EFFECTS OF COMPUTER BASED MASTERY LEARNING APPROACH ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND MOTIVATION IN BIOLOGY IN BOMET DISTRICT, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented for the award of a degree in any other University.

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Recommendation

This thesis has been submitted with our recommendation as University supervisors.

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DEDICATION

This work is dedicated to my loving wife, Magdalene and our children Emmaculate, Emmanuel and Mitchell for their love, patience, company and encouragement.

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The successful completion of this work is attributed to constant advice and material assistance provided by many people who I owe a lot of gratitude. Although their names may not appear herein, their contributions greatly helped shape this thesis. First and foremost, I sincerely thank the Lord God Almighty for grace that enabled me to conclude this study. I am greatly indebted to my supervisors Prof. F.N. Keraro and Prof. S.W. Wachanga for their encouragement, patience, intellectual guidance and exceptional kindness in their supervisory role during my research work to the conclusion of this study. My heartfelt gratitude goes to the entire staff of the Department of Curriculum, Instruction and Educational Management of Egerton University for enabling me to overcome many unexpected hurdles during my study. I acknowledge the total and unreserved assistance accorded to me by Mr. Leo Ogola, especially during the data analysis. I would also like to sincerely thank the head teachers and cooperating teachers for allowing me to carry out research in their schools. I highly appreciate Mr. Zack Wambugu of Zack Computer Systems for the assistance he accorded me in the preparation of the software that was used in this study. May God bless and reward according to his riches in glory, all the mentioned and unmentioned for their hand in this study.

ABSTRACT

The knowledge of biology is applied in many aspects of human life including genetic engineering, population control, branches of medicine and environmental conservation. It has a significant role to play in enhancing the country's socio-economic development by enabling exploitation of land, animal and other natural and human resources. Inspite of this, the overall achievement in biology in Kenya Certificate of Secondary Examination (KCSE) has been poor. Approaches used in the instructional process have been identified as among the factors contributing to the problem of low achievement. In this study an attempt was made to overcome this problem by using Computer Based Mastery Learning (CBML) approach as an intervention to investigate its effects on students' Achievement and Motivation. A non-equivalent Solomon's Four Group design (quasi-experimental research design) was used in which four co-educational secondary schools were purposively sampled. The four schools were randomly assigned to four groups. Students in all the groups were taught the same biology content. Teachers of the experimental groups taught using CBML approach while teachers of the control groups taught using the conventional methods. The study focused on the topic Respiration and involved a sample of 167 Form two students in four schools in Bomet District. Two instruments namely Biology Achievement Test (BAT) and Students' Motivation Questionnaire (SMQ) were used to collect data. The instruments were validated by five research experts in Science Education and five practising high school biology teachers. Reliability was estimated using Cronbach's alpha coefficient. A reliability co-efficient of 0.77 was obtained for BAT and 0.79 for SMQ. Inferential statistics ANOVA, t-test and ANCOVA were used for data analysis. Hypotheses were tested at an alpha level of 0.05. The findings indicate that students taught using CBML approach had significantly higher scores in BAT and SMQ than those taught using conventional approaches. The findings further indicate that there is no gender difference in achievement and motivation when CBML is used. It is recommended that CBML teaching strategy be incorporated in teacher education programes. Designers of computer based learning programmes should also be encouraged to include CBML to enhance student learning.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANCOVA- Analysis of Co-Variance

ANOVA- Analysis of Variance

BAT- Biology Achievement Test

CBI- Computer Based Instruction

CBML- Computer Based Mastery Learning

CAI- Computer Assisted Instruction

KCSE – Kenya Certificate of Secondary Education

KIE- Kenya Institute of Education

KNEC- Kenya National Examinations Council

MLA- Mastery Learning Approach

NCST- National Council for Science and Technology

SMQ- Student Motivation Questionnaire

SPSS- Statistical Package for Social Sciences

UNESCO- United Nations Educational Scientific and Cultural Organization

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Biological knowledge has been used throughout the centuries because it has a wide range of applications in most aspects of human life. It's applications in genetic engineering has resulted in the production of high yielding plant and animal species. This has made tremendous contribution towards meeting the demand of food requirements for the ever growing human population (Keraro, Wachanga & Orora, 2007). Biological knowledge has also been applied in branches of medicine such as organ transplant and control of a wide range of diseases. Biological knowledge is also applied in industry such as the use of microorganisms in food processing. Other areas where biological knowledge has been applied include population control and environmental conservation (UNESCO, 1986)

Secondary school biology enables learners to acquire knowledge and skills useful in every day life and in development of desirable attitudes (Brown, 1995). According to UNESCO (1975), school biology should be relevant to real life and experiences of learners. There is need to change from closely directed learning of facts to conceptual understanding, application of acquired knowledge and skills to solve emerging problems. Students leaving high school should be able to use biology in their every day life (Rose, 1971; Orora, Wachanga & Keraro, 2005). For this to be realized, effective teaching approaches that enhance learning need to be developed and used in the teaching of biology. Expository approaches cannot stand up to the challenges of the new demands and objectives of biology education hence a fresh look at new approaches should be taken (UNESCO, 1986). In recent years, science educators have used the constructivist approach to enhance students' learning (Trowbridge, Bybee & Powell, 2004). According to Good and Brophy (1995) learners' are seen not just as accessing information but also as constructing their own meanings. Aslop and Hicks (2001) point out that learning of science is essentially an active process. Therefore, the teaching of biology should enhance active learner participation.

The actual outcomes of instruction depend largely on what happens in classrooms. If scientific knowledge is presented in terms of proven facts and absolute truths readily communicated through texts and lectures, then students will come to regard science as a static body of knowledge that is founded on well-defined methods (Roth & Roychoudhury, 2003). Knowledge, for these students, consists of memorizing a body of information for later retrieval. If, on the other hand, students actively engage in science processes, they recognize that scientific knowledge is based on experiments in which the meaning of data is negotiated and theories are not absolute. Knowledge, in this context, consists of learning experimental methods and the norms and practices of scientific communities as much as it does learning known facts and current theories within a domain (Wheeler, 2000).

In teacher-centred instruction, learning focuses on the mastery of content, with little development of the skills and attitudes necessary for scientific inquiry. The teacher transmits information to students, who receive and memorize it. Assessments of knowledge typically involve one right answer. The curriculum is loaded with many facts and a large number of vocabulary words, which encourages a lecture format of teaching (Leonard & Chandler, 2003). In contrast, in a student-centred curriculum, learning science is active and constructive, involving inquiry and hands-on activities. The goal is to develop critical thinking and problem-solving skills by posing and investigating relevant questions whose answers must be discovered. The teacher acts as a facilitator, creating the learning conditions in which students actively engage in experiments, interpret and explain data, and negotiate understandings of the findings with peers. In this approach, the teacher puts less emphasis on memorizing information and more emphasis on inquiry and hands-on activities through which students develop a deeper knowledge and appreciation of the nature of science (National Research Council, 1996, 2000, 2003; Singer, Marx, Krajcik, & Chambers, 2000). Thus when learners are actively involved during the instructional process, their achievement and motivation to learn would improve.

Achievement in Kenya Certificate of Secondary Education (KCSE) biology has continued to remain poor (KNEC, 2012). Table 1 shows the achievement in KCSE in Biology for the period 2008-2012.

Table 1

The achievement of Candidates in KCSE Biology from 2008-2012

Year	2008	2009	2010	2011	2012
Mean %	27.44	41.95	30.32	28.78	25.29

Source KNEC, 2008; 2012.

The data in table 1 indicates that there have been fluctuations, the highest percentage mean achievement was 41.95 in 2009 and the lowest was 25.29 in 2012.

Table 2 shows the achievement by gender in KCSE biology for the period 2008-2012.

Table 2

The achievement by Gender in KCSE Biology from 2008-2012

Year	2008	2009	2010	2011	2012
Girls Mean %	25.00	38.99	28.49	30.07	24.36
Boys Mean%	29.84	44.70	32.01	34.53	27.86

Source KNEC, 2008; 2012.

The data in table 2 indicates that there is gender disparity in favour of boys. A paired t-test was used to assess the performance for the years 2008-2012. The mean for boys was 33.79 compared to girls with mean score of 29.38.The mean difference between the two scores is 4.41, CI (3.24-5.57), $P<0.001$ which is statistically significant.

