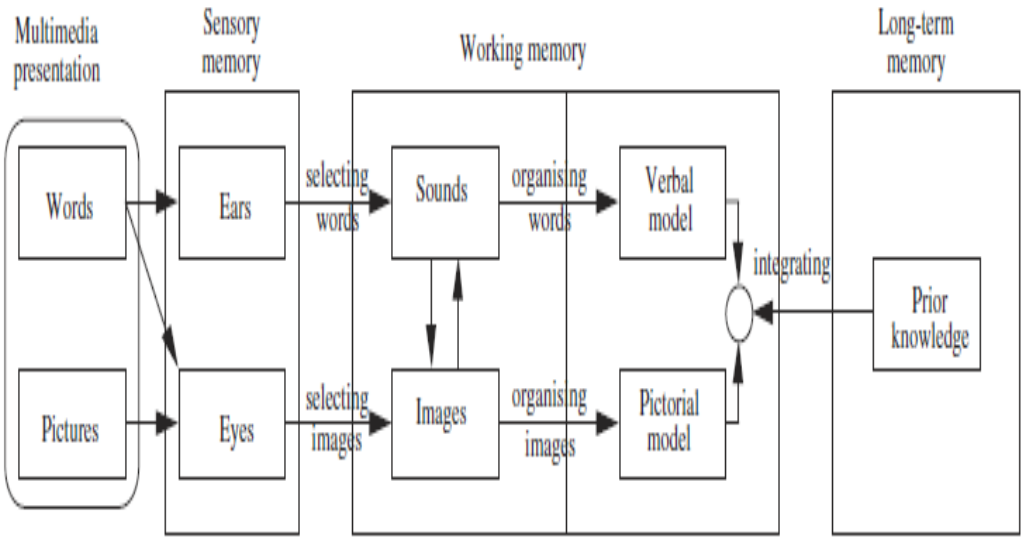


Figure 1.1: Schematic representation of cognitive theory of multimedia learning
Source: Adapted from Mayer (2005)

1.11 Conceptual Framework

Conceptual framework refers to how a researcher conceptualizes relationship between variables in a study and shows them graphically or diagrammatically. It shows independent variables and dependent variables and how they are related or how they influence one another (Mugenda & Mugenda, 2003). The attitude of teachers of Biology and students alike towards Computer-Assisted Instruction as well as conventional instruction is key in determining whether this pedagogical skill will be integrated in the teaching and learning of Biology content or otherwise. Besides, the pedagogical instruction method that teachers of Biology employ in curriculum instruction influences students' academic achievement in Biology.

However, there are intervening variables that may influence the incorporation of Computer-Assisted Instruction technique in the teaching of Biology in secondary schools.

These variables are school policy and culture as well as government policy on Computer-Assisted Instruction incorporation in schools. The conceptual framework is illustrated in Figure 1.2.

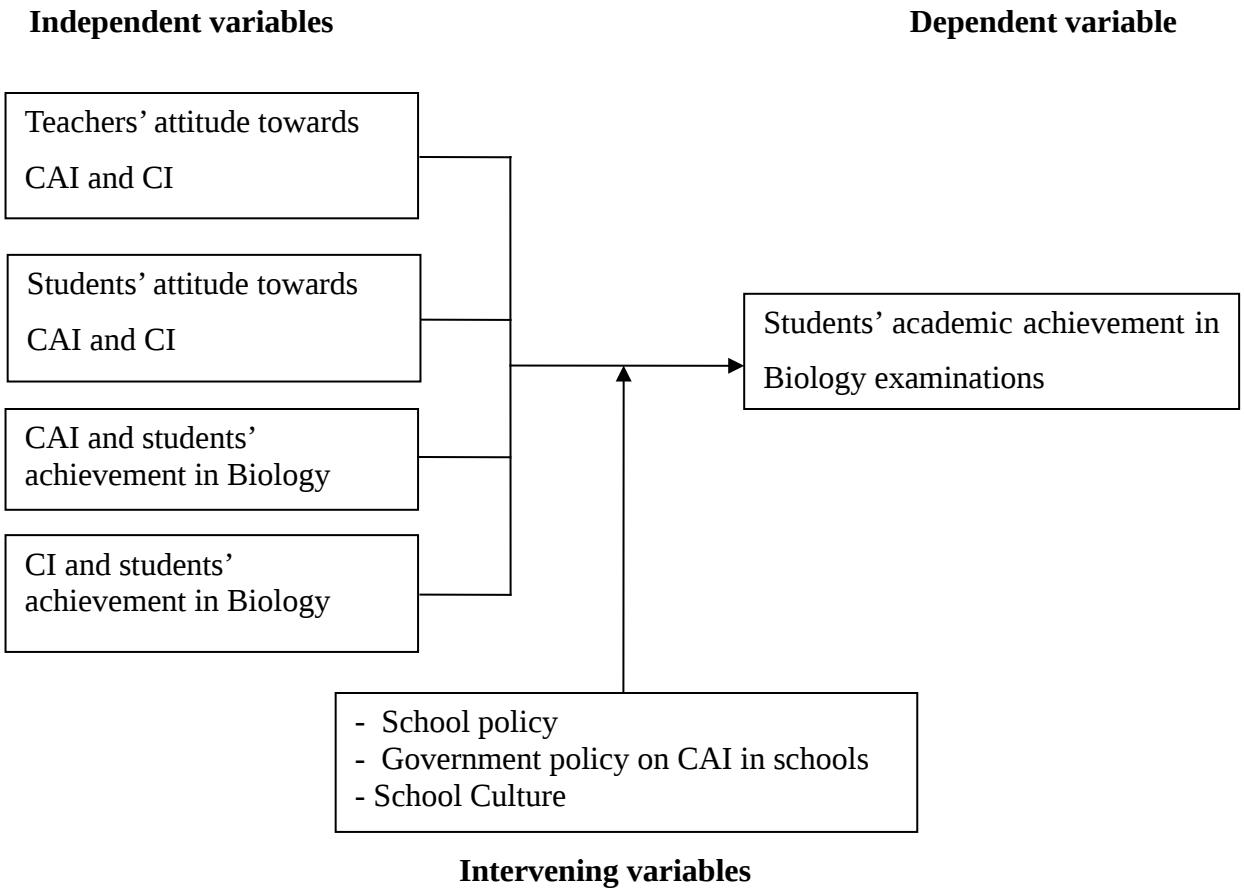


Figure 1.2: Conceptual Framework

1.12 Operational Definition of Terms

Computer Assisted Instruction (CAI): CAI is an interactive instructional technique where a computer is used to present the instructional material and to monitor the learning of the learners. It provides individualized and self-paced instructions to the learners.

Conventional Instruction: Conventional Instruction (CI) is the most common method of teaching used by the teachers for carrying out the teaching learning process in the classroom situations. In this method, the teacher talks more or less continuously to deliver the facts and ideas worth remembering but the class does not converse with the teacher.

Academic achievement: Achievement means accomplishment of performance in a given skill or body of knowledge. Achievement signifies performance carried out successfully. In the present study, achievement stands for the scores obtained by students in the criterion-referenced test after giving instructions through CAI and Conventional I (CI).

1.13 Summary of the Chapter

This chapter has presented a brief background to the study as well as the problem statement. The study majorly focused on investigating whether the use of computers in instruction make any difference in student achievement in Biology. The chapter also presents the theoretical perspective on which the study was based and the subsequent conceptual framework.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of relevant literature to this study. Specifically, the chapter presents: the concept of Computer-Assisted Instruction (CAI); the efficacy of Computer-Assisted Instruction (CAI) in education; teacher and students attitude towards Computer-Assisted Instruction (CAI); and, differences in performance between male and female students under Computer-Assisted Instruction (CAI) technique.

2.2 The Teaching of Biology in Kenya

Types of learning with strong emphasis on responsibility of the learner particularly CAI are gaining popularity over traditional forms such as CI (Janine, Tonde & Wouter, 2014). In Kenya, the secondary school syllabus (2009) recommends CAI but most teachers of Biology prefer CI method (Chirwa & Njuge, 2013). A question therefore arises as to why CI is being used by most teachers despite CAI recommendation. Nwagbo (1999, as cited in Akinyemi & Afolabi, 2010) explains that in CAI, the teacher provides illustrative materials for students to study on their own. Leading questions are then asked by the teacher to enable students think and provide conclusions through adoption of science processes guided by computer instructions. Nwagbo believes that if the learner is allowed to discover relationships and methods of solutions by himself/herself, make his/her own generalizations and draw conclusions from them, s/he may then be prepared to make wide applications of the material learned (Akinyemi & Afolabi, 2010). Ibe (2013)

concurs that use of CAI method results in enhanced comprehension of concepts in learners.

According to Moore (2008), CI emphasizes presenting ideas and information meaningfully and effectively so that the learner can derive other meanings from what s/he is presented with. The teacher then checks for comprehension by asking questions to asses students' understanding of the material explained or studied. CAI and CI aim at enhancing learning among students but differ in their instructional approaches. CAI requires process skills such as experiment design, observation and manipulation of variables to discover answers; whereas CI uses lecturing, asking questions and giving notes to learners to memorize content.

Mayer (2011) recommends using CAI because it helps students meet two important criteria for effective learning. Firstly, activating or constructing appropriate knowledge to be used in making sense of new incoming information and secondly, integrating new incoming information with appropriate knowledge base. However, CI is strongly supported by Mayer and Campbell (2008). This is because CI involves questioning, and when students answer questions and receive feedback, they process materials more deeply and store material in a more retrievable form. Secondly, there is engagement which increases students' attention so that they are more likely to encode the presented material, and thirdly, metacognition, which implies that answering questions help students to gauge their level of understanding so that they can allocate their cognitive processing to aspects of the lesson they do not understand.

Various scholars have different accounts why CI is more prevalent in schools than CAI. According to Shing-fong, Yin-kum Law and Mark Shin-kee Shum (2009), teachers' resistance is expected because the new practice bears little resemblance to the practices they had experienced as students themselves.

However, according to Alexander (2012) and Hogan (2012), CAI does not necessarily yield better education outcomes though few studies have been conducted to authenticate this. In Nandi South sub-county, students' performance in Biology in K.C.S.E examinations is low (Table 1.1). It is not clear whether CAI or CI or a combined use of both CAI and CI can yiled better results in Biology examinations. This study sought to unravel this puzzle.

2.3 The Concept of Computer-Assisted Instruction (CAI)

In the research literature, computer-assisted instruction (CAI) is a generic term that includes a range of varying forms of computer technology in curriculum instruction. Computer-Assisted Instruction (CAI) is synonymously referred to as Computer-Assisted Learning (CAL) or Computer-Based Instruction (CBI) (Passerini, 2012).

Since the advent of microcomputers and instructional software for education, Computer-Assisted Instruction (CAI), Computer-Assisted Learning (CAL), or Computer-Based Instruction (CBI) has provided a supplemental instructional method in schools. There are not precise definitions of the terms CAI, CAL and CBI. Generally, the concept of CAI in the early research was aligned to "drill-and practice" programmes (Cognition and Technology Group, 1996). CAL includes more sophisticated programs that incorporate

tutorial instruction (Wright& Marsh II, 2008). Many CAL systems also include record keeping and management systems. However, CAL also goes by a variety of other names, such as CAI and CBI.

With respect to CBI, it places emphasis more on individualisation of the learning process to accommodate the needs, interests, proclivities, current knowledge, and learning styles of the students. CBI software consists of tutorial, drill and practice and, more recently, Integrated Learning Systems (Schacter, 2010).

Modern implementation of CAI includes more advanced hardware and software technology, and allows for greater student interaction, and greater stores of information (Christman, Badget & Lucking, 2007). In the more recent evaluations of research on computer-assisted learning, CAI is more a generic term covering drill-and-practice, tutorials, simulation/interactive thinking, word processing, conferencing, and other activities (Fletcher-Flinn & Gravatt, 2005).

This study adopts the definition of Computer-Assisted Instruction (CAI) provided by the Association for Education Communications and Technology (2007) which defines Computer-Assisted Instruction (CAI) as a method of instruction in which the computer is used to instruct the student and where the computer contains the instruction which is designed to teach, guide, and test the student until a desired level of proficiency is attained. There has been a dramatic increase in the capabilities of computers, along with reduced cost, that has influenced an increase in the various forms of computer-delivered

instruction (Brown, 2011). This increase has been seen in education as well as in other disciplines (Passerini, 2012).

Over the past three decades, educational researchers have investigated the effects of computer use on student achievement and attitudes. The general belief is that computer technology allows educators more options for communicating, facilitating the lesson, and enhancing the teaching and learning. Proponents claim that computer technology makes learning easier, more efficient, and more motivating (Schacter & Fagnano, 2009).

These beliefs are supported by research that has found that learning with Computer-Assisted Instruction (CAI) added to the traditional teaching methods produces a higher level of academic achievement than traditional teaching methods only (Fletcher-Flinn & Gravatt, 2005). Traynor (2003) suggests that computer-assisted instruction affects cognitive processes and increases motivation by the following ways: personalizing information; animating objects on the screen; providing practice activities that incorporate challenges and curiosity; providing a fantasy context; and, providing a learner with choice over his/her own learning.

This area of research is expanding to include computer applications in support of the academic curriculum (Lee & Vail, 2005; Simic, 2003). CBE and CBI often refer to the general use of computers in the classroom setting. Such use may involve many facets of instruction and can utilize a variety of computer technologies and applications such as, databases, drill and practice and Web quests. CAI is used when describing more specific applications such as drill-and-practice, tutorials, or simulation activities offered either as

a stand-alone activity or supplemental activities to enhance teacher-directed instruction (Cotton, 2007).

2.4 The Efficacy of Computer-Assisted Instruction (CAI) in Education

In many studies, CAI has been shown to have some benefits, although there are also cases where none were observed. With CAI, there is a form of one-to-one instruction (or two students together at each computer), plus the opportunity for the students to proceed at their own pace, repeating parts of the exercise as they wish. None of these features are easily available in a didactic classroom situation. In addition, there is added variety and, perhaps, novelty in CAI, along with the potential to use vivid and animated graphics, enabling three dimensional aspects, and other features to be viewed more realistically (Levine & Donitsa-Schmidt, 2009). Not all computer programs have these features, but the potential is certainly there.

In a study that was conducted to find out the effects of the computer on attitudes, motivation or learning, and the possible advantages of computer-assisted test programs by Jackson (2010), secondary school students were classified into control and experimental groups. The assessment of the experimental group was done using computers, whereas that of the control group was done through a written test. The statistical evaluations displayed a higher achievement rate for the experimental group that received a computer-assisted test. Levine and Donitsa-Schmidt (2009) compared the traditional learning strategies with computer-based activities. Applications and the assessment were administered after the students were distributed into control and experimental groups. The results of the evaluations showed that the experimental group

was more successful at answering the questions of the Biology Achievement Test than the control group.

In another study, Demircioğlu and Geban (2011) compared CAI with the CI on 6th grade students in science classes. Students of the experimental group were taught with CAI in addition to the traditional teaching method. Students of the control group were taught through problem solving. The achievement rates of the two groups were compared through a *t*-test and the group that was taught through CAI was found to be more successful. A study by (Jackman, Moellenberg & Brabson, 2008) showed that achievement rate increased when general Biology applications were made through the use of CAI.

There have also been problems with evaluations of technology, including the fact that it has been often treated as an undifferentiated variable and, further, as an independent variable. Evaluations have often suffered from poor design and poor measures of outcomes. However, percolating through has been a view that the features of the software; the features of the context, including the students, the teacher and the way technology is used, and the interactions among these are the vital considerations (Clark, 2006).

Although findings from meta-analyses and other studies comparing CAI with Conventional/traditional Instruction generally show a small advantage in favour of CAI over traditional instruction, as research on CAI effectiveness progressed, it became

imperative for researchers to find answers to the question of why any CAI advantage occurred (Cotton, 2007).

With the introduction of computer into the educational system, it has been discovered that teaching could be developed in a more flexible way through Computer- Assisted Instruction (CAI) in order to make it more responsive to student's learning. According to Babalola (2008), the most important feature in computerized instruction is that it permits a high degree of individualization. This in effect means that students can proceed at their own pace, following a path through the curriculum as suited to their particular interest and talent. However, the introduction of computer in the last couple of years has had little or no impact on the traditional daily activities within the school system (Yusuf, 2005).

According to Cotton (2007) in Yusuf and Afolabi (2010), the use of CAI as a supplement to conventional instruction produces higher achievement than the use of conventional instruction alone, research is inconclusive regarding the comparative effectiveness of conventional instruction alone and CAI alone, and that computer-based education (CAI and other computer applications) produce higher achievement than conventional instruction alone. In addition, students learn instructional content faster with CAI than with conventional instruction alone, they retain what they have learned better with CAI than with conventional instruction alone. Moreover, Karper *et al*. (as cited in Yusuf & Afolabi, 2010) show that CAI has been found to enhance students' performance than conventional method.

Findings from meta-analyses that attribute effect to the medium (computer) alone have ignited considerable debate among researchers. Clark (2006) believes that instructional methods embedded in the medium influence learning. To support his argument he found consistent evidence from his review of previous meta-analyses and other studies of media's influence on learning. He explained that studies comparing CAI with traditional classroom instruction were basically meaningless because they hopelessly confounded media and instructional method. "If media were conducted under rigorous controls," he speculated, "the method and not the media would prove consequential."

Clark (2006) concluded that "the media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries and causes changes in our nutrition". The corollary of this argument is that the relative merits of employing computers in education are only economic factors associated with access and speed of delivery rather than pedagogical or cognitive benefits.

On the other hand, Kozma (2004) believes that the medium and methods combine to interact with and influence how students learn and process information. The author suggests that future studies attempt to understand the media's relationship to learning rather than its effects on learning. Kozma (2004) further reasons that learning with media can be thought of as "a complementary process within which representations are constructed and procedures performed, sometimes by the learner and sometimes by the medium. Controversies over the efficacy of CAI have given rise to longitudinal studies and other contextual approaches which demonstrate technology's potential for supporting a learner-centred approach to education (Means *et al*., 2005).

Dalton and Hannafin (2009), in a study involving junior high students, found that CAI tended to be the most effective instructional delivery system compared to CI technique. In a large curriculum integration project involving first through eighth grades, Lore and Chamberlain (2008) found that a CAI integrated curriculum was effective when averaged over all grades. However, some grades performed at or above the benchmark while other grades performed below. Specifically, they found that grades 3, 4, 6, and 7 met or exceeded the goal level of academic achievement. Price (2003) conducted an attitude survey and observed student progress in a middle school science project where CAI was used as a tutorial and research tool.

It was concluded that the use of CAI in this way encouraged an overall improvement in motivation and interest in the science research project and hence students' academic achievement. Christmann *et al*. (2007) conducted a meta-analysis of the effect of CAI in secondary education.

They selected only studies that were correlative, quasi-experimental, or experimental in design and concluded that CAI had a greater effect size than conventional/traditional pedagogical techniques. Their research indicated that secondary students exposed to CAI showed higher academic achievement than 57.2% of those students exposed to traditional instruction. Roberts and Madhere (2005) in a study involving elementary and junior high schools found out marginal successes in academic gains in reading and mathematics and an overwhelming positive student attitude toward the computer assisted medium of instruction and learning. In a report on the academic progress of mathematics and physics students taking CAI-based advanced placement courses (middle school through early

high school), Ravaglia, Suppes, Stillinger and Alper (2005) argued that such courses were shown to be effective for the targeted students.

As evidence, they suggested that these students, upon completion of the CAI courses, scored especially high on Advanced Placement (AP) exams. In a study of CAI in a secondary science classroom, Brophy (2009) established that CAI is effective in science classroom settings. Tseng (1999) found that a Biology CAI was useful in teaching first grade students since results indicated that most students advanced in knowledge.

In a similar study involving elementary students, Chang (2010) reported a significant increase in scores on a measure of academic achievement when CAI on arithmetic was used to teach addition and subtraction. Stern and Repa (2008) show that CAI was successfully used to teach social skills to teens enrolled in a behaviour modification program. In a similar study, Dunn (2009) found that Biology students in the CAI treatment group scored significantly higher than the control group on conventional/traditional instruction.

Crowe (2004) researched the impact of modelling technology in instruction on social studies education students. The author noted that the social studies discipline had not kept pace with other disciplines in integrating technology into instruction. Crowe integrated technology instruction in two courses she taught at a university in a social studies education course and a seminar course that education major students take before their 96-hour practicum. She taught both courses to the same group of 23 students.

One student dropped the course after being called for active duty to serve in the military. The researcher's purpose was to model the use of technology in instruction and encourage student use of technology. The researcher employed the strategy of modelling different technological classroom instructional methods and required the students to complete a project implementing technology. During the first course, students were asked to complete a technology survey. The survey attempted to gain an understanding of the students' technology use comfort levels and their willingness to incorporate technology in their instruction as future teachers.

Throughout the semester, the professor documented the use of technology through lesson plans, journals, and student work. Crowe (2004) interviewed a student in the course. The student utilized technology frequently in the class, yet the subject expressed during the interview that she felt she lacked the knowledge and comfort to employ technology. The student interview occurred on two different occasions. After transcribing and evaluating the interviews, the professor decided to ascertain the perceptions of a second student.

The second interviewee had collaborated on class assignments with the first interview subject. He expressed a high comfort level using technology. The results of the interviews with the two students led to Crowe (2004) devising another student survey. The second questionnaire dealt the with the subjects' influences of technology. The second survey was administered at the end of the second course before the 96-hour practicum. After the second survey three more students participated in one on one interviews with the professor. Crowe (2004) found that teacher modelling of technology strongly influences students' desire and motivation to employ similar instructional techniques. After the first,

course the researcher noted students employing technological strategies throughout their coursework.

By the end of the second course students were using technology more frequently and comfortably. The professor observed students using PowerPoint and incorporating images, graphics, video clips, charts, graphs, and music into their presentations. She noted that even when technology was not required most of the students still chose to incorporate technology into their assignments. Students began using websites to enhance their assignments. Some students created web sites for their future classes. The researcher highlighted the students' perceptions that the instructional method of incorporating technology strongly impacted their acceptance and utilization of technology themselves. Crowe shared she learned that professors must model instructional technology and doing so or failure to do so sends an important message to their students.

In this researcher's opinion, the researcher demonstrated the importance of modelling technology especially if future teachers are going to be expected to incorporate technology in their instruction. Similar to Ward et al. (2009), Crowe found technological instruction cannot proceed and be enhanced without the support and encouragement from the administration and faculty. Crowe (2004) did not identify the age group of her students. Most likely some of these students would have qualified as digital natives. It would have been important for her to note whether the students who felt more comfortable with using technology were digital natives or not. It would have been good to know if some of the students were digital immigrants.

As Kvavik *et al*. (2004), Kennedy *et al.* (2008) and Bennett *et al.* (2008) clarified, the varying levels of technological expertise does exist between the digital natives. Crowe's research could have added to this information if the ages of the students had been identified. Using her students for the study provides some drawbacks to the validity of the research. The question arises if the students were completely honest answering the two surveys. Did the students respond in a manner they perceived that their professor wanted them to? In the case of the student interviews the subjects may have been hesitant to be candid because their professor was interviewing the, the same professor who was responsible for their grade in the course. Crowe's (2004) intention for her research was good, and her results did show that modelling is important to increase student learning and incorporating technology in instruction. By being part of the study the researcher led the validity of the results to some speculation even though the study resulted in positive outcomes for the 22 students.

2.5 Teacher and Student Attitudes toward Computer-Assisted Instruction (CAI)

Teachers and students' attitudes toward CAI are key not only in the use of CAI in curriculum implementation but also to the academic achievement of students in specific disciplines. However effective CAI may be, it may not be utilized in the classroom if it lacks the acceptance of teachers, students, or both groups (Barron *et al*., 2003).

2.5.1 Teacher Attitudes towards Computer-Assisted Instruction (CAI)

Previous studies have examined the usage patterns of CAI by classroom teachers. These studies have established that a majority of teachers do not use CAI to assist their students in the learning process (Barron *et al*., 2003). This is especially true of science subjects.