The achievement in KCSE Biology in Bomet District is equally low and conforms to the national trend. Table 3 shows the achievement in KCSE Biology in Bomet district for the period 2008-2012.

Table 3

The achievement in KCSE Biology in Bomet District from 2008-2012.

Year	2008	2009	2010	2011	2012
Mean %	39.83	40.25	41.33	38.30	41.30

Source KNEC, 2012.

The data in table 3 shows that there have been fluctuations in achievement in KCSE biology in Bomet District. The highest percentage achievement was 41.33 in 2010 and lowest was 38.30 in 2011. However, there was a steady increase from 39.83 in 2008 to 41.33 in 2010, but this achievement is still low.

Table 4 shows the achievement in KCSE Biology of the best five girls' schools and best five boys' schools in Bomet District.

Table 4

Achievement in KCSE Biology of the best five Girls' Schools and five best boy's Schools in Bomet District in 2012.

Girls School	Mean %	Boys School	Mean %
Ndaraweta	53.45	Longisa	73.90
Chebonei	53.58	Tenwek	72.05
Kong'otik	48.76	Kabungut	62.51
St. Mary's	44.79	Mulot	54.70

KNEC, 2012

The data in Table 4 indicates that boys' schools have had higher mean percentage achievement than girls' schools. This further indicates that there is gender disparity in favor of boys in KCSE biology achievement in Bomet District

From the foregoing analysis, it is clear that unless urgent measures are taken to curb the problem, the low achievement in biology at the Kenya Certificate of Secondary Education (KCSE) national examinations will persist. According to Changeiywo (2000), some of the factors that affect students' performance in science are: time allocation, availability and use of instructional materials, lack of well trained teachers, relevance of the curriculum to the needs of the society, attitude of students and teachers towards the subject, examination pressure and language of instruction used in the subject. Further, Adewuyi (2001) noted that the style of teaching employed by a teacher is a powerful factor in motivating learners to learn. Learners, therefore, need to be taught using more effective approaches that actively engage them in the learning process.

Computer based instruction is an effective approach in that it provides individualized instruction and learning occurs at learners own pace and time frame (Curtis & Howard, 1990; Munden, 1996). CBI enhances learning and improves retention rate of students; it motivates and develops sense of efficacy (Cotton, 1999). It also allows a learner to interact with the computer (Chabay & Sherwood, 1992) and as a result, it is impossible for a learner to assume the role of a mere observer (Lockard & Abrams, 1987). Coller (2004) indicated that instruction supplemented by properly designed CBI is more effective than instruction without CBI. Alessi and Trollip (1991) emphasized that there are four major types of CBI programmes namely: Tutorials, Drills and practice, instructional games and simulations.

Tutorial uses the computer to deliver an entire instructional sequence similar to a teacher's classroom instruction on the topic. Tutorial form of CBI teaches students new information. Student interacts with the computer programme much like a student would interact with a teacher in a one to one session. Concepts are presented to a student, a student's understanding is measured and the computer programme then provides more instruction or remedial instruction based upon his or her responses (Cox, 1995; Poole, 1997 & Roblyer, 2000).

Drills and practice provide exercise in which students work on example items and receive feedback. Feedback and practice provided in the programme enable students memorize learning material or refine skills already taught to them. Advantage of drill and practice is that it provides automatic feedback to students' responses, record keeping and the variation of pace depending on students' knowledge (Slavin, 2003).

Instructional games are courseware with a function to increase motivation by adding game rules to learning activities. Students may be more willing to work at practicing skills if they know they can do so by playing a game. Depending on the particular game, students can compete against the computer programme or against other students (Roblyer & Edwards, 2000).

Simulation is a computerized model of a real or imagined system designed to teach how a system works. Simulations differ from tutorial, drill and practice activities by providing learner structured activities. It allow students to experience events, or phenomena that they are not able to experience first hand and that would be too difficult or dangerous to duplicate in the classroom setting. The person using the courseware usually chooses tasks and the order in which to do them. He/she can also control the speed of processes to study the effects

(Bitter & Pierson, 1999; Roblyer & Edwards, 2000).
Kiboss, Tanui and Nassiuma (2003) observed that the use of CBI Simulation has proved successful in teaching difficult concepts in Physics, Biology, Mathematics and Geography. No empirical research has specifically examined the dynamics of one to one computer tutorials and their effects on solving related problems (Hepper et al., 1993). Using the tutorials, students will hopefully internalize the concepts presented. It is on this basis that CBI tutorial was adapted in this study.

Mastery Learning Approach (MLA) is an instructional method where students are allowed unlimited opportunities to demonstrate mastery of content taught (Kibler, Cegala, Watson, Baker & Miler, 1981). MLA involves breaking down the subject matter to be learned into units of learning, each with its own objectives. Results from research studies on MLA shows that there is better retention and transfer of material, yields greater interest and more positive attitudes (Kibler et al, 1981). Block (1971) states that students with minimal prior knowledge of material have higher achievement through mastery learning than with traditional methods of instruction.

In this study, the elements of mastery learning were incorporated into the CBI tutorial. The tutorial used the visual basic language. Lessons were presented using computer and students went through the tutorial in biology topic respiration. At the end of each learning objective in the lesson were quizzes. The students were required to answer questions and upon attaining a score of 80% they would be allowed to move to the next topic. This approach was referred to as Computer Based Mastery Learning (CBML). The study also sought to establish whether there were any gender disparities in achievement in biology and motivation to learn.

1.2 Statement of the Problem

The overall students' achievement in biology in KCSE has been poor. Conventional teaching approaches have been identified as some of the factors contributing to this poor achievement and lack of motivation to learn. A teaching method that would be appropriate is one that would not only enhance achievement but also increase students' motivation to learn. The focus of this study was therefore to investigate the effects of CBML on students' achievement in biology and motivation to learn.

1.3 Purpose of Study

This study sought to determine the effects of CBML on students' achievement in biology and motivation to learn in secondary schools in Bomet District, Kenya. It also sought to compare boys' and girls' achievement and motivation when they are taught using CBML.

1.4 Objectives of the Study

The specific objectives of this study were:

1. To determine whether there is a difference in achievement in biology between students exposed to CBML and those exposed to conventional learning approach.
2. To establish whether there is a difference in motivation to learn biology between students exposed to CBML and those exposed to conventional learning approach.
3. To investigate whether there is a gender difference in achievement in biology between students exposed to CBML.
4. To find whether there is a gender difference in motivation to learn biology between students exposed to CBML.

1.5 Hypotheses of the Study

To achieve the objectives of this study the following null hypotheses were tested.

Ho1: There is no statistically significant difference in achievement in biology between students exposed to CBML and those exposed to conventional teaching approaches.

Ho2: There is no statistically significant difference in motivation to learn biology between students exposed to CBML and those exposed to conventional teaching approaches.

Ho3: There is no statistically significant gender difference in achievement in biology when students are exposed to CBML.

Ho4: There is no statistically significant gender difference in motivation to learn biology when students are exposed to CBML.

1.6 Significance of the Study

The findings of this study contribute towards the improvement of instructional strategies in secondary school biology. The same strategies should be applied in the teaching of other science subjects. It provides a basis for curriculum developers and policy makers to acknowledge and advocate for learner centred science education curriculum. It also provides information to Educators and designers of computer based learning programmes to be used in enhancing student learning.

1.7 Scope of the Study

The study involved 167 Form two students in four Provincial co-educational Secondary Schools in Bomet district. The four schools were randomly sampled into experimental and control groups. The experimental groups were taught using CBML approach while control groups were taught using conventional approaches. The biology topic that was covered in the study was Respiration.

1.8 Limitation of the Study

The teacher's presentation of the biology content may vary slightly from teacher to teacher; this might influence the scores in Achievement test. The variations were minimized by using teachers who have at least a Diploma in biology education and have taught for at least three years.

1.9 Assumptions of the Study

In this study the following assumptions were made:

(i) That all respondents were co-operative in providing the required data.

(ii) That the presence of the researcher in the schools sampled did not influence the responses to be given by the subjects involved in the study.

(iii) The teachers involved in the study embraced the challenges of using CBML in the teaching of the biology topic respiration and taught to the best of their ability.

1.10 Definition of Terms

Below are the constitutive and operationalised meanings of terms as used in the study.

Achievement - A person's success attained through effort and skill which can be assessed by means of a testing device.

In this study it refers to student attainment of scores in biology test.