Becker *et al*. (2007) observe that the overall average usage rate of CAI in the classroom in this group of teachers was less than 20%. In addition, Wilson and Notar (2010) found out that across all subject areas and specializations, teachers were eight more times more likely to use computers in their schools to track student grades than for teaching. Investigations to determine the reason for this reluctance among classroom teachers was conducted by Benson (2004).

By surveying and personally interviewing classroom teachers, the researcher found out that most teachers were reluctant to use CAI in their classroom because of their negative attitude towards CAI majorly because they lacked proper training on how to use CAI programmes. Benson (2004) also noted that the lack of use of CAI by teachers had tremendously influenced students' academic achievement in science subjects negatively.

2.5.2 Student Attitudes towards Computer-Assisted Instruction (CAI)

Research has found out that attitude of students towards CAI has generally been positive (Howard *et al*., 2004). In addition, Burton (2008) and Inoue (2009) found out that students' interest in new methods of learning, such as CAI, was very high in areas where the students struggled academically. It is a reasonable hypothesis that students who are struggling in a subject find the individualized instruction offered by CAI to be more inviting for them than learning in the conventional/traditional instruction approach.

Today's students are more technologically inclined than any other generation (Howard *et al*., 2004). Therefore, students are often more open than their teachers to new methods of

computerized instruction. However, these technologically advanced methods of instruction must be effective and efficient to be adopted in the classroom.

D'Angelo and Wooley (2007) research included three areas: the technologies students experience in the classroom; students' perceptions of technological learning environments; and do subpopulations of students view the effectiveness of technological learning environments differently. The research study took place at a large Midwestern university with students enrolled in criminal justice courses. Subjects were from four different courses and almost equally represented the freshman, sophomore, junior and senior classes. No incentive was offered for participation in the study. The racial breakdown of the subjects was "88% Caucasian, 6% African-American, 5% Latino, and 1% different racial/ethnic background" (D'Angelo & Wooley, 2007, p. 465).

D'Angelo and Wooley (2007) determined that 98% of the students had been exposed to technology in the classroom. Consistent with other research performed by Bartsch and Cobern (2003) and Hansen and Williams (2008), the subjects' perceived that learning was enhanced when the PowerPoint presentation method of instruction was used in class. Participants felt that the PowerPoint presentation method of instruction was more effective then classes using the chalk and lecture method of instruction and classes using Blackboard© and online course activities. For the subpopulations, there was no difference in students' perception when comparing "gender, race, academic major, and college status" (D'Angelo & Wooley, 2007).

In this researcher's opinion the research study should be replicated at other colleges and universities. It would be good to perform the study at schools that are noted for their technological use and those that lack the technological means. This study focused exclusively on students' perception and not learning. Another area where D'Angelo and Wooley (2007) could improve their study would be to identify the positive and negative aspects of PowerPoint as perceived by the students. The study should also be replicated at a more racially balanced institution.

Burke and James (2005) sought to discover students' perceptions of the effectiveness of PowerPoint instruction in college business courses. The authors wanted to ascertain students' insights as to what makes PowerPoint presentations effective and determine the frequency of use by professors. The setting for the study was an urban university in the South. Data was collected over a two-week period starting with 230 participants. Some professors offered extra credit to students to encourage participation in the research study. Students were asked to answer only the Likert type questionnaire one time, as they may be enrolled in two or more classes participating in the study.

Burke and James (2005) found almost 33% of the faculty stated they never used PowerPoint presentations in class. Twenty-seven percent of the faculty claimed to utilize PowerPoint always and 14.3% claimed to use PowerPoint frequently. The student participants rated PowerPoint presentations effectiveness in their class. The results indicated that the subjects identified the most effective use of the PowerPoint instructional method was in their management courses followed by marketing and economics. Accounting was the one class that students did not deem PowerPoint as an

effective teaching tool. To gain a clear understanding of the students' perceptions Burke and James (2005) asked the subjects to articulate what they deemed as positive and what was negative about the faculty using the PowerPoint presentation method of instruction in class. The positive aspects of using PowerPoint instruction included organization and structure, graphics, pictures, and visuals.

The negative aspects of PowerPoint as viewed by the subjects were related to the instructor not using the presentation software properly. This study distinguished the effectiveness of PowerPoint instruction by course content. PowerPoint was found not to be as effective for courses that emphasize mathematical or quantitative fundamentals where demonstration for working out problems is necessary. Burke and James (2005) failed to use an accurate method to recruit subjects for the study.

Students had the option to participate with the enticement of extra credit or class participation points. There were various reasons as to whether the student would participate or not. There was no way to determine if a student answered more than one questionnaire in other business classes especially with the enticement of extra points. The research study did identify if the subjects viewed learning through technology more positively in conceptual courses rather than the quantitative courses.

2.6 Differences in Performance between Male and Female Students under Computer-Assisted Instruction (CAI) Technique

Studies have shown differences in the attitudes of male and female students to the use of computer in schools. According to the study carried out by Spotts *et al*. (1997) in USA on

gender and use of instructional technologies males rated their knowledge and experience with some innovative technologies higher than did females.

For frequency of use, no significant differences were found with the exception of video, where females indicated use that is slightly more frequent. Both rated technologies as important to instruction. Few decades ago, the computer was observed to be male dominated and its usage belonged to techies comprised mostly of men (Huynh *et al*., 2005). In their studies, they found that there is no statistically significance validating gender differences in pattern of online interaction between male and female students. The research conducted by Mitra *et al*. (2000) on gender and computer use in an academic institution explored the nature of the relationships between gender, categories of computer use and attitudes toward computers in a computer-enriched environment where all students were provided with network access and laptop computers over a four year period.

The results indicated that women were less positive about computers than men and the use level of computers by women were less frequent than for men. This change in the relationship is a throwback to the earlier days of computing when research had indicated that men were more positively disposed toward computers than women were. Achuonye and Olele (2009) also in their study on Internet using patterns of Nigerian teacher-trainees, found that more female students were personally connected to the internet than their male counterparts were; but that male students surf the internet more than females.

This indicated a male dominance in skills, which is more important than mere possession of computer. This study revealed a worry that gender barriers which have earlier been identified to hinder females in science and technology (Achuonye, 2006; Onwuegbuna & Onwuegbuna, 2006) may be persisting to this present era of information super-highway.

Shashaani (1997) using a sample of 202 College students also in USA, found that females were less interested in computers and less confident than males; males were more experienced. Further analysis of the students' responses showed that one semester of computer training improved their attitudes towards computers.

Studies like those of Bello (1990) did not find any form of influence being exerted by gender on student's performance. Yusuf and Afolabi (2010) concluded that gender has no influence in the academic performance of male and female students exposed to CAI either individually or co-operatively. Literature review shows positive attitudes towards Computer Assisted Instruction among learners. What is not clear is whether sustained utilization of computer for instruction would improve student scores in Biology. There is a push to integrate computer in the secondary school curriculum in Kenya. Nevertheless, there is a need for increased understanding of the role of computer in learning Biology. This study sought to reduce the paucity of literature in this area.

2.7 Combined Influence of Conventional and Computer-Assisted Instruction on Academic Achievement

Using CI and CAI methods, Hansen and Williams (2008) performed a study comparing cross-cultural psychology classes. The 101 subjects for the study were from a

predominately white, southern college. The subjects ranged in age from 18 to 21. Archival data was used for the 56 students in the CI class. Forty-eight students were in the CAI class. A several year span existed between the CI and CAI classes. Hansen and Williams (2008) did not provide the actual number of years between the two studies. Both classes were expected to purchase four to five books and take three exams throughout the semester. The CI class used textbooks. The CAI class used one textbook and three paperback novels written by minority authors and internet to search for relevant literature. The CAI class visited each other's homes, participated in a restaurant experiment, and engaged in role-playing.

The students received instruction through lectures, textbooks and novels, video clips and multicultural experiences (Hansen & Williams, 2008). The CI class received instruction through lectures and textbook readings. Subsequent analysis conducted by Hansen and Williams (2008) found significant differences between the classes on their exams. The CAI class performed better on exam two, and the CI class performed better on exam three. The requirements for the CAI class were to hand in a PowerPoint/video presentation along with taking exam three. The CI class only had to take the exam. Both classes completed a course evaluation.

The majority of the CI class subjects claimed that they did not purchase nor read all the assignments for the course. Therefore, there was little class discussion and more lecture time. The CAI class stated that they enjoyed discussing their readings, conversing with each other, and choosing their video presentations. Although they expressed a heavier workload, on the course evaluations the students in the CAI class's experiences were

more positive than the CI classes. The biggest flaw with Hansen and Williams' (2008) research study was the time span between the classes being compared. The results would have been more accurate if there were two classes participating in the study at the same time with one class receiving the CI method and the other class receiving the CAI method. The authors attributed the comments on the evaluations of the CAI class concerning the workload to be a result of the stress and anxiety placed on them because they had to hand in a video presentation as well as prepare for the exam. Another influence on the study results could have been the timing of the evaluations. Had the evaluations taken place at a different point in the semester the students may not have felt as stressed by the workload and the results may have been different.

However, the results of the study did not meet the expectations of the researchers. The CAI class was perceived as more engaged and involved in learning throughout the course, yet the assessments did not indicate that they learned more than the CI class. The study leaves many unanswered questions that could be addressed by this study. Pucel and Stertz (2005) also performed a research study comparing CAI to CI. Their study focused on student satisfaction and academic achievement for in-service teacher education courses for career and technical education teachers. The researchers noted that in the career and technical education field many educators are first trained in their career fields and once they become teachers they receive teacher education training.

The University of Minnesota offered in-service instruction to teachers in career and technical education courses using CAI and CI. The teachers taught at the high school level and at technical and career colleges. The purpose of the study was to identify a

model for CAI and to determine if CAI demonstrated similar results to CI (Pucel & Stertz, 2005).

The CI and CAI classes had the same assignments, objectives, and grading criteria. Students did not engage in the CAI and CI classes at the same time. For all the courses, student satisfaction surveys and grades were gathered at the end of the semester. Pucel and Stertz (2005) did note that not all students answered the student satisfaction questionnaires. The results of the Purcel and Stertz's (2005) study found a wide disparity between the performance of students taught through CAI and CI.

Ninety-two percent of the students who were taught through CAI were satisfied with the course. However, only 52 percent of the students who were taught through CI indicated their satisfaction (Pucel & Stertz 2005). The data indicated that there was a statistically significant difference in the student evaluations between the two methods of instruction. Interestingly, the students taught through CAI method indicated that they learned more than those taught through CI yet more than one-half of the students would have preferred the traditional method of instruction.

Purcel and Stertz (2005) made a good effort to make the learning environments as equal as possible. The study could have been improved if the same instructor taught both classes using CAI and CI. Instructor teaching style could have influenced the students' preferences and performance. The researchers were thorough in their attempt to provide as equal as possible learning environments for their study. After the courses were developed by the instructors, the curriculum coordinator also looked at the course

material. The study could have been enhanced if the course offerings had taken place at the same time. The researchers made the assumption that the students from different semesters were equal.

2.8 Summary of the Chapter

This chapter has presented a review of literature related to this study. The chapter has presented the review based on the objectives that the study sought to achieve. Empirical studies reviewed in this chapter indicate that there are mixed opinions among scholars on the relationship between Computer Assisted Instruction and students' achievement. Besides, there are also mixed opinions on the relationship between Conventional Teaching methods and students achievement. It is not clear therefore whether the utilization of computer for instruction would improve student scores in Biology more than the conventional instruction approach. This study sought to bridge this knowledge gap. The succeeding chapter presents a detailed discussion of the research design and methodology.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter presents the research design, the area of study, the study population, sample size and sampling technique. The data collection instruments, validity and reliability of research instruments and method of data analysis are also discussed in the chapter. The study sought to establish teachers' and students' attitude towards Computer-Assisted Instruction (CAI) and conventional Instruction (CI), find out the influence of Computer-Assisted Instruction (CAI) on academic achievement of students in Biology, find out the influence of Conventional Instruction (CI) on academic achievement of students in Biology, and, establish the impact of a combined use of Computer-Assisted Instruction (CAI) and Conventional Instruction (CI) on academic achievement of students in Biology in secondary schools in Nandi South sub-County.