Co-educational secondary schools – These are secondary schools where boys and girls learn together.

Conventional learning approach- also referred to as regular or traditional methods, refers to instructional methods in which technology is used very little; blackboard chalk and lectures are the primary teaching tools.

In this study, the term referred to the mode of instruction that was used to teach the control groups.

Control group - Refers to group of subjects that is matched with experimental group, but is not exposed to any treatment.

In this study it refers to group of students taught using conventional methods

Computer based instruction- refers to virtually any kind of computer use in educational setting.

Drill and practice- Software that provides exercise in which students work on example items and receive feedback on their correctness.

Effect- Refers to a change or result of something.

In this study refers to change in achievement and motivation as a result of teaching using computers

Form two –This is the second year in Kenyan secondary school education system

Gender- Refers to difference between male and female in socio-cultural aspects rather than the physical difference only.

In this study it is used to refer whether one is a male or a female.

Instructional games- are courseware with a function to increase motivation by adding game rules to learning activities

Mastery learning – An instructional method whereby students are not to advance to a subsequent learning objective until they demonstrate proficiency with the current one.

Motivation- This refers to affective psychological process that influences students to learn biology. This will be measured using a student Motivation Questionnaire (SMQ).

Simulation- is a computerized model of a real or imagined system designed to teach how a system works.

Tutorial- Software that uses computer to deliver an entire instructional sequence similar to teachers' classroom instruction on the topic.

Treatment- Is subjection to some agent or action.

In this study it refers to teaching of the experimental group using CBML Approach.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature relevant to the variables of the study it focuses on the importance of biology, teaching approaches, constructivism, active learning, computer based instruction, computers and students learning, mastery learning, achievement, motivation, achievement and motivation, gender and computer based instruction. The theoretical and conceptual framework that guided the study concludes the chapter.

2.2 Importance of Biology

Biological knowledge has a wide range of applications aimed at addressing welfare of the human race. It was used in the Ancient Chinese civilization (5700-3600 BC) in the battle against disease (Starr, 1991). In the Mesopotamia Civilization (2000-1595 BC), the Babylonians had good knowledge of human anatomy and physiology. They also had knowledge of surgery and even performed delicate eye operations. Biological knowledge was utilized in the ancient Egyptian civilization (3000-1000 BC) to advance medical practices such as surgery, production of therapeutic drugs and preservation of dead bodies (Huff, 1995). Today, it is applied in areas of health and nutrition, environmental conservation, agricultural production for example water requirements of particular crops and industrial production of alcohol. It is also useful in forensic science and population control (Brown, 1995). Biology is a core subject in secondary school curriculum in Kenya. Some of the main objectives of teaching biology are to promote creative processes of students and investigate social implications of the subject (Kenya Institute of Education, 1992). Biology thus should be taught in a manner that motivates and enables learners to master the concepts.

2.3 Teaching Approaches

Teaching approaches refers to all the steps or ways that a teacher uses when presenting the contents of the lesson (Maundu, Sambili & Muthwii, 1998). The goals of teaching are that the students may gain knowledge, skills, deepening of understanding, and development of problem solving ability or change in perception, attitudes, values and behavior (Shiundu & Omulando, 1992). The biology teaching approaches are grouped into two major categories: the expository approach that is characterized by the predominance of teacher talk, giving and explaining facts and doing demonstrations with little or no student involvement in practical activities, while the inquiry approach is characterized by students' active involvement in the learning activities with the teacher taking on the role of the facilitator in the learning process (Okere, 1996; Maundu et al, 1998)

The expository approach may not be very useful in the teaching of biology especially considering that biology is a practical subject. However, the approach continues to be used especially in topics where teacher exposition is the only satisfactory approach because of lack of teaching resources and/or facilities or time for example evolution, genetics, cell division, reproduction and respiration (Brown, 1995; Maundu et al, 1998).

The inquiry approach to teaching and learning enable students to develop science process skills such as observation, collection and presentation of data, drawing conclusions, inferring and ability to manipulate apparatus (Okere, 1996; Maundu et al, 1998). This approach is time consuming and there is fear that students might not master the scientific methods involved. Yet it is the most preferred approach to science teaching/ learning because it makes the learner to think, to formulate and test hypotheses like real scientists and develop independence of the teacher.

The biology curriculum and syllabus advocates for inquiry approaches to teaching biology (KIE, 1992). Okere (1996) points out that science teaching in the majority of Kenyan secondary schools is predominantly science first rather than application first, that is, practicals are done to confirm theory taught in class. During practical lessons, students often follow some rigid laid down procedures to confirm laws and/or principles already established. This approach to science teaching seems to go against the current constructivist theory of learning which recommends active learners involvement in constructing meaning from input by processing it through their existing cognitive structures. It is also inconsistent with the discovery theory where learning that is meaningful to a student is developed through the discovery that occurs during exploration (Okere, 1996). With the incorporation of the CBI tutorial, intake of information from the learning environment is active and systematic because learner participation is an integral part of the instructional process.

2.4 Constructivism

Constructivism is a theory of learning based on the idea that knowledge is constructed by the learner based on mental activity. Learning is considered to be an active social process (Vygotsky's, 1978). According to social constructivists, the process of sharing individual perspectives-called *collaborative elaboration* (Meter & Stevens, 2000) results in learners constructing understanding together that wouldn't be possible alone (Greeno, Collins & Resnick, 1996)

Social constructivist view learning as an active process where learners should learn to discover principles, concepts and facts for themselves, (Brown, Collins & Duguid, 1989; Ackerman 1996). For the social constructivist, reality is not something that we can discover because it does not pre-exist prior to our social invention of it. Kukla (2000) argues that reality is constructed by our own activities and that people, together as members of a society, invent the properties of the world. Knowledge is thus a product of humans and is socially and culturally constructed (Ernest, 1991; Prawat & Floden, 1994). McMahon (1997) agrees that learning is a social process. He further states that learning is not a process that only takes place inside our minds, nor is it a passive development of behaviors that is shaped by external forces and that meaningful learning occurs when individuals are engaged in social activities.

In the social constructivist viewpoint the instructor and the learners are equally involved in learning from each other (Holt & Willard-Holt, 2000). This means that the learning experience is both subjective and objective and requires that the instructor's culture, values and background become an essential part of the interplay between learners and tasks in the shaping of meaning. Learners compare their version of the truth with that of the instructor and fellow learners to get to a new, socially tested version of truth (Kukla, 2000). The task or problem is thus the interface between the instructor and the learner (McMahon, 1997). This creates a dynamic interaction between task, instructor and learner. This entails that learners and instructors should develop an awareness of each other's viewpoints and then look to their own beliefs, standards and values, thus being both subjective and objective at the same time (Savery, 1994).

2.4.1Types of constructivism

Constructivism comes in different strengths from weak to moderate to extreme with different point of focus. Some constructivist views focus on shared social construction of knowledge; others see social forces as less important. There are, however, two major strands of constructivist perspective. One strand is called cognitive constructivism based on the epistemology of Piaget and the other is social constructivism based on thoughts of vygotsky

(Roblyer & Edwards, 2000; Maddux, Johnson & Willis, 1997).

2.4.2 Cognitive constructivism

The roots of constructivist approaches to education lie primarily in developmental psychology. Developmental psychologists see people neither as entities that merely react to their environments nor as computing machines, but as organisms that develop and grow over time in interaction with their environments. This perspective stresses the importance of each individual's autonomy as a thinker and learner (Tiene & Ingram, 2001).

Flavell (1985) as cited in Roblyer & Edwards (2000) observed that cognitive constructivism is based on the epistemology of Piaget who referred to himself as a "genetic epistemologist" or a scientist who studies how knowledge begins and develops in individuals. Two widely recognized features of Piaget's theories are: Stages of cognitive development and Processes of cognitive functioning

2.4.3 Stages of cognitive development

Piaget believed that all children go through four stages of cognitive development while the ages at which they attain these stages vary somewhat. Every individual attains these stages in a sequence, from simple to complex. These stages are sensorimotor stage, preoperational stage, concrete operational stage and formal operations stage.

Sensorimotor stage

This is the first stage. It is from birth to about 2 years. In this stage, children explore the world around them through their senses and through motor activity. In the earliest stage, they cannot differentiate between themselves and their environments (if they cannot see something, it does not exist). They also begin to have some perception of cause and effect that is they develop the ability to follow something with their eyes.