3.2 Research Paradigm

Philosophical paradigm refers to the basic set of beliefs that guide actions, also known as paradigms, epistemologies and ontologies (Creswell, 2009). It is the general orientation about the view of the world and the nature of research that the researcher holds, which leads to the researcher embracing either qualitative, quantitative or mixed methods approaches. It consists of philosophical assumptions that guide and direct thinking and action (Creswell, 2009). There are four different worldviews: post positivism, constructivism, and advocacy/participatory and pragmatism. Post positivism holds that causes determine effects or outcomes and that knowledge develops through careful

observation and measurement of objective reality that exists out there in the world. It deals with testing laws and theories to verify or confirm so as to understand the world. Hence it advocates for quantitative approaches (Cohen & Swerdlik, 2003).

Constructivism holds that meaning is constructed by human beings as they engage with the world whereby the researchers and respondents experiences, contexts and culture contribute to meaning (Creswell, 2009). Therefore, social constructivism embraces qualitative research. Advocacy holds that research should be intertwined with a political aspect with an action agenda for reform addressing issues such as empowerment, oppression and inequity. As such, participants in research are engaged as active collaborators. Pragmatism is not committed to any one system of philosophy. Instead, it focuses on the research problem and uses all approaches available to solve it (Cohen & Swerdlik, 2003). The research reported here embraced the pragmatic worldview in which a quasi-experimental research design was employed, allowing the use of qualitative and quantitative techniques sequentially and concurrently.

3.3 Research Design

This study adopted a quasi-experimental research design. Quasi-experimental design is one that has features of an experimental design but lacks the key ingredient-random assignment. With respect to internal validity, they often appear to be inferior to randomized experiments. However, there is something compelling about these designs; taken as a group, they are easily more frequently implemented than the randomized experiments (Cohen & Swedlik, 1993). This design was considered appropriate for

collecting data necessary to determine the relationship between the incorporation of Computer-Assisted Instruction (CAI) and students' academic achievement in Biology.

Since this study involved selecting groups, upon which the independent variable (CAI) was tested, without any random pre-selection processes, this design was found appropriate. This design involved the pre-test and post-test for all of the comparison groups that were considered in the study.

3.4 Study Area

Biology is taught in all schools within the Republic of Kenya. The attempt to mount Computer Assisted Instruction is a nation-wide endeavour. Research to find out the impact of CAI on teaching and learning Biology may have been done in any area in Kenya. However, this research was keen in selecting one of the counties within western Kenya close to the researcher's workplace. Out of the many sub-counties in North Rift Valley and western region, the researcher randomly selected Nandi-South sub-county.

Nandi South sub-County is located in Nandi County. Nandi County is located in the former Rift Valley province and borders the following counties; Uasin Gishu to the North and East, Kericho to the South East, Kisumu to the South, Vihiga to the South West, and Kakamega to the West. It has five sub-counties, namely: Aldai (Nandi South), Emgwen (Nandi Central), Mosop (Nandi North), Nandi East and, Tinderet. The main economic activity in Nandi South sub-county is agriculture. There are currently thirty-eight (38) secondary schools in this sub-county (Nandi South Sub-County Education Office, 2013). Nandi South sub-county suits the researcher's purpose because there is paucity of

information in the literature on the impact of CAI and conventional teaching methods on students' academic achievement in Biology. New research data will be useful to educational planners in the sub-county but will also be applicable to other areas with similar curriculum and teachers as Nandi South sub-County (Appendix 1).

3.5 Target Population

The target population for this study comprised of all secondary schools in Nandi County. Statistics from the County Education Office indicated that there were 136 secondary schools in Nandi County by the time of this study. The accessible population comprised of 38 Secondary Schools in Nandi South sub-county with a student population of 8,723 by the time the study was being conducted. The teachers of Biology in the secondary schools in the sub-county were 81 (Nandi South sub-County Education Office, 2014). Students' population was drawn from Form Three and Form Four classes.

3.6 Sample Size and Sampling Procedures

Some experts argue that a large sample size reduces the degree of standard error (Mugenda & Mugenda, 2003). Moser and Kalton (1971), however, warn that having a large sample does not automatically guarantee accuracy of results if it was poorly selected. Gall and Borg (2000) have demonstrated how larger samples can yield results that are closer to parameters of the population. However, since this relationship is infinite, then a researcher has to choose a sample which is reasonable based on time and resources.

Secondary schools were selected basing on the 30% formula of sampling provided by Mugenda and Mugenda, (2003). Therefore, eleven (11) secondary schools were randomly selected. This implies that 11 head teachers were purposively selected to participate in the study. Teachers of Biology were selected purposively. A sample of twenty four (24) teachers of Biology from those who teach Form Three and Form Four classes was selected using random sampling technique. This sample represented 30% of the population of the teachers of Biology.

The sample size of the students was determined by using the formula indicated by Kathuri and Pals (1993). The formula is as follows:

$S=X^2NP\ (1-P)/d^2\ (N-1)+X^2p\ (1-p)$

Where:

S-Required sample size

N-The given population size (in this case, 8,723)

P-Population proportion of 0.50

d-Degree of accuracy (in this case, error factor of 0.05)

X^2-Chi-square value for one degree of freedom at a confidence level of 0.95.

Kathuri and Pals (1993) developed a table based on the above formula detailing the sample size selection for various finite populations (Appendix 1).The population of the students in the selected secondary schools was 8,723. From the table, the sample size for a population of 8,723 is 368. Therefore, a total of 368 students were sampled for the study. The students were selected using stratified random sampling technique. The basis

of stratification was the Form level of the students. The total number of respondents for this stud was therefore 403.

Table 3.1: Respondents' Sample Size

Respondents	Sample
Head teachers	11
Teachers of Biology	24
Students	368
Total	**403**

3.7 Data Collection Instruments

The main data collection tools for this study were the questionnaire (for students' and teachers' of Biology) and interview schedule for head teachers. A standard questionnaire containing both closed and open-ended questions was used to elicit information relevant to the variables under study. Opie (2007) notes that although closed ended questions limit the respondents' expressions, they are useful in helping the researcher to code and to compare responses.

On the other hand, open-ended questions are useful in motivating the respondents by allowing them to answer the questions in a relatively relaxed manner. There were two sets of questionnaires, for the students and for teachers. The questionnaire for students comprised of two sections. Section A solicited students background information while Section B contained items on students' attitude towards Computer Assisted Instruction (CAI). Like the students' questionnaire, the teachers' questionnaire comprised of two sections. Section A contained items on teachers' background information while Section B

contained items on teachers' attitude towards Computer Assisted Instruction (CAI) and Conventional Instruction (CI).

Besides, Criterion Reference Tests (CRT) tool was employed in measuring the achievement of students at the pre-test and post-test phases. The items in the CRT were of fill-in-the blanks type, multiple-choice types, matching type and right or wrong answer type.

3.8 Pilot Study

According to Murray (2003), piloting is important because it helps to identify ambiguities of the items and vague questions for improvement. A pilot study was conducted before the main study. For this purpose, two (2) secondary schools with similar characteristics to those under study but those that were not included in the sample were selected. These were one (1) boys' and one (1) girls' secondary school in the neighbouring Aldai Constituency. Twenty students (20), ten from each category were randomly selected. In addition, two head teachers and two (2) teachers of Biology, one from each secondary school were involved in the exercise.

3.8.1 Validity of Research Instruments

Validity refers to the accuracy and meaningfulness of inferences that are based on the research results (Mugenda & Mugenda, 2003). Validity is the degree to which results obtained from the analysis of the data actually represent the phenomena under study; to determine the accuracy and meaningfulness of the data. To determine content validity of the instrument items, the researcher's supervisors were contacted to assist in ensuring that

the instruments' items were in relation to the set objectives and content area under study. Their suggestions and comments were used as a basis to modify the research items and make them adaptable to the study.

Basing on the feedback from the experts, the wordings of the instruments were modified appropriately. During the pilot study, teachers and students were requested to leave unanswered items they found ambiguous. Completed questionnaires were studied and improved appropriately. The suitability of the items was decided basing on three indices: the average score index for each statement; the 'undecided' index, or the frequency of undecided responses made on each statement; and, the 'ambiguity' index, or the number of respondents who considered an item ambiguous. Suitable items were then retained. They were those that received a high average score, a low undecided frequency and a low ambiguity index. Unsuitable items were those, which received more than average frequency of 'undecided' responses and more than three ambiguous tallies. Unsuitable items were therefore left out.

3.8.2 Reliability of Research Instruments

Reliability of research concerns the replicability and consistency of methods and results (Wiersma & Jurs, 2005). Reliability refers to the measure of the degree to which research instruments yield consistent results or data after repeated trials (Mugenda & Mugenda, 2003). Reliability in research is influenced by random error. As random error increases, reliability decreases. Error was eradicated through accurate coding, clear instructions to the subjects, and proper training of interviewees to reduce bias. Data collected from the pilot study was used to compute the reliability of the instruments' items. Cronbach's

alpha coefficient was computed to determine internal consistency of the items. This method is appropriate owing to the fact that it requires only one administration of the test (Cohen & Swerdlik, 2005). It is also appropriate where items have got choices (Cozby, 2003). The reliability coefficient of the items in the questionnaire ranged from 0.7784 to 0.9234 for the attributes studied. Table 3.2 provides the results of computations of reliability test.

Table 3.2: Item Reliability Tests

Variable	Number of Items	Cronbach's Alpha
Teachers' and students' attitude towards CAI and CI	9	0.8613
CAI and students' academic achievement in Biology	11	0.8459
CI and students' academic achievement in Biology	8	0.9234
CAI and CI and students' academic achievement in Biology	12	0.7784

3.9 Data Collection Procedure

The researcher requested for an introductory letter from Moi University. This letter assisted the researcher in getting permission from the National Commission for Science, Innovation and Technology (NACOSTI) to conduct the research. The researcher identified and trained two research assistants who assisted in administering the questionnaires to the respondents. The research assistants were involved in facilitating efficiency in data collection. A criterion reference test (CRTS) was prepared and used for measuring the achievement of students taught through CAI and Conventional Instruction.

On the basis of the scores obtained in the Raven's Standard Progressive matrices, the students were matched on three levels of intelligence, that is, high, middle and low. After that they were equally distributed in the experimental and control group for experimentation. The experiment was conducted in two phases. In the first phase before being exposed to the teaching material, both the groups were pre-tested with criterion referenced test (CRT) prepared on CAI and CI. After this, the students were provided with orientation and instructions about the treatment to be allotted to them. The purpose of such an orientation was to get over the anxiety and curiosity of the students, which could have hindered the final outcome of the results.

The students of the experimental group were given a trial of the CAI material so that they could have been able to know what they had to do while going through the instructional material. Similarly, the students of the control group were made familiar about the objectives to become familiar with the experimental setup. The second phase of the experiment was concerned with the real execution of the experiment.

During this phase, the group designated as experimental group was exposed to Computer Assisted Instructions and the group designated as control group was taught through Conventional Instruction. Both groups were taught concepts in photosynthesis. After treatment, that is, at the end of each unit, both the groups were tested with Criterion Referenced Test (CRT) to measure their achievements. Then the scores of Criterion Referenced Test were compared in order to assess the effectiveness of the two methods of teaching.

3.10 Data Analysis

After data collection, responses from all questionnaire items and interview schedule items were cross-checked to facilitate coding and processing for analysis using. Statistical Package for Social Sciences (SPSS) computer programme version 20.0. Responses from interview schedules were analysed basing on emerging themes. Chi-square correlation analysis was computed to establish the influence of CAI and CI on academic achievement of students in Biology. T-test ratios were computed to establish significance differences between the mean scores of experimental and control groups at the pre-test and post-test levels. Findings of the study were presented in form of tables, charts and graphs.

3.11 Ethical Considerations

In line with the principles of research, certain ethical considerations were adhered to in the course of this study. First, the respondents were informed as fully as possible of the nature and purpose of the research, the procedures to be used, and the expected benefits to the respondents and schools in the country. Respondents were required to voluntarily give their consent to participate in the study, free from any coercion. Secondly, the respondents were assured of confidentiality and anonymity in all phases of the research and were informed of the right to withdraw at any time. The researcher respected the privacy of respondents and ensured that school records and other data were not disclosed unless disclosure was permitted by the respective school policies. Finally, the researcher adhered to the Moi University policy rules and procedures, which stipulate that research be undertaken by those appropriately qualified and experienced. The researcher ensured

that wholesale or partial lifting of material published or unpublished without acknowledgement was avoided.

3.12 Summary of Chapter

This chapter has presented a detailed description of the research design as well as the research paradigm that was adopted in this study. The chapter has presented a description of how data for this study was collected, analysed and presented. The succeeding chapter presents data analysis, presentation, interpretation and discussion.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSION

4.1 Introduction

This chapter presents the analysis, presentation, interpretation of the data collected in the study. The chapter also presents the discussion of the findings. Findings are presented based on the objectives that the study sought to achieve. The study objectives were:

1. To analyse the relationship between attitude of teachers and students towards Computer-Assisted Instruction (CAI) and conventional Instruction (CI) and achievement in Biology
2. To find out the influence of Computer-Assisted Instruction (CAI) on academic achievement of students in Biology
3. To find out the influence of Conventional Instruction (CI) on academic achievement of students in Biology
4. To establish the impact of a combined use of Computer-Assisted Instruction (CAI) and Conventional Instruction (CI) on academic achievement of students in Biology in secondary schools in Nandi South Sub-County.

Out of a total of 392 questionnaires that were given out, 327 were filled and returned; 303 from students and 24 from teachers of Biology, yielding a response rate of 83.4%. This was considered a reliable response rate to put to use in making generalizations from the findings.

4.2 Respondents' Background Information

4.2.1 Teachers' Background Information

There were 24 teachers of Biology who were sampled in this study and whose responses were analysed. Of these teachers 19(79.2%) were male while 5(20.8%) were female. This was attributed to the fact that majority of female teachers prefer training in humanities and linguistic specializations unlike the males who prefer science-oriented courses.

The researcher also found it significant to establish the experience of these responses as teachers of Biology. This was because the researcher would easily match respondents' responses basing on their experience in the teaching of the discipline. Majority (33.3%; 8) of them had been teaching Biology for between 5 and 10 years, 29.2% (7) for between 2 and 5 years and 12.5% (3) for between 1 and 2 years. Those who had an experience of over 10 years were 6(25%). Figure 4.1 illustrates this information.

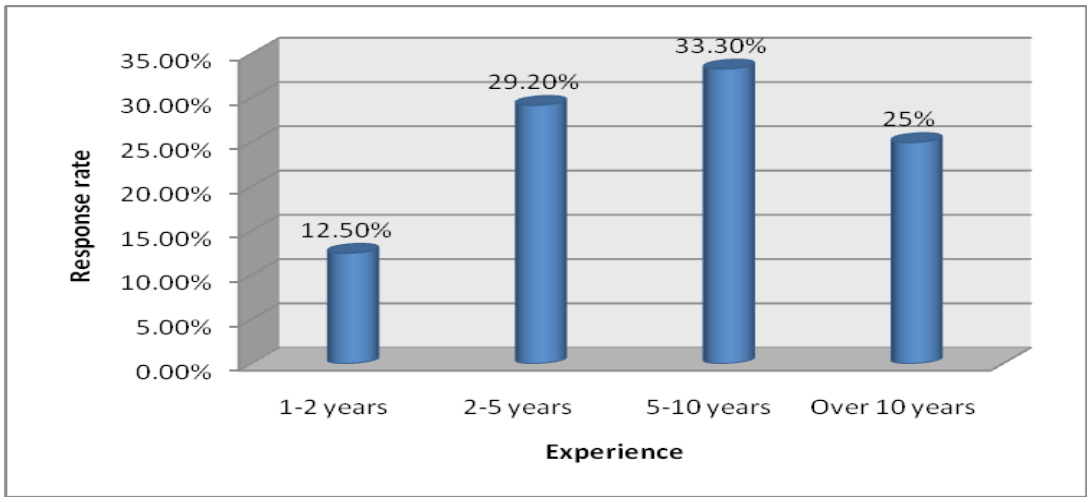


Figure 4.1: Teaching experience of respondents in Biology

When asked to indicate their academic qualifications, 12.5% (3) of them indicated that they had attained a diploma, 70.8% (17) an undergraduate degree and 16.7% (4) a

masters. None of these respondents had attained a doctorate degree. This information was significant since it informed the researcher on the level of exposure of respondents in pedagogical techniques employed in the instruction of Biology curriculum content. This information is presented in Table 4.1.

Table 4.1: Academic Qualification of Respondents

Academic qualification	Frequency	Percentage
Diploma	3	12.5
Undergraduate	17	70.8
Masters	4	16.7
PhD	0	0
Total	**24**	**100**

Respondents were asked to indicate whether they studied Biology as a major discipline or as a minor. Majority (70.8%; 17) indicated that they studied Biology as their major subject while 29.2% (7) studied as a minor discipline. This information was significant because it informed the researcher on the degree of authority that respondents had as far as pedagogy in Biology was concerned.

4.2.2 Students' Background Information

Complete responses which were used for purposes of analysis in this study were collected from 303 students. Of these students, 211(69.6%) were male while the other proportion of 30.4% (92) were female. This was attributed to the fact that girl-child enrolment is still low in Nandi County.

Respondents were drawn from all the form levels. There were 57(18.8%) respondents drawn from form one, 77(25.4%) drawn from form two, 98(32.3%) drawn from form three and 71(4) drawn from Form Four. Table 4.2 presents a summary of this information.

Table 4.2: Gender and Form Level of Student Respondents

Form	Male (%)	Female (%)
One	37 (12.2)	20 (6.6)
Two	48 (15.8)	29 (9.6)
Three	78 (25.8)	20 (6.6)
Four	48 (15.8)	23 (7.6)
Total	**211 (69.6)**	**92 (30.4)**

The student respondents were also asked to indicate the highest grade they had ever attained in Biology examinations. Majority (110; 173) of the students indicated that their highest grade ever scored in Biology was grade D and grade C respectively. There were few students who claimed to have ever attained grades B and A (12 and 2 respectively). However, there were students (6) who indicated that they were poor in the subject and had only managed grade E in the examinations they had attended to. Figure 4.2 summarizes this information.

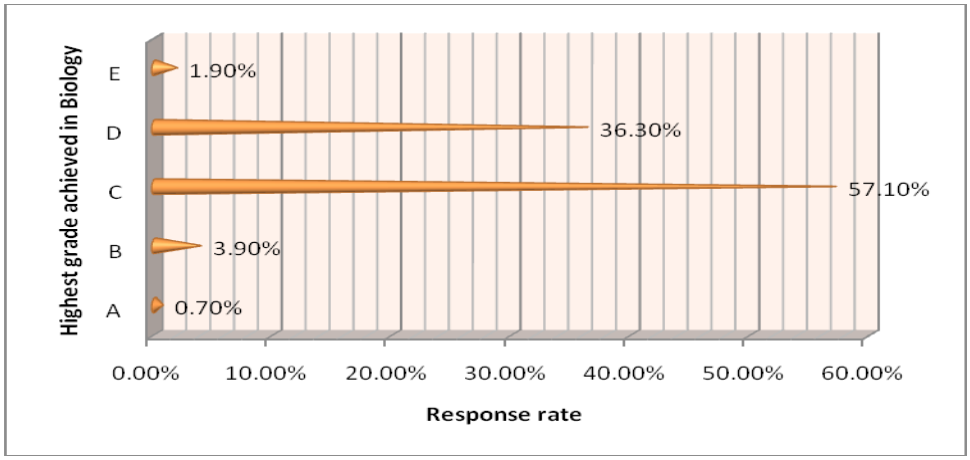


Figure 4.2: Highest grades achieved in Biology

4.3 Attitude of Teachers of Biology and Students towards Computer-Assisted Instruction and Conventional Instruction

4.3.1 Attitude of Teachers of Biology towards CAI and CI

The study sought to establish the attitude that teachers of Biology hold for Computer-Assisted Instruction (CAI) and Conventional Instruction (CI). This was done by the aid of a five-point Likert scale. When asked to indicate whether CAI assumes a more biological background than CI, majority of the respondents agreed. There were mixed reactions as to whether CAI follows a more logical sequence in presenting the Biology content than CI. Majority of the respondents disagreed with the fact that CAI allows for a deeper understanding of the content of Biology by students when compared to CI.

Majority of the respondents were generally in agreement that CAI was a total waste of time as compared to CI. Besides, majority of the respondents indicated that CAI was generally more complicated than CI in application. Only a few of the respondents agreed to the fact that CAI was more interesting to students than CI. Few of the respondents indicated that CAI was not complicated to them but majority observed that CAI was too complicated for them in instructing the content in Biology. Generally, there were few teachers of Biology who expressed satisfaction with the application of CAI. Majority of teachers preferred the application of CI in the instruction of the content in Biology. The attitude of teachers of Biology was measured on a five-point Likert scale; Strongly Agree (1); Agree (4); Undecided (3); Disagree (2); Strongly Disagree (1). Table 4.3 presents a summary of the finding.

Table 4.3: Attitude of Teachers towards CAI and CI

Statement	5	4	3	2	1	Mean
I have all through been employing CI in teaching Biology	12	9	1	2	0	**4.3**
CAI lessons assume a more biological background than what I have	9	10	2	3	0	**4.0**
CAI follows a logical sequence	7	5	5	4	3	**3.4**
CAI presents concepts in a manner that allows for students deeper understanding	2	7	5	5	5	**2.8**
CAI is more interesting to students	11	9	1	2	1	**4.1**
Use of CAI is a waste of time	12	7	3	2	2	**4.3**
CAI is complicated for me	13	9	0	1	1	**4.3**

Majority of the teachers indicated that they have been applying CI in the teaching of Biology as opposed to CAI (mean, 4.3). a negative attitude by the teachers of Biology towards CAI was evident when majority of them indicated that use of CAI is a waste of time (mean, 4.3) and that CAI is complicated for them (mean, 4.3).

This finding was attributed to low computer literacy levels among teachers of Biology. There were 8(33.3%) teachers who indicated that they had no computer skills, 13(54.2%) with basic computer skills, 2(8.3%) with intermediate skills while only 1(4.2%) had advanced computer skills. This is illustrated in Figure 4.3.

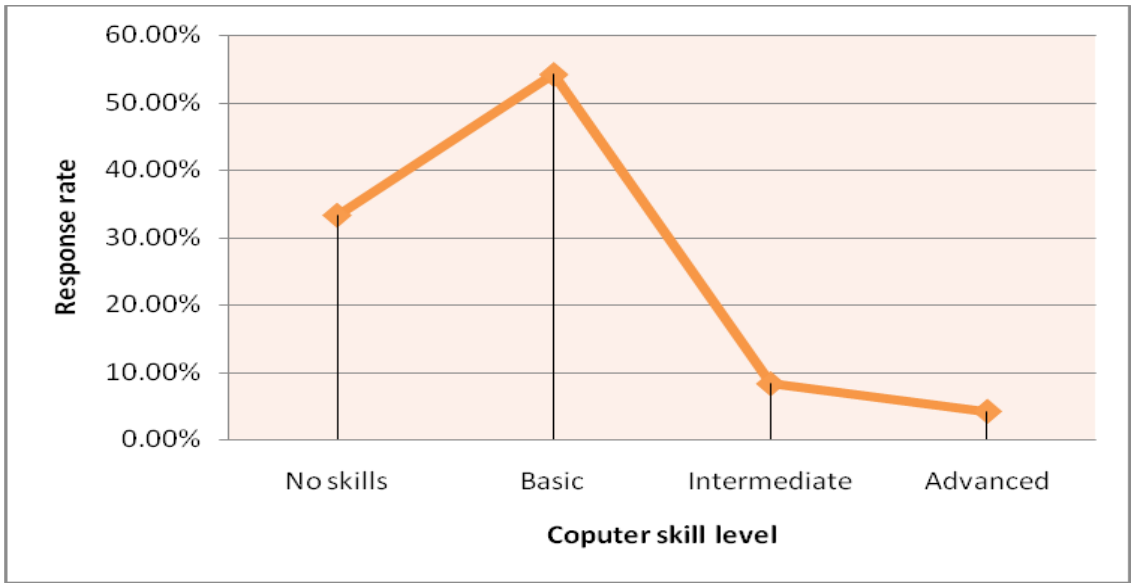


Figure 4.3: Teachers' computer skills' level

The researcher found out that most teachers were reluctant to use CAI in their classroom because of their negative attitude towards CAI majorly because they lacked proper training on how to use CAI programmes. Benson (2004) notes that the lack of use of CAI by teachers had tremendously influenced students' academic achievement in science subjects negatively.