Preoperational stage

This is the second stage. From about age 2 years to about age 7 years. Here children develop greater abilities to communicate through speech. They are able to engage in symbolic activities such as drawing objects and playing by pretending and imagining. Develop numerical abilities such as the skill of assigning a number to each object in a group as it is counted. Increase their level of self-control and are able to delay gratification, but are still fairly egocentric. Unable to do what Piaget called conservation tasks (tasks that call for recognizing that a substance remains the same even though its appearance changes for example shape is not related to quantity.

Concrete operational stage

Concrete operational stage is the third stage. It is from about age 7 to about age 11years. At this stage, children increase in abstract reasoning ability and ability to generalize from concrete experiences. They also develop concepts of conservation of quantities.

Formal operational stage

This is the fourth and the last stage. It from about age 12 to about age 15 years. At this stage, children can form and test hypotheses, organize information and reason scientifically. They can also show results of abstract thinking in the form of symbolic materials for example writing drama.

2.4.4 Processes of cognitive functioning

Piaget's theory as summarized by woolfolk (1998), Wade and Tavris (1998), Roblyer and Edwards (2000) suggest that mental functioning depends on two inborn tendencies. These inherited tendencies are Organization and Adaptation.

Organization

All human beings are designed to organize their observations and experiences into a coherent set of meanings. Every human is born with a tendency to organize his thinking processes into psychological structures. These psychological structures are our systems of understanding and interacting with the world. Simple structures are continually combined and coordinated to become more sophisticated and thus more effective. These structures are called schemata in Piaget's theory (Woolfolk, 1998).

Schemata are the basic building blocks of thinking. They are organized mental systems or categories of perception and experience. Schemes may be very small and specific or they may be larger and more general. As a person's thinking processes becomes more organized, new schemes develop; behavior also becomes more sophisticated and better suited to the environment (Woolfolk, 1978).

Adaptation

It is one's inborn tendency to get adjusted with the environment. One's cognitive development takes place through a gradual process of interacting with one's environment. When a person confronts with new and unfamiliar features of his environment that do not fit with his current views of the world a state of "disequilibrium" occurs. The state of disequilibrium is resolved through one of two processes of adaptation. These processes are: (i) assimilation (ii) accommodation.

Assimilation

Is the process by which one fits or incorporates new information into existing schemes. Assimilation involves trying to understand something new by fitting it into what we already know. At times, one may have to distort the new information to make it fit.

Accommodation

Is the process by which one changes the existing schema or view of the world to incorporate the new experiences. If data cannot be made to fit any existing schemes then more appropriate structure must be developed, hence accommodation is the process of modification and addition in the existing structures to accommodate the new information.

Ormrod (2000) summarizes Piaget's basic assumptions about children's cognitive development in the following ways:

1. Children are active and motivated learners.
2. Children's knowledge of the world becomes more integrated and organized over time.
3. Children learn through the processes of assimilation and accommodation.
4. Cognitive development depends on interaction with one's physical and social environment.
5. The process of equilibration (resolving disequilibrium) helps to develop increasingly complex levels of thought.
6. Cognitive development can occur only after certain genetically controlled neurological changes occur.
7. Cognitive development occurs in four qualitatively different stages.

2.4.5 Social constructivism

There is a great deal of overlap between the two shades of constructivism i.e. the cognitive and the social, but social constructivists lay more emphasis on the social context of learning. Social constructivism emphasizes the importance of interaction of a child with its environment for his cognitive development. Social constructivist perspective is grounded in the ideas of theorists such as john Dewey and Lev Vygotsky (Roblyer & Edwards, 2000; Maddux, Johnson & Willis, 1997).

2.4.5.1 Dewey's social constructivism

Educators credit John Dewey with one of the fundamental promises of constructivist thinking. His ideas like student centered education, learning by doing and need to centre student instruction on relevant, meaningful activities support constructivist models of teaching (Roblyer & Edwards, 2000).

Dewey viewed education as a process of social activity. He viewed school as a miniature society where children encounter personal and social problems and their experience lead them to construct and reconstruct their knowledge (Ornstein & Levine, 1995).

2.4.5.2 Vygotsky's social constructivism

Vygotsky's brand of constructivism is called social constructivism because he viewed learning as a socially mediated activity and emphasized the critical importance of a child's social interaction in his cognitive development. He was of the view that children develop in social and group setting. His twin concepts of scaffolding and the zone of proximal development are important for social constructivist perspective (Muddex, Johnson & Willis, 1987; Roblyer & Edwards, 2000; Woolflk, 1998).

According to Woolfolk (1998) the zone of proximal development is the area/ phase where the child cannot solve a problem alone, but can be successful under adult guidance or in collaboration with a more capable peer. Explaining the concept of zone of proximal development (Muddex, Johnson & Willis, 1997) contend that thinking and problem solving skills can be placed in three categories. Some can be performed easily by child other cannot be performed even with help. Between these two extremes are skills the child can perform with the help from others. Those skills that can be performed with the help of adults or more capable peers fall in the zone of proximal development. This is the area where instruction can succeed, because real learning is possible.

Scaffolding means the support for learning and problem solving. The support could be clues, reminders, encouragement, breaking the problem down into steps, providing an example, or anything else that allow the student to grow in independence as a learner (Woolfolk, 1998; Muddex, Johnson & Willis, 1997; Roblyer & Edwards, 2000).

2.4.6 Principles Essential to Constructivist teaching.

According to Brooks (1993) there are ten principles essential to constructivist teaching. These are:

Learning takes time: Learning is not instantaneous. For significant learning one need to revisit ideas, ponder them try them out, play with them and use them. This cannot happen in a short time.

Learning is an active process: Learner uses sensory input and constructs meaning out of it. Learners need to do something, because learning involves the learners engaging with the world.

People learn to learn as they learn: Learning consists both of constructing meaning and constructing systems of meaning. Each meaning we construct makes us better able to give meaning to other sensations

Constructing of meaning is mental: It happens in the mind. We need to provide activities which engage the mind as well as the hands.

Learning involves language: The language we use influences learning. People talk to themselves as they learn, and language and learning are inextricably intertwined.

Learning is a social activity: Our learning is intimately associated with our connection with other human beings, our teachers, our peers, and our family. Conversations, interaction with others and collaborations are an integral aspect of learning.

Learning is contextual: We do not learn isolated facts and theories in some abstract ethereal land of the mind separate from rest of our lives. We learn in relationship to what else we know, what we believe, our prejudices and our fears.

One needs knowledge to learn: It is not possible to assimilate new knowledge without having some structure developed from previous knowledge to build on. The more we know the more we can learn.

Learning is not passive: Learning involves the learner engaging with the world and extracting meaning from his/her experiences.

Motivation is a key component in learning. Not only is the case that motivation helps learning, it is essential for learning (Brooks, 1993)

2.4.7 Constructivist Views of Teaching and Learning

The aim of constructivist learning is to provide learning environments that offer maximum learner control and learning opportunities that are meaningful to the learner, allowing the learner to be more active in their construction of mental representations of phenomena (Mayer, Caruso & Salovey, 1999; McCombs, 2000). Learning is the result of constructed meaning. What a student “brings” cognitively to the learning environment is very important as it will determine what and how knowledge is constructed by a learner (Ausubel, 1963; Winn, 2003).

Secondary school classrooms have often been teacher-led and static in the way that material is made available to learners. Teachers have typically relied upon conventional methods such as lectures that culminate in a final exam to evaluate achievement. With this approach, the student is seen as a passive recipient of information and the teacher is viewed as the primary information presenter (Laurillard, 2002). This promotes a reliance on rote learning in an attempt to memorize important facts that may be used in an exam (McCombs, 2000).

Constructivist models shift the focus from a student as passive recipient of information to an active constructor of knowledge (Good & Brophy, 1995). A basic tenet of constructivism is that students learn by doing. Students bring prior knowledge into a learning situation in which they must critique and re-evaluate their understanding. Learning is a social and active process, where the focus shifts from teacher-directed to student-directed learning.