4.3.2 Attitude of Students towards CAI and CI

The study also sought to establish the attitude of students towards CAI and CI in learning the content in Biology. When asked to indicate whether they easily understood Biology content more through CAI, majority of them were undecided. Few of them disagreed and agreed respectively that they understood Biology content better when taught through CAI than CI. The large proportion of students who were undecided is a clear indication that majority of the teachers of Biology were not employing CAI in teaching Biology.

The students were therefore unable to compare CAI and CI since most teachers were employing CI only in their teaching. However, majority of students indicated that they had adequate skills in computer applications and therefore were of the opinion that using computers in learning did not amount to a waste of time. There were some of the students who were still undecided mainly because they had not interacted with computers for learning in their schools. The few students who were being taught Biology through CAI indicated that this learning methodology had sharpened their computer skills. These students disagreed that learning biology through computers is complicated. However, majority of the students either affirmed that learning Biology through CAI was complicated or they were simply undecided. This finding is presented in Table 4.4.

Table 4.4: Number of students with positive and negative attitude towards CAI and CI

Attribute	Positive	Negative	Total
CAI	97	56	153
CI	65	85	150
Total	**162**	**141**	**303**

Source: Field data (2014)

To establish the relationship between attitude and teaching methodology employed, a Chi-square test was computed. The results of the analysis are illustrated in Table 4.5.

Table 4.5: Correlation between Attitude and Teaching Methodology

Correlations			
		Attitude	**Teaching methodology**
Attitude	Chi-square Correlation	1.000	.897
	Sig. (2-tailed)		.002
	N	303	301
Teaching methodology	Chi square Correlation	.897	1.000
	Sig. (2-tailed)	.002	
	N	303	303

A strong correlation that was significant was found (χ^2 (301) = .897, $p < .05$). The null hypothesis was therefore rejected. Therefore, attitude has a strong impact on the teaching methodology employed in the instruction of Biology. Howard *et al*. (2004) indicates that research has found out that attitude of students towards CAI has generally been positive. In addition, Burton (2008) and Inoue (2009) found that students' interest in new methods of learning, such as CAI, was very high in areas where the students struggled academically. It is a reasonable hypothesis that students who are struggling in a subject find the individualized instruction offered by CAI to be more inviting for them than learning in the conventional/traditional instruction approach.

Today's students are more technologically inclined than any other generation. Therefore, students are often more open than their teachers to new methods of computerized instruction. However, these technologically advanced methods of instruction must be effective and efficient to be adopted in the classroom. It therefore follows from these findings that students are ever willing to learning through CAI but majority of teachers in Nandi-South sub-County have been reluctant to adopt CAI. This could partly be the explanation for the dismal performance in national examinations in biology in secondary schools in Nandi-South Sub-County.

4.4 Influence of CAI on Students' Academic Achievement in Biology

Table 4.6 shows that the t-ratios between the experimental and control group on the two teaching methods were 0.34, and 0.72 respectively, which suggests that these are not significant at both 0.01 and 0.05 levels when students were taught through CAI in experimental group and taught through conventional method of teaching in control group. The mean achievement scores of students in the two teaching methods, i.e. CAI and CI were 6.22 and 7.11 in experimental group. In the control group, mean achievement scores for the two teaching methods were 5.54 and 6.4 respectively at the pre-test stage. Thus, it can be concluded that the two groups, i.e. experimental and control groups do not differ significantly in their achievement. This indicates that both groups were found similar in their achievement in the teaching methods of Biology.

Table 4.6: Significance of Difference between the Mean Scores of Experimental and Control Group, Pre-Test Level (N=303)

Units	**Groups**				
	Experimental **Mean**	Control **Mean**	**SED**	***'t'***	**Level of significance**
CAI	6.22	5.54	0.34	0.94	NS
CI	7.11	6.4	0.72	1.48	NS

Table 4.7 shows that t-ratios between experimental and control group on the two teaching methods i.e. CAI and CI were 6.97and 5.97 respectively. These t-ratios were found to be significant at both 0.01 as well as 0.05 levels of significance when students were taught through CAI in experimental group and taught through conventional method of teaching in control group. There is therefore significant difference in the mean scores of students exposed to CAI and CI during curriculum instruction. Table 4.7 also shows that the mean achievement scores in the two methods were 28.71 and 32.68 respectively whereas mean achievement scores of control group were 25.4 and 28.05 respectively at post-test stage. By the comparison of mean scores of students in experimental group and control group, it was found out that mean scores of the experimental group were higher than that of control group. It is therefore concluded that CAI was more effective than Conventional Teaching in improving the achievement of students in Biology content.

Table 4.7: Significance of Difference between the Mean Scores of Experimental and Control Group, Post-Test Level (N=303)

Units	Groups				
	Experimental	**Control**			
	Mean	**Mean**	**SED**	***'t'***	**Level of significance**
CAI	28.71	25.4	0.64	6.97	0.01
CI	32.68	28.05	0.77	5.97	0.01

Generally, results of the study indicate that the students of the experimental and control groups did not differ significantly in their achievement on learning using the two teaching methods at the pre-test stage. Thus, both the groups were found to be equal on the basis of their achievement scores at the pre-test stage. Also t-ratios were found significant at both the levels of significance for the two methods of teaching Biology at the post-test stage. There was significant difference in the mean achievement scores of experimental group taught through CAI and control group taught through CI. It was found that the mean scores of students of the experimental group were higher than that of the control group of students. CAI was found more effective than CI in the teaching of Biology at the post-test stage. This finding of the study indicates that students exposed to CAI achieved higher scores in Biology than those who were taught by Conventional Instruction (CI).

Teachers and students alike were asked to indicate the level at which achievement in Biology is influenced by CAI. A proportion of 8.3% (2) of the teachers indicated that CAI influenced students' academic achievement in Biology to a low extent, 29.2% (7) indicated that the influence was moderate, 20.8% (5) indicated that the influence was

high while 41.7% (10) were undecided. Again, since the proportion of teachers who employ CAI is lower than the proportion of those who do not, majority of these teachers could not comment on the influence of CAI on students' academic achievement in Biology (Table 4.8)

Those teachers who did not believe that CAI had an influence on students' academic achievement indicated that students could still learn and achieve when taught by the conventional approach. They cited CAI as being complicated both to the teachers and would therefore cause more trouble in using it, both to the teacher and the learner. A teacher responded as follows:

> I believe that what a student cannot do manually, he/she cannot do using a computer. A CAI software is simply an aid to learning…it does not cause learning itself…the learner must be in a position to comprehend the content even without CAI….

Another teacher who shared in the same sentiments observed as follows:

> This CAI technique is a total waste of time…you do not move at the appropriate pace. The content in Biology is crowded and yet a teacher has to complete the syllabus early so as to spare time for revision…how do you do that when using the slow CAI approach?

Teachers who advocated strongly for CAI were of a contrary opinion.ne of them observed as follows:

> Today, the learners we teach are exposed to technology… …they want something that motivates them to concentrate throughout the lesson. Conventional teaching approach cannot since it's boring and teacher-centred. CAI is the way to go if we are to motivate our learners to learn and hence improve their grades in Biology and other science subjects.

Another teacher who shared in the same observations indicated as follows:

> My colleagues should be informed that CAI makes a teacher's and hence a learner's work easier…it has content which is tailor-made for specific units

> complete with teaching aids and illustrations. CAI helps one complete the syllabus even earlier…teachers should not fear CAI…in this technological world, we have no choice but to embrace it.

Students too were asked to indicate the extent to which CAI influences their academic achievement in biology. Majority (198; 65.3%) of the students were undecided on the influence of CAI on students' achievement in Biology. This was attributed to the fact that majority of these students were being taught through CI and therefore would not vividly indicate how CAI would influence their academic achievement.

Those who indicated that CAI influenced their achievement in Biology to a low extent were 11(3.6%), moderately were 22(7.2%) and highly were 72(23.8%). One of the student respondents observed that:

> I wish all subjects were taught using computers, learning would be very interesting and fulfilling…no one would fail. CAI has made me love Biology, now I perform much better than before….

One of the student respondents who was of a contrary opinion observed that:

> Computers are good but I don't think they influence ones academic achievement in Biology…you must first have comprehended the content… CAI simply supplements what you have already learned.

Majority of the head teachers (86.9%; 20) observed that CAI, if always employed by teachers of Biology can positively influence students' achievement in the subject. A head teacher indicated as follows:

> In today's technological world, it is only logical that teachers device better approaches of teaching sciences. CAI is one such effective method.

Another head teacher observed that:

> I am a teacher of Biology and I can tell for a fact that students taught through CAI perform better than those taught through traditional approaches…CAI sustains students' interests and hence makes it more enjoyable….

Head teachers who were of a contrary opinion (13.1%) observed that they did not believe that CAI had the capacity to improve students' achievement in Biology. These respondents mainly shared on one theme; that teachers need to be as innovative as possible to make their classes interesting and enjoyable without complicating it. They argued that introducing computer software in Biology classes would even complicate instruction even further, now that most students were performing dismally in Biology.

Table 4.8: Level of Influence of CAI on Achievement

Level of influence			
Low extent	**Moderate extent**	**Undecided**	**High**
8.3% (2)	29.2% (7)	41.7% (10)	20.8% (5)

The findings of this study are partly buttressed by studies conducted by Schacter and Fagnano (2009) who established that computer technology allows educators more options for communicating, facilitating the lesson, and enhancing the teaching and learning. Proponents claim that computer technology makes learning easier, more efficient, and more motivating to learners.

4.5 Influence of CI on Students' Academic Achievement in Biology

Respondents views were also sought on how conventional instruction influences students' academic achievement in Biology. The extent of the influence of CI on students' academic achievement in Biology was sought from teachers of Biology, head teachers and students basing on a four-point Likert scale; low extent, moderate extent, undecided and large extent. Commenting on the influence of CI on students' academic achievement

in Biology, teachers of Biology had mixed reactions. A proportion of 16.7% (4) of them indicated that CI influenced students' academic achievement in Biology to a low extent, 25% (6%) moderately, 37.5% (9) to a high extent while 20.8% (5) were undecided.

Majority (69.6%; 16) observed that CI influences students' academic achievement to a large extent while majority (197; 65%) of the student respondents were undecided. Table 4.9 provides a summary of this finding.

Table 4.9: Summary of Responses of Influence of CI on Students' Achievement

Extent of influence	Teachers of Biology	Head teachers	Students
Low extent	4 (16.7%)	3 (27.3%)	49 (16.2%)
Moderate extent	6 (25%)	2 (18.2%)	37 (12.2%)
Undecided	5 (20.8%)	2 (18.2%)	197 (65.0%)
Large extent	9 (37.5%)	4 (36.4%)	20 (6.6%)
Total	**24**	**11**	**303**

Source: Field data (2014)

Generally, respondents presented mixed opinions on the extent to which CI influenced students' academic achievement in Biology. Some of the responses from the respondents were sampled and presented as follows:

> I believe that CI is just an instruction technique like any other…as far as I am concerned, teaching Biology to students through CI still impacts their achievement positively just like any other method. I do not believe that we should do away with CI in favour of CAI…that will be complicating learning…. (Teacher of Biology)

Another teacher of Biology observed as follows:

> It is time all teachers of Biology adopted CAI in their delivery of curriculum content. This is the surest way to develop students' interest in the subject. CI is too archaic and too teacher-centred… more often, it leaves out students in the learning process….

A head teacher respondent observed as follows:

> I believe that the main explanation for the dismal performance of students in this school in Biology is that teachers are still rooted in the traditional CI method. This method makes their content delivery teacher-centred and hence boring to the students. I have insisted severally that teachers of science embrace CAI in their content delivery but this has been met with resistance… perhaps because of fear of technology….

Corroborating the finding of this study, Demircioğlu and Geban (2011) I their study compared CAI with the CI on 6th grade students in science classes. Students of the experimental group were taught with CAI in addition to the traditional teaching method. Students of the control group were taught through problem solving. The achievement rates of the two groups were compared through a *t*-test and the group that was taught through CAI was found to be more successful. A study by (Jackman, Moellenberg & Brabson, 2008) showed that achievement rate increased when general Biology applications were made through the use of CAI than CI.

4.6 Impact of Combined use of CAI and CI on Students' Achievement in Biology

The study also sought to establish the impact that a combined use of CAI and CI had on students' achievement in Biology. These responses were solicited from teachers of Biology and head teachers. Majority of teachers of Biology (19; 79.2%) and were of the opinion that a combined use of CAI and CI positively influences students' academic achievement. Majority (22; 95.7%) of the head teacher respondents too indicated that a combined use of CAI and CI positively influenced students' academic achievement in Biology. Those respondents who were of a contrary opinion and those who were undecided were of a negligible proportion a presented in Figure 4.4.

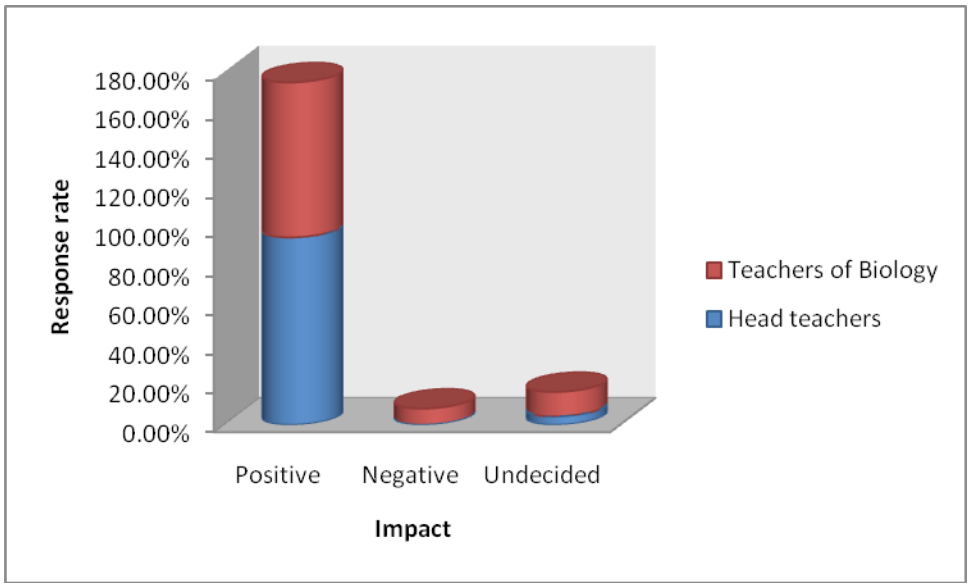


Figure 4.4: Influence of CAI on students' achievement cited by teachers

Majority of respondents indicated that using both CAI and CI would result in positive results because these techniques complimented each other. A head teacher was quoted as saying:

> Much as CAI is the best approach for instructing Biology content, it is equally important to buttress it with traditional teaching approaches. This way, students who may not be comfortable with one instructional technique may still learn through another alternative technique.

A teacher respondent indicated as follows:

> Some of our students are not techno-savvy and over-relying on CAI alone for instructional purposes will disadvantage such students. I find it professional to employ both approaches if we are to achieve optimal learning results.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusions and recommendations of the study. These are derived from the findings of the study. The summary, conclusions and recommendations are presented based on the findings of the objectives that the study sought to achieve.

5.2 Summary of Findings

The study sought to achieve the following objectives: to analyse the relationship between attitude of teachers and students towards Computer-Assisted Instruction (CAI) and conventional Instruction (CI) and achievement in Biology; to find out the influence of Computer-Assisted Instruction (CAI) on academic achievement of students; to find out the influence of Conventional Instruction (CI) on academic achievement of students; and, to establish the impact of a combined use of Computer-Assisted Instruction (CAI) and Conventional Instruction (CI) on academic achievement of students in Biology. The study adopted a descriptive research design approach.

5.2.1 Teachers' and Students' Attitude towards CAI and CI

The study established that majority of students had a positive attitude towards CAI and were of the opinion that their teachers of Biology employ CAI in teaching Biology. Teachers who displayed positive attitude towards CAI observed that CAI would arouse interest among the students to learn concepts in Biology. The teachers claimed that this

was because majority of students today are techno-savvy and therefore teachers should take advantage of their computer skills in making their lessons more interesting to students. However, some teachers displayed a negative attitude towards CAI claiming that such an approach would simply make learning Biology more complicated. This was attributed to lack of requisite computer skills among such teachers.

5.2.2 Influence of CAI and CI on Students' Academic Achievement

CAI was found to have a significant positive influence on students' academic achievement compared to CI. Most respondents were of the opinion that Biology be taught through CAI if students' academic achievement in the subject were to be improved. However, majority of respondents affirmed that a combine use of CA and CI would yield even better results as far as students' academic achievement in Biology was concerned.

5.3 Conclusion

In conclusion, the study established that majority of students preferred that Biology be taught entirely through CAI as opposed to CI. Majority of students claimed that CI was boring and teacher-centred and therefore did not provide room for their full participation in such classes. Majority of the students also indicated that their computer skills were at the intermediary stage and would therefore be comfortable being taught through CAI.

Majority of teachers preferred CI over CAI claiming that CAI wastes time and is more complicated. This was however attributed to the inadequate computer skills that these teachers indicated. However, those teachers who observed that CAI should full be

implemented in the teaching of Biology indicated that their computer skills were beyond the intermediary stage. They therefore did not find a problem applying CAI in their classes.

A combined use of CAI and CI was found to be more effective than singly using CAI or CI. The respondents claimed that this was because these pedagogical techniques complemented each other if used simultaneously. This way, they claimed, would provide a platform of learning on which each learner's needs were taken care of.

5.4 Recommendations

Based on the findings and conclusions of the study, the study makes the following recommendations:

a) In order to promote the use of CAI in teaching Biology, training should be given to both pre-service and in-service teachers for developing instructional materials for CAI. Besides, development of CAI material should be made part of teaching subjects and the student teachers should develop computer assisted instructional material for at least one unit of a particular class. The teacher educators should motivate the pre-service as well as the in-service teachers to develop positive attitude towards the application of CAI in the teaching-learning process

b) The curriculum planners should also include content in the textbooks that can be converted into Computer Assisted Instructional Material (CAIM) easily. The teachers should be given special instructions by the administrators to teach such content through CAI.

c) The administrators should also motivate the pre-service as well as the in-service teachers to develop a positive attitude towards the application of CAI in the teaching- learning process.

d) The administrators should also arrange for workshops and seminars for in-service teachers to provide them training to develop material for CAI. Finally, it is the duty of school administrators to ensure that their schools are well equipped with computers and computer technicians who can constantly provide help to teachers who wish to learn CAI and how to incorporate it into the teaching-learning process.

5.5 Suggestions for Further Research

Future studies can build on the results of this study to enrich the existing knowledge in the area being investigated. Based on the analysis of data and the ensuing findings, the following suggestions for further research are presented:

1. A study can be carried out to identify additional factors that influence teachers' attitudes towards CAI in education.
2. Further research is needed to determine whether attitudes are the best predictor of teachers' use of CAI in school systems.

REFERENCES

Achuonye, K. A., & Olele, C. N. (2009). Internet Using Patterns of Nigerian Teacher-Trainees: Implications for Teacher Education in Nigeria. *J. Sci. Teach. Assoc. Nig., 44*(1&2), 103-108.

Achuonye, K. A. (2006). Human factor considerations for limiting gender barriers in our classrooms. *Int. J. Afr. Wom. Educ*., *2*(1), 102-107.

Ahmed, M. A. (2008). *Influence of personality factors on biology lecturers' assessment of difficulty levels of genetics concepts in Nigerian colleges of education* (Unpublished PhD thesis). University of Ilorin, Ilorin.

Babalola, I. E. (1998). The Need for Computer Assisted Instruction the Classroom Situation. *Nig. J. Comput. Lit., 2*(1), 58-68.

Basturk, R. (2005). The effectiveness of computer-assisted instruction in teaching introductory statistics. *Educational Technology & Society*, *8*(2), 170-178.

Becker, H. J., & Hativa, N. (2007). History, theory and research concerning integrated learning systems. *International Journal of Educational Research, 21*(1), 512.

Clark, R. E. (2006). Evidence for confounding in computer based instruction studies: Analysing the meta-analysis. *Educational Communications and Technology Journal*, *33*, 249-262.

Cohen, R. J., & Swerdlik, M. E. (2005). *Psychological Testing and Assessment. An Introduction to Tests and Measurement* (6th ed.). Boston: McGraw-Hill.

Cozby, P. C. (2003). *Methods in Behavioral Research* (8th ed.). Madrid: McGraw-Hill.

Frankel, J. R., & Wallen, N. E. (2000). *How to Design in Education*. New York: Longman Publishers.

Cotton, K. (2007). *Computer-assisted instruction*. North West Regional Educational Laboratory. Retrieved June 12, 2007 from http://www.borg.com/~rparkany/PromOriginal/ETAP778/CAI.html

Christmann, E. P., Lucking, R. A., & Badgett, J. L. (2010). The effectiveness of computer-assisted instruction on the academic achievement of secondary students: A meta-analytic comparison between urban, suburban, and rural educational settings. *Computers in the Schools*, *13*(3/4), 31-40.

Fletcher-Flinn, C. M., & Gravatt, B. (2005). The efficacy of computer assisted instruction (CAI): A meta-analysis. *Journal of Educational Computing Research, 12*(3), 219-242.

Huynh, M. Q., Lee, J., & Schuldt, B. A. (2005). The Insiders' Perspectives: A Focus Group Study on Gender Issues, in a Computer Supported Collaborative Learning Environment. J. Inf. Technol. Educ., Retrieved 15 May 11 from http://jite.org/documents/Vol4/v4p237-255Huynh14.ptd

Karper, C., Robinson, E. H., & Casado-Kehoe, M. (2005). Computer assisted instruction and academic achievement in counsellor education. *Journal of Technology in Counseling*, *4*(1). Retrieved December 22, 2007 from http://jtc.colstate.edu/Vol4_1/Karper/Karper.htm

Koul, L. (1997). *Methodology of Educational Research*. New Delhi: Vikas Publishing House PVT Ltd.

Kothari, C. R. (2005). *Research Methodology: Methods and Techniques.* India: P&F Publishers.

Kozma, R. (2004). Will media influence learning? Reframing the debate. *Educational Technology Research and Development, 42*(2), 7-19.

Means, B., Blando, J., Olson, K., Middleton, T., Morocco, C. C., Remz, A. R., & Zorfass, J. (2005). *Using technology to support education reform*. Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Mitra, A., Lenzmeier, S., Avon, R., Qu, N., & Hazen, M. (2000). Gender and Computer Use in an Academic Institution: Report from a Longitudinal Study. *J. Educ. Comput. Res., 23*(1), 67-84.

Mugenda, O. M., & Mugenda, A. G. (2003). *Research Methods: Quantitative and Qualitative Approaches*. Nairobi: Acts Press.

Murray, R. T. (2003). *Blending Qualitative and Quantitative Research Methods in Thesis and Dissertations*. New York: Corwin in Press.

Nassiuma, K. D., & Mwangi, W. J. (2004*). Statistical Methods for Information Analysis. An Introduction.* Njoro: Egerton University Press.

Omwenga, E., Waema, T., & Wagacha, P. (2003). *A model for introducing and implementing e-learning for delivery of educational content within the African context.* Nairobi: Mvule Africa Publishers.

Onwuegbuna, S. N., & Onwuegbuna, J. O. (2006). Factors hindering effective participation of women in technical and vocational education programme in Nigeria. *Multidiscip. J. Res. Dev., 7*(1), 54-60.

Schacter, J. (2010). *The impact of educational technology on student achievement: What the most current research has to say*. Santa Monica, CA: The Milken Exchange on Education Technology.