Social negotiation is important in constructivism (Vygotsky, 1962). Learning occurs and is demonstrated in social contexts. Effective social situations encourage collaboration and tolerance of other viewpoints. Constructivist practitioners suggest that social negotiation legitimizes concepts constructed by a learner. That is, not every new idea constructed by a learner is correct, but the learning community will inform a learner of his/her misconceptions and help him/her to adjust. The instructor serves as a guide for a learner by presenting learning opportunities and directing the learner toward learning resources (Lambert & McCombs, 1998). The instructor must consider student perceptions and determine whether personal learning goals and interpersonal needs are being met. From the learner's perspective instruction should be meaningful and relevant and provide appropriate learning challenges. Tasks should support critical thinking and flexibility with respect to learning opportunities and individual differences. Learner control should be emphasized and there should be opportunities for social interaction and support for individual interests (Lambert & McCombs, 1998). In these ways, meaning is constructed through the assimilation and accommodation of information, ideas originally presented by (Piaget, 1995). The belief is that computer technology has the potential to transform a passive learning environment into one that is more active and under the control of the learner.

2.5 Active Learning

Active learning is an umbrella term that refers to several models of instruction that focus the responsibility of learning, on learners. In active learning learners work in pairs, discuss materials while role-playing, debate, engage in case study, take part in cooperative learning, or produce short written exercises (Bonwell & Eison, 1991). These techniques may be used as a "follow up" exercise or as application of known principles, but it may not be used to introduce material. Proponents argue that these exercises may be used to create a context of material, but this context may be confusing to those with no prior knowledge. The degree of instructor guidance students need while being "active" may vary according to the task and its place in a teaching unit. Examples of "active learning" activities include:

A **class discussion** may be held in person or in an online environment. Discussions can be conducted with any class size, although it is typically more effective in smaller group settings. This environment allows for instructor guidance of the learning experience. Discussion requires the learners to think critically on the subject matter and use logic to evaluate their and others' positions. As learners are expected to discuss material constructively and intelligently, a discussion is a good follow-up activity given the unit has been sufficiently covered already (McKeachie & Svinicki, 2006).

A **think-pair-share** activity is when learners take a minute to ponder the previous lesson, later to discuss it with one or more of their peers, finally to share it with the class as part of a formal discussion. It is during this formal discussion that the instructor should clarify misconceptions. However students need a background in the subject matter to converse in a meaningful way. Therefore a "think-pair-share" exercise is useful in situations where learners can identify and relate what they already know to others.

A **learning cell** is an effective way for a pair of students to study and learn together. A learning cell is a process of learning where two students alternate asking and answering questions on commonly read materials. To prepare for the assignment, the students will read the assignment and write down questions that they have about the reading. At the next class meeting, the teacher will randomly put the students in pairs. The process begins by designating one student from each group to begin by asking one of their questions to the other. Once the two students discuss the question, the other student will ask a question and they will alternate accordingly. During this time, the teacher is going around the class from group to group giving feedback and answering questions. This system is also referred to as a student dyad (Goldschmid, 1971).

A **short written exercise** that is often used is the "one minute paper." This is a good way to review materials and provide feedback. However a "one minute paper" does not take one minute and for students to concisely summarize it is suggested that they have at least 10 minutes to work on this exercise.

A **collaborative learning group** is a successful way to learn different material for different classes. It is where students are assigned in groups of 3-6 people and they are given an assignment or task to work on together. This assignment could be either to answer a question to present to the entire class or a project. The students in the group choose a leader and a note-taker to keep them on track with the process. This is a good example of active learning because it causes the students to review the work that is being required at an earlier time to participate (McKinney, 2010).

A **student debate** is an active way for students to learn because they allow students the chance to take a position and gather information to support their view and explain it to others. These debates not only give the student a chance to participate in a fun activity but it also lets them gain some experience with giving a verbal presentation (McKinney, Kathleen, 2010).

A **reaction to a video** is also an example of active learning because most students love to watch movies. The video helps the student to understand what they are learning at the time in an alternative presentation mode. It should be ensured that the video relates to the topic that they are studying at the moment. Try to include a few questions before you start the video so they will pay more attention and notice where to focus at during the video. After the video is complete divide the students either into groups or pairs so that they may discuss what they learned and write a review or reaction to the movie (McKinney, 2010).

A **class game** is also considered an energetic way to learn because it not only helps the students to review the course material before an exam but it helps them to enjoy learning about a topic. Different games such as jeopardy and crossword puzzles always seem to get the students minds going (McKinney, 2010).

From a constructivist perspective, computer technology also has the potential to support diverse needs and capacities within the student population and to allow students greater control over their learning (McCombs, 2000), as well as the potential for deeper processing of information, especially if the computer is used to replicate authentic activities. But having computer tools available is, by itself, not enough. The tools have to be paired together with appropriate pedagogy to be effective (Laurillard, 2002).

In an instructor-led, lecture-based classroom, students frequently do not have the opportunity to ask questions or engage in discussion that would allow them to reflect on and refine their understanding of the material being presented (Laurillard, 2002). Under such circumstances, technology is often used only as an extension of the blackboard (Yazon, Mayer-Smith, & Redfield, 2002), or for drill-and-practice and tutorials (Roblyer, 2003). Supporters of technology implementation have argued that computer technology can be effective in changing the traditional teacher-centred classroom to a more constructivist student-centered classroom (Jonassen & Reeves, 1996), through the introduction of interactive and dynamic computer applications (Shuell & Farber, 2001). In order for learning to be effective the learner must actively use the tools available in order to build a deeper understanding of the material to be learned (Brown et al, 1989).

2.5.1 Learning Experiences

Within the constructivism, learner-centered framework, positive learning experiences would include feelings of effective interactions with the instructor and other students where the learner felt that he or she was in control of their own learning. Positive learning experiences are facilitated through increased opportunities for active participation and increased access to learning resources (Lambert & McCombs, 1998).

Students need to develop effective learning strategies in order to promote life-long learning (Zimmerman, 1994). Learners use a variety of strategies to learn material. Bloom (1956) put forth taxonomy of six categories in the cognitive domain to describe learning. These are Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. The category “knowledge” relies on recall of information and promotes the use of rehearsal as a learning strategy. “Comprehension” focuses on the elaboration and understanding of material. “Application” strategies focus on use, demonstration or organizational strategies. “Analysis” strategies focus on explanation and comparison. “Synthesis” requires the learner to create new ideas, and “evaluation” focuses on critical evaluation of material. Rehearsal techniques tend to be the least effective strategy for deep processing of information. More effective strategies include the use of synthesis and/or evaluation techniques where the learner can relate ideas to previous knowledge, critically evaluate material, and be more active and aware of their learning (Entwistle, 1994). These effective strategies may be enhanced when technology is well integrated into courses. In this study the effects of combining computer technology with mastery learning was investigated.

2.6 Computer Based Instruction (CBI)

CBI is defined by Frenzel (1980) as the process by which written and visual information is presented in a logical sequence to a student by a computer. The computer serves as an audio visual device. The students learn by reading the text material presented or by observing the graphic information displayed. The primary advantage of the computer over other audio-visual devices is the automatic interaction and feedback that the computer can provide. Multiple paths through the course material can be taken, depending upon the individual student’s progress.

Locatis and Atkinson (1984) describe CBI as a mode of instruction that involves student interaction with the computer directly. Typically students access program presented in segments, with each segment including information and questions or problems for students’ response. The correctness of each response is indicated immediately and remedial or new information is presented. Sometimes students also have the option of requesting help or skipping ahead. Although the tutorial (information- practice-feedback) form of CBI is most typical, there are other forms such as drill and practice exercise, simulations and games.

Steinberg (1991) defines CBI as computer presented instruction that is individualized, interactive and guided. He is of the view that CBI is not a method of instruction. Many methods are implemented in it, including direct and exploratory lessons, drills, games and simulations.

According to Munden (1996) CBI is an educational medium in which instructional content or activities are delivered by a computer and appropriate feedback is provided. Roblyer and Edwards (2000) defined CBI as software designed to help teach information and/ or skills related to a topic.

All these definitions of CBI presented agree that computer plays a role of tutor and imparts instructions either through tutorials or simulations or any other mode of presentation. Computer hardware and specifically designed software is needed to accomplish the specific goals of learning. In this study CBI tutorial was used.

2.6.1 Types of CBI programs

There are many types of CBI programs each of the CBI program is appropriate under different instructional circumstances. Poole (1997), Cox(1995), Gasert and Futrell (1995), Maddux, Johnson & Willis (1997) and Bitter & Pierson (1999) have mentioned and explained the following types of CBI software: Software for drill and practice, Tutorials, Instructional games, Simulations, Microcomputer Based Laboratories (MBL), Integrated learning systems (ILS), Problem solving and Reference software.