Schacter, J., & Fagnano, C. (2009). Does computer technology improve student learning and achievement? How, when, and under what conditions? *Journal of Educational Computing Research, 20*(4), 329-343.

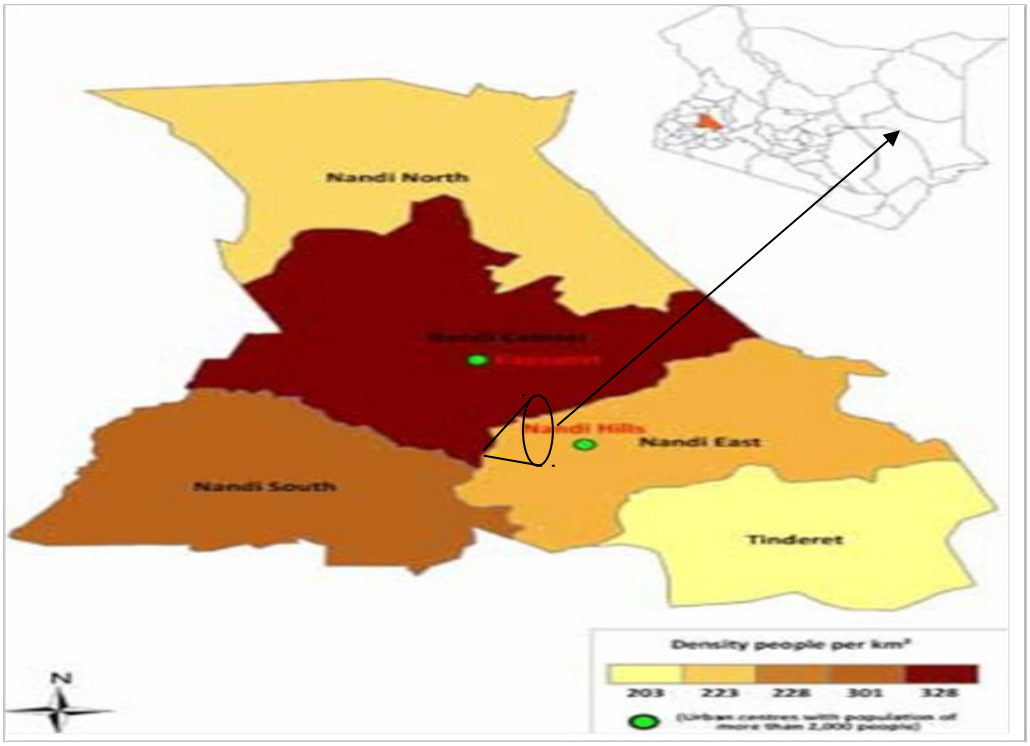
Shashaani, L. (1997). Gender differences in Computer attitudes and use among College students. *J. Educ. Comput. Res., 16*(1).

Yusuf, M. O. (1998). A Study of the dimensions of teachers' attitudes towards computer education in Nigerian Secondary Schools. *Nig. J. Comput. Lit., 2*(1): 47-58.

Yusuf, M. O., & Afolabi, A. O. (2010). Effects of Computer Assisted Instruction (CAI) on Secondary School Students' Performance in Biology. *The Turk. Online J. Educ. Technol., 9*(1), 62-69.

APPENDICES

Appendix 1: Study Location



Appendix 2: Table for Determining the Size of a Randomly Chosen Sample

The table for determining the size of a randomly chosen sample for a given population of N cases such that the sample proportion is within + 0.05 of the population within a 95% level of confidence.

N		**S**		**N**		**S**		**N**		**S**
10		10		220		140		1200		291
15		14		230		144		1300		297
20		19		240		148		1400		302
25		24		250		152		1500		306
30		28		260		155		1600		310
35		32		270		159		1700		313
40		36		280		162		1800		317
45		40		290		165		1900		320
50		44		300		169		2000		322
55		48		320		175		2200		327
60		52		340		181		2400		331
65		56		360		186		2600		335
70		59		380		191		2800		338
75		63		400		196		3000		341
80		66		420		201		3500		346
85		70		440		205		4000		351
90		73		460		210		4500		354
95		76		480		214		5000		357
100		80		500		217		6000		361
110		86		550		226		7000		364
120		92		600		234		8000		367
130		97		650		241		9000		368
140		103		700		248		10000		370
150		108		750		254		15000		375
160		113		800		260		20000		377

Source: Extracted from Kathuri and Pals (1993)

Appendix 3: Questionnaire for Teachers of Biology

I am a Master's student in Moi University. I am conducting a study entitled, **'Impact of Selected Instructional Methods on Students' Academic Achievement in Biology in Secondary Schools in Nandi South Sub-County, Kenya'.** You have been selected as one of the respondents of this study. Your responses will be used for purposes of this study only and will be treated with utmost confidentiality. Please feel free to fill in your responses in this questionnaire as you may deem appropriate.

Thank you.

SECTION A: Background Information

1. Please indicate your gender

   Male ( ) Female ( )

2. State your academic qualification.

   Diploma ( ) Undergraduate ( ) Masters ( ) PhD ( )

   Others (specify)……..

3. Did you pursue Biology as your major subject in college?

   Yes ( ) No ( )

4. For how long have you been serving in this school?

   1-2 years ( )

   3-5 years ( )

   6-10 years ( )

   Over 10 years ( )

5. How long have you been teaching Biology in this school?

   1-2 years ( )

   2-5 years ( )

5-10 years ( )

Over 10 years ( )

6. What is the highest aggregate mean that this school has ever attained in Biology K.C.S.E examinations?

SECTION B: Attitude of Teachers of Biology towards Computer Assisted Instruction (CAI) and Conventional Instruction (CI)

Conventional instruction-Traditional methods of teaching

7. Please indicate your level of agreement with the following statements by ticking against your appropriate response. Use the scale provided.

Strongly Agree- 5
Agree - 4
Undecided- 3
Disagree - 2
Strongly Disagree- 1

Statement	**5 (SA)**	**4 (A)**	**3 (U)**	**2 (D)**	**1 (SD)**
I have all through been employing CI in teaching Biology					
CAI lessons assume a more biological background than what I have					
CAI follows a logical sequence					
CAI presents concepts in a manner that allows for students deeper understanding					
CAI is more interesting to students					
Use of CAI is a waste of time					
CAI is complicated for me					

8. How would you rate your computer skills?
   ( ) Basic (Able to do basic word processing and use of the internet)
   ( ) Intermediate user (Have mastered the basics and have developed additional skills, including the use of different software programs
   ( ) Advanced user (Knowledgeable of hardware and software, able to trouble shoot, advice and teach others)
   ( ) I have no computer skills

SECTION B: Influence of CAI on Students' Academic Achievement

9. In which way do you think your students learn new concepts in Biology best?
   ( ) By hearing the concepts
   ( ) By seeing/reading the concepts
   ( ) By both hearing and seeing the content
10. In your opinion. Do you think the use of computer assisted instruction influences students' achievement in Biology?
    If yes, in which way and to what extent? (Please elaborate)
    ……
    ……
    ……
    ……
    ……
11. In your opinion, how do you compare students' achievement in Biology if taught through the use of computer assisted instruction and conventional instruction and when taught using one of the approaches?
    ……
    ……
    ……
    ……
    ……
12. Examine the combined impact of use of CAI and CI in teaching Biology on students' academic achievement.
    ……
    ……
    ……
    ……
    ……
13. In your opinion, what do you think needs to be done to improve the teaching and learning of Biology?
    ……
    ……
    ……
    ……
    ……
    ……
    ……...

Thank you for your time and effort

Appendix 4: Questionnaire for Students

I am a Masters student in Moi University. I am conducting a study entitled, **"Impact of Selected Instructional Methods on Students' Academic Achievement in Biology in Secondary Schools in Nandi South Sub-County, Kenya'.** You have been selected as one of the respondents of this study. Your responses will be used for purposes of this study only and will be treated with utmost confidentiality. Please feel free to fill in your responses in this questionnaire as you may deem appropriate.

Thank you.

SECTION A: Background Information

1. Indicate your gender.
   Male ( )

   Female ( )

2. In which form are you?

   Form 1 ( )

   Form 2 ( )

   Form 3 ( )

   Form 4 ( )

3. What grade did you attain in last term's Biology examination? ……

4. What is the highest grade that you have attained in Biology examinations?

   ……..

SECTION B: Students' Attitude towards Computer Assisted Instruction (CAI) and Conventional Instruction (CI)

5. Please indicate your level of agreement with the following statements by ticking against your appropriate response. Use the scale provided.

   Strongly Disagree- 1
   Disagree - 2
   Undecided- 3
   Agree - 4
   Strongly Agree- 5

Statement	**1**	**2**	**3**	**4**	**5**
I enjoy lessons of Biology taught through CI					
I enjoy lessons of Biology taught through CAI					
I understand lessons of Biology taught through CI					
I understand lessons of Biology taught through CAI					
CAI is a more modern way of learning					
Use of CAI is a waste of time					
CAI is complicated for me					

6. How would you rate your computer skills?

   ( ) Basic (Able to do basic word processing and use of the internet)

   ( ) Intermediate user (Have mastered the basics and have developed additional skills, including the use of different software programs

   ( ) Advanced user (Knowledgeable of hardware and software, able to trouble shoot, advice and teach others)

   ( ) I have no computer skills

7. In your opinion, do you think computer assisted instruction should be adopted in all schools in the teaching of Biology? Please elaborate your answer.

   ……

   ……

   ……

Thank you for your cooperation

Appendix 5: Criterion Reference Test

Respond to the following questions:

1. What form of energy do cells need in order to do work?
   ……
   ……
   ……
   ……
2. What types of organisms must obtain their food by consuming other organisms?
   ……
   ……
   ……
   ……
3. What is the chemical equation for photosynthesis?
   .....
   .....
   .....
   .....
4. Where is the energy used in photosynthesis obtained?
   ……
   ……
   ……
   ……
5. What are the reactants for photosynthesis?
   ……
   ……
   ……
   ……
6. What are the end products of photosynthesis?
   ……
   ……
   ……
   ……
7. In which part of the leaf does photosynthesis primarily occur?
   ……
   ……
   ……
8. In what cellular organelle does photosynthesis occur?
   ……
   ……
   ……
   ……
9. What is the primary light gathering pigment in plants?
   ……
   ……
   ……
10. What is the function of chlorophyll?
    ……
    ……

……
……

11. What part of the visible spectrum is not absorbed by chlorophyll?
……
……
……
……

12. What are the tiny disk like structures in chloroplasts that contain chlorophyll?
……
……
……
……

13. What are the sacs of three disks like structures called?
……
……
……
……

14. What is another name for the light independent reaction?
……
……
……
……

15. What are the four main steps of the light dependent reaction?
……
……
……
……

16. Write two things that are needed for the light reaction?
……
……
……
……

17. What is produced by the light reaction of photosynthesis
……
……
……
……

18. What three substances must be supplied to the Calvin Cycle?
……
……
……
……

19. What is the energy from ATP and NADPH used for in the Calvin Cycle?
    ……
    ……
    ……
20. What is produced in the Calvin Cycle?
    ……
    ……
    ….....
21. Write some factors that affect the rate at which photosynthesis occurs.
    ……
    ……
    ……
    …… ……..
22. In what cellular organelle does glycolysis occur?
    ……
    ……
    ……
23. During respiration what is glucose used for?
    ……
    ……
    ……

Thank you for your time and effort

Appendix 6: Interview Schedule Guide for Head Teachers

1. Do teachers of Biology in this school employ computer assisted instruction during their lessons?
2. How do you compare the influence of computer assisted instruction and conventional instruction on learner achievement in Biology in this school? (probe for reasons)
3. In your opinion, what do you think is the attitude of teachers of Biology towards computer assisted instruction in this school?
4. In your opinion, what do you think is the attitude of students towards computer assisted instruction in this school?
5. Are there instances where teachers of Biology in this school employ both computer assisted instruction and conventional instruction in the teaching of Biology? How has been the impact on learner achievement?
6. In your opinion, what do you think needs to be done to improve pedagogical skills of teachers of Biology in this school?
7. Any other comment on the teaching of Biology in this school?