(a) Software for drill and practice

Drill and practice software are used to provide repetitive exercise for rote skills that have been taught some other way. It is not the function of drill and practice to impart instructional activities. Rather drill programs are useful for sustaining, refining, or perfecting performance in some category of behavior already learned by another method. Usually drill and practice is employed to increase the speed or accuracy of student performance of certain task. Software for drill and practice allows learners to work problems or answer questions and get feedback on correctness. It is an important learning technique for building basic knowledge and basic intellectual skills, such as number manipulation, vocabulary and spelling sentence construction. These skills are the foundation for higher level intellectual activity. Good drill and practice software provides the user with an enjoyable opportunity for repetitive interaction and immediate feedback on the accuracy of response. Drill and practice software is typically associated with behaviourism, because students are commonly given questions are expected to make responses to the questions and then receive some sort of reinforcement, (Hsu, Chen & Hung, 2000; Roblyer & Edwards, 2000; Poole, 1997; Geisert & Furtell, 1995; Maddux, Johnson &Willis, 1997).

(b) Tutorials

Tutorials act like tutors by providing all the information and instructional activities a learner needs to master a topic. All the skill based body of knowledge is presented on screen followed by quiz to asses the user's comprehension of the concept or acquisition of the skill. The software monitors the progress on the basis of the results of the quiz taking the user on the new material or back over old material. A good tutorial presentation is enjoyable, thorough and sensitive to the user capabilities; and provides immediate and appropriate feedback. Interactivity is key to user involvement and perseverance (Cox, 1995; Poole, 1997; Roblyer, 2000).

Tutorial software is more associated with the cognitive learning theory because new knowledge is presented in a systematic way. It is expected that students learn principles and rules, comprehend them and become able to apply the newly acquired knowledge to new situations. A computer based tutorial program works with an individual student in a very interactive manner and often provides an ideal learning situation for information transmission (Hsu, Chen & Hung, 2000).

(c) Software for simulation

Simulations are powerful tools for learning. Simulations model a real or imagined system to show how these systems work or similar ones work. They involve the learner in a vicarious experience, of events or process a kind of 'trial run on reality'. As such they marry nicely into a constructivist philosophy of teaching. Students experience life vicariously through the simulation, constructing knowledge about the world from that experience (Poole, 1997; Roblyer & Edwards, 2000).

Simulations software simulates an environment, it allows learner to change the values of parameters in the system, and provides feedback in the form of graphical or diagrammatic display of how the systems' behavior changes. Simulations provide a means for learning about an environment that may otherwise not be available to learner to explore, for reasons of safety, time, expanse, or general practicality. A simulation focuses on exploration and discovery learning. It is not an exercise that necessarily has a fixed or correct solution, and the route to the solution may be varied. A computer simulation offers the opportunity for relationships to be explored and exposed by the student's direct manipulation of the variables in the model. Although simulations programs are usually constructivist, that is they allow students to construct their own knowledge, they can have cognitive orientations also (Cox, 1995).

Alessi & Trollip (1991) identify two main types of simulations:

- Those that teach about something.
- Those that teach how to do something.

These two main types are further classified into four categories i.e physical, process, procedural and situational simulations.

Physical simulations. Users manipulate objects or phenomena represented on the screen. For example, students see selections of chemicals with instructions to combine them to see the result or they may see how various electrical circuits operate, (Roblyer & Edwards, 2000).

Process simulations. These speed up or slow down processes that usually either take so long or happen so quickly that students could not ordinarily see the events unfold. For example courseware may show the effects of changes in demographic variables on population growth or the effects of environmental factors on ecosystems. Biological simulations like those on genetics are popular, since they help students experiment with natural laws of genetics by pairing animals with given characteristics and showing the resulting offspring, (Roblyer & Edwards, 2000).

Procedural simulations. These activities teach the appropriate sequences of steps to perform certain procedures. They include diagnostic programs, in which students try to identify the sources of medical or mechanical problems, and flight simulators in which students simulate piloting an airplane or other vehicle (Roblyer &Edwards, 2000).

Situational simulations. These programs give students hypothetical problem situations and ask them to react. Some simulations allow for various successful strategies such as letting students play the stock market or operate businesses. Others have most desirable and least desirable options such as choices when encountering a potentially volatile classroom situation (Roblyer & Edwards, 2000).

(d) Games

Instructional games are course ware whose function is to increase motivation by adding game rules to learning activities. Instructional games can be similar to drill and practice or simulation courseware but their instructional connotation to the student is different due to entertaining and competitive environment. When students know they are going to play a game, they expect a fun and entertaining activity because of the challenge of the competition and the potential for winning (Roblyer & Edwards, 2000).

Cox (1995) mentions that some simulations are designed as games, often including role-playing. In such simulations the program focuses not only on the underlying model but also on the way in which the learner interacts with the model. Learning may be built up by discovery and conjecture; the simulation encourages learning by inquiry and decision making. According to Hsu, Chen & Hung (2000), instructional games are usually associated with behaviourism because of the variety of reinforcement mechanism inherent in game environments in which students are motivated by competition and game rules to strive to reach to the goal.

(e) Problem solving

Problem solving software requires students to apply higher-order strategies and synthesize knowledge from multiple curricular areas in order to solve problems. Students can test hypotheses, learn from mistakes and refine skills as they gain mastery of problem solving techniques. Software of this type can provide practice in solving problem by modelling general critical thinking steps, by focusing on specific subject- area issues, or by creating an open environment in which students can discover their own strategies. The problem solving software affords the user more freedom than does the drill and practice or tutorial software but does not necessarily present the real world context that characterizes simulation software (Bitter& Pierson, 1999). Problem solving software teaches directly through explanation and/ or practice, the steps involved in solving problems or help learners acquire problem solving skills by giving them opportunities to solve problems.

A problem solving software is more a sophisticated type of learning than that of drill and practice. The computer presents fairly complex problems in which students can learn and improve their problem solving skills. These types of problems cannot be solved by simple memorization; problem solving programs are designed to promote students' higher order learning skills such as logic, reasoning and pattern recognition. As they interact with the program, they gradually move from simple trial and error to more logical and systematic thinking processes (Hsu, Chen& Hung, 2000; Roblyer & Edwards, 2000).

(f) Integrated Learning Systems(ILS)

According to Underwood and Brown(1997), ILS are systems across computer networks that provide a comprehensive, multiyear collection of CBI delivered primarily through a model of individual assessment and task assignment and which record and report student achievement. The development of ILS is grounded firmly in the behavioural school of learning theory. ILS have largely addressed mathematical and language material where the body of content is arranged hierarchically.

(g) Software for microcomputer based laboratories (MBL)

MBL software has enabled the students to automate the process of gathering data from experiments, conducting relevant analysis and producing meaningful reports. Scientific experiments are linked to micro-computers in laboratories to automate the process of recording the results of experiments. Complete data sets can be stored in secondary memory for further analysis. Summary data are produced as text and in a graphical format (Poole, 1997). Theory underlying purpose of MBL is precision in data collection and analysis.

(h) Reference software

Reference software can take the form of any traditional reference works, such as dictionaries and encyclopaedias. Other reference software presents extensive collections of information on a focused topic. Electronic reference works can be utilized just as traditional reference material would be. Depending on the particular learning activity, students might refer to software as needed to answer specific questions. They also might openly explore a multimedia reference without specific goals to guide their learning. The multimedia components of reference software present information in graphic, audio or other alternative formats that allow uniquely unlimited access to students who might not be developmentally able to contend with the text version of the information (Bitter & Pierson, 1999).

2.7 Computers and Students Learning

The use of computers allows experiential learning or knowledge which is gained through the discovery of new information during application of prior knowledge which is significant. Constructivist theory, where individuals draw upon prior knowledge to construct or form new schema offers a foundation for discovery learning (Bruner, 1960). When confronted with a new stimulus, individuals use their own knowledge base to accommodate the new information and change their schema in memory (Piaget, 1964). Including experiential learning experiences as part of classroom provides the learner an opportunity to draw the connection between new information and real world.

Roblyer (2003) argues that there is a shift in learning strategies that flexibility of computer technology affords. The introduction of computers into the classroom has come with promises to change the passive learning approach by introducing interactive dynamic capabilities into the classroom. This will provide a richer learning environment where the learner can be more actively involved in his or her own learning (Schank, 1993). Milliken and Barnes (2002) found that students perceived computer-enhanced lectures to be an improvement over traditional teaching methods and felt that the use of computer technology in class aided their comprehension of the subject matter. In a meta-analysis of sixty five studies concluded by Kuchler (1998) revealed that CBI has positive effect on retention of mathematical concepts and skills of secondary school students; it improves students' attitude towards several aspects of schooling and attitude towards learning. CBI makes learning more enjoyable for students.

Bunnet (1999) and Albon (1997) assert the need for CBI due to its flexibility and its potential to use skilful teaching techniques that minds of human instructors have developed over many ages. In addition studies conducted have suggested that computer aided education facilitates learning, draws students skills in problem solving and involves the students. In CBML students are involved in learning as they discuss assessment questions at the end of each learning objective.

2.7.1 Computer use and Achievement

Impact of computer use on students' achievement shows mixed results (Wilson, 1993; Butzin, 2000). While some suggests that CBI can improve students' basic skills in such disciplines as mathematics (Koedinger & Mark, 1997). Others report that, in some instances, the use of computers to teach basic skills have a negative impact on academic achievement (Wenglinsky, 1998).

Ravitz et al (2002) conducted a study to explore questions about whether there is a positive or negative relationship between achievement and student computer use. They also wanted to examine whether results vary by amount of computer use in school or at home. The results of this study found that there is a negative relationship between in school computer use and student achievement. Another study by the Educational Testing Service (ETS) reported that students who spent more time on computers in school actually performed slightly worse than those who spent less time on them (Wenglinsky, 1998). The results from this study suggest that technology can help academic achievement, depending on how it is used and on how trained the teachers are in using technology. In addition, this same study found that technology affects fourth graders less than eighth graders, that the eight graders who used computers primarily for “drill and practice” scored more than half a grade lower than students who did not use them in that way, and that drill software had little impact on the performance of fourth grade students.

However a considerable body of research has reported positive findings. Miller (1999) conducted a qualitative study of computer tutorial software as a mode of instruction in intermediate algebra classes. Benefits that emerged in this study were immediate feedback from the computer and the individualization of instruction. A major analytic review (Kulik, 1994) reported that the average effect of computer tutorials was to raise student’s scores. Adori and Gittman’s (1998) carried out a research on tenth grade global studies course showed that students using CBI achieved significantly higher than did students taught by traditional methods. In this study CBML enhanced students’ achievement in biology.

2.7.2 Information Technology and Mastery Learning

For decades various research studies have been done to improve instructional techniques and have investigated many different approaches. Some investigations have looked at the effects of specific media (like interactive video), while others have looked at broader approaches, which may incorporate several different media and/or particular techniques, such as Mastery learning. Most of these studies have yielded very little that warrants optimism (Clark, 1983).

Visual illustrative media are thought to make learning more concrete and relevant by bringing the real world into the classroom through the use of a variety of still and moving pictorial displays (Levie & Lentz, 1982; Dwyer’s, 1978; Levin et al, 1987). Cognitive psychology supply an explanation for this, information is stored in two separate but inter-connected systems within the brain: a verbal system, which accepts speech or print, and an image system. Research shows that media which involve bi-modal presentations; such as the graphics-based computers are more effective than uni-modal media (Spencer, 1991)

An investigation of different approaches to teaching with information technology involving presentations and animated graphics only are not beneficial in terms of increasing student's achievement. Other research studies with film, television and transparencies have also reached the same conclusion (Spencer, 1981). One area that has shown more promise than others is the provision of corrective feedback and a demand for mastery performance.

The interactive mode of the information technologies, which includes tutorials, provides the key to the success of those approaches. The essence of this mode is that it provides opportunities for feedback. Therefore the most effective methods of instruction are the ones which include diagnostic interactions combined with mastery conditions. Research shows that computer-based methods are most successful when interactively simulating real world events or tutoring, both of which capitalize on the provision of feedback (Kulik, Kulik & Cohen, 1980).

Spencer (1996) noted that as effective methodologies are translated into new media for instruction they will retain their effectiveness, this is when mastery methods are included in a computer based system for teaching and learning. In this study the effects of computer based mastery learning on students' achievement and motivation to learn was investigated.

2.8 Mastery Learning

Mastery learning technique is a strategy of teaching which is expected to bring all or almost all students to a level of mastery, typically 80%. It is based on the principle that all students can learn a set of reasonable objectives with appropriate instruction and sufficient time to learn (Levine, 1985; Bloom, 1981). It is an innovation which in its various forms is designed towards making learners perform beautifully well on an academic task (Adepoju, 2002). In mastery learning, a pre-specified criterion level of performance is established which students must master in order to complete the instruction and move on. It includes frequent assessment of students' progress, provision of corrective instruction and emphasis on cues, participation, feedback and reinforcements.

Bloom (1968) and Block (1971) note that instead of evaluating students relative to their peers, mastery learning assumes that nearly all students can perform competently, not just those in the upper range of the normal curve. The critical variable is time some students simply need additional opportunity to master the learning objectives. CBML which brings in the benefits of interactive tutorial and mastery learning gave students such opportunities which are missing in conventional learning approaches.

2.8.1 Mastery Learning in Schools

Studies indicate that mastery learning technique yield better than conventional learning approach in students' performance and achievement. Lee (1971) in his study with students in Arithmetic and science found that mastery learning has positive effects on learning. Ezewn (1986) in his study involving only girls concluded that the mastery taught group was better than the non mastery group. Olubodun (1986) studied the effects of mastery learning strategies on the students' cognitive and affective outcomes in mathematics', the result showed that mastery learning technique enhanced student learning better and they were able to retain more. Clark, Guskey, and Benninga (1983), found that students mastery learning group demonstrated higher levels of achievement and motivation.

Block (1971) states that students with minimal prior knowledge of material have higher achievement through mastery learning than with traditional methods of instruction. It also increases the attitude and interest of students (Fehlen, 1976). Bloom suggests that mastery learning procedures are likely to enhance learning outcomes in almost all subject areas. However effects are largest in mathematics and sciences since learning in these subject areas is generally more highly ordered and sequential (Guskey & Gates, 1986). By using CBML software, that incorporates mastery learning assessment questions. The learner's will be able to master the learning objectives before moving to subsequent objectives.

2.9 Achievement

Achievement is the outcome of education or the extent to which a student, teacher or institution has achieved their educational goals. It is commonly measured by examinations or continuous assessment but there is no general agreement on how it is best tested or which aspects are most important, procedural knowledge such as skills or declarative knowledge such as facts (Ward, Stoker & Ward,1996).

Individual differences in academic performance have been linked to differences in intelligence and personality (Sophie, Benedikt, & Tomas, 2011). Students with higher mental ability as demonstrated by intelligence quotient tests (quick learners) and those who are higher in conscientiousness (linked to effort and achievement motivation) tend to achieve highly in academic settings. A recent meta-analysis suggested that mental curiosity (as measured by typical intellectual engagement) has an important influence on academic achievement in addition to intelligence and conscientiousness (Sophie, Benedikt & Tomas, 2011).

Children's semi-structured home learning environments transitions into a more structured learning environment when children start first grade. Early academic achievement enhances later academic achievement (Bossaert, Doumen, Buyse & Verschueren, 2011). Parent's academic socialization is a term describing the way parents influence students' academic achievement by shaping students' skills, behaviours and attitudes towards school. Parents also influence students through the environment and discourse parents have with their children. Academic socialization can be influenced by parents' socio-economic status. Highly educate parents tend to have more stimulating learning environments (Katherine 2007).

Children's first few years of life are crucial to the development of language and social skills. School preparedness in these areas help students adjust to academic expectancies (Kerry, 1995). Another very important enhancer of academic achievement is the presence of physical activity. Studies have shown that physical activity can increase neurotic activity in the brain Exercise specifically increases executive brain functions such as attention span and working memory (Tomporowski, Cathrin, Miller & Naglieri 2008). Assessment questions at the end of each learning objective in CBML approach provides useful activities to students while learning. This will in turn enhance students' achievement.

2.10 Motivation

The definition of motivation may take several forms and differ upon its application. Husen and Postlethwaite (1993) define motivation as a psychological process that determines the intensity, direction and persistence of a person's behaviour related to learning.

Kleinginna and Kleinginna (1981) argues that it is an internal state or condition that serves to activate or energize behaviour and give it direction in other words, it is:

a) A desire or want that energizes and directs goal oriented behaviour.

b) An influence of needs and desires on the intensity and direction of behaviour.

Franken (1994) states that it is: The arousal, direction, and persistence of behaviour.

However, according to Keller and Litchfield (2002), motivation can be defined as a person's desire to pursue a goal or perform a task. In the educational arena, the goal or task pursued should be student engagement in the learning environment. Motivation is personal and individual to each student, but the teacher can tap into this latent resource. Since much of motivation is internal, designers of instruction can use humanistic psychological theory to inform planning. Developing successful motivational strategies poses difficulties both extrinsically and intrinsically in any learning environment. In other words, motivation can focus on extrinsic, non personal factors, or intrinsic, personal factors.

At the root of classroom motivation is the individual. The individual learner ultimately decides whether to participate in learning. Factors that affect this decision may be extrinsic or intrinsic (Keller & Litchfield, 2002). Keller (1999), a pioneer in the field of motivational design, has articulated the foundational challenge to the field: Motivation, which has traditionally been viewed by many people as a highly idiosyncratic and variable condition, can be approached systematically. Research on motivation and motivational design shows that there are stable elements of motivation, and even some of the unstable elements are predictable.

Therefore, predicting these elements and utilizing proven instructional strategies and classroom factors, such as classroom environment and interpersonal relationships, would be an invaluable tool for teachers. Whereas several models exist for evaluating such factors, the most prominent model for evaluating motivation is the ARCS model (Keller, 1987). The main categories for the ARCS model (attention, relevance, confidence and satisfaction) provide a systematic structure for designing motivational strategies for learners. This structure may be integrated with lesson plans and instructional goals to implement motivational tactics. An evaluation of the instructional material, combined with an evaluation of the student and teacher, will help the designer integrate effective motivation. As mentioned above, the ARCS method is intended to be systematic; however, the individual learner's motivation is not often measured systematically. Therefore, the instructor must insert personal judgment to shape instructional strategies towards the learner or learners (Keller & Litchfield, 2002). While other motivational models exist, the ARCS model has been applied to a variety of classroom and learning environments, including computer based learning and distance learning (Keller, 1999).

Keller and Litchfield (2002) emphasize that true motivation takes place at three levels: motivation to learn, motivation to work, and self motivation. Each level places responsibility on the learner. However, the instructional designer or teacher can work with the environment and other extrinsic motivators to enhance the possibility of self-motivation. Skinner and Bellmont (1993) advocate that the best approach to student motivation is at the intersection of psychology and educational factors. They contend, "This model has at its cornerstone the notion that the source of motivation is internal to the child, so that when the social surrounding provides for children's basic psychological needs, motivation will flourish.

Seifert (2004) outlines four major theories that seek to explain student motivation from a systemic approach: self-efficacy theory, attribution theory, self-worth theory, and achievement goal theory.

Self-efficacy theory looks to a student's confidence in his or her capabilities as the primary motivation to achieve. Attribution theory, put forth by Weiner (1985), holds that students will attribute academic results to certain attitudes or actions held before the outcome. The attribution then becomes a motivating factor for future actions. A more emotional approach, that of self-worth theory (Covington, 1984), contends that student academic behaviour is a result of the desire to increase or maintain self-worth. Finally, achievement goal theory states that motivation to succeed is based on set goals, which are set by goal-oriented learners (Seifert, 2004). Given these four major approaches to motivation, it can be observed that traditional classroom factors (like lecturing) could have positive or negative effects on students' motivation to engage in classroom learning. Furthermore, well designed instruction that utilizes CBL may greatly affect student motivation.

Motivation maximizes students learning. In addition to this, motivated students make teacher's jobs of managing instruction programme simpler, a very useful element, particularly in co-operative learning situations where students work by themselves most of the time. When they are academically motivated, their teachers often become professionally motivated (Wachanga, 2002). Hamacheck (1995) also holds that although motivation cannot be directly observed, it can be inferred from the behaviour which he called "ability" where ability is what an individual is able to do and motivation is an inner drive that compels one to keep working.

2.10.1 Instructional Design

Reiser and Dick (1996) present an appropriate systemic model for instructional design. Figure 1 shows instructional design model.

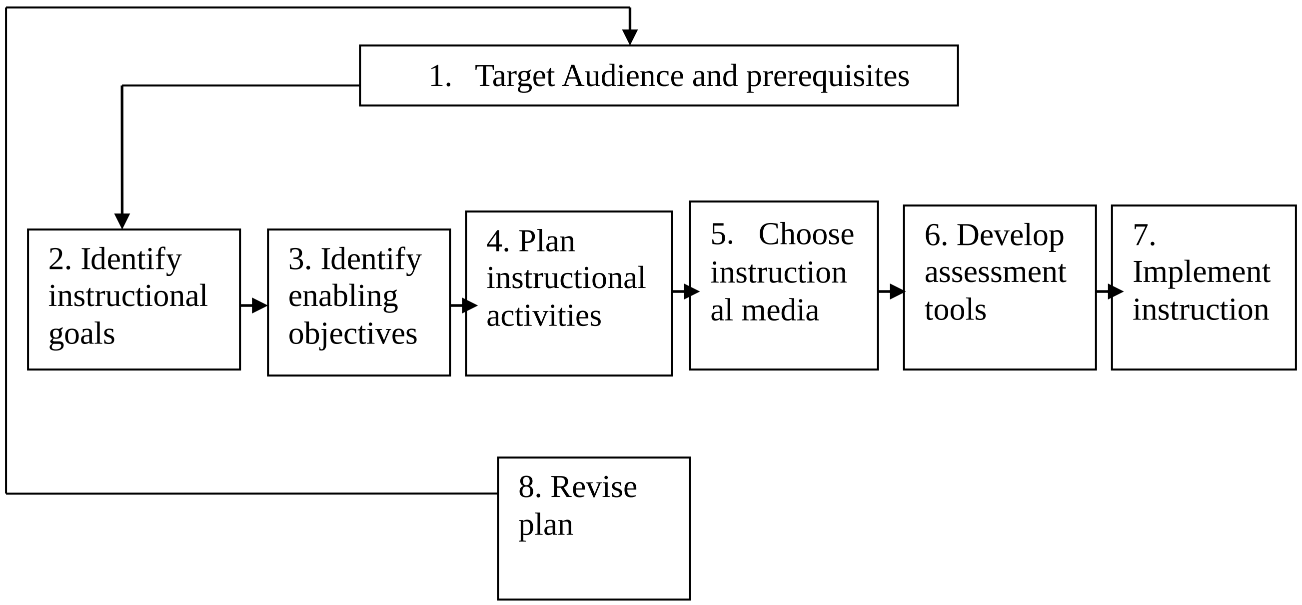

Figure 1: Instructional design model

This design fits the research focus on computer-based instructional strategies. The fifth step of the process, "choosing instructional media," is where CBL approach is anchored, using computer based media to meet the goals and objectives of motivating students. Computer-based learning (CBL) is the use of computers as a complementary or central part of the educational experience. Computers provide audio and visual as well as text, and can be integrated into the instructional delivery system. This integration causes a de facto combination of recreational use with educational use, which is likely to motivate students to learn more interactively and to utilize their prior knowledge base.

According to Keller (2006), motivational design is the systematic process of arranging resources and procedures to bring about changes in student motivation. It aims at creating new materials or systems with which students learn (Hakkinen, 2002). The Reiser and Dick (1996) instructional design model itself provides a motivational design focused on solving specific problems related to instruction such as designing materials, adjusting teaching style and designing the structures of courses themselves. The focus of motivational design is the specific strategies, principles and processes for making instruction appealing to students. Motivational design strives to make instruction more intrinsically interesting. The balance issue with motivation is how to make instruction appealing while supporting the content focused goals of learning. It is on this basis that CBML is used to boost students' motivation to learn and enhance achievement.

2.10.2 Humanistic Theory

Humanistic theory is a psychological perspective where the whole human is centre. Humanists emphasize the here-and-now instead of examining the past or predicting the future. The ultimate goal of living, in this perspective, is to attain personal growth and understanding, and key concepts are free will and a drive for self actualization (Eggen & Kauchak, 1999). Abraham Maslow, a humanist theorist, contends motivation and drive are a part of human self-awareness.

Motivational instructional strategy seeks to enable this awareness in students with hopes of effectively engaging them in the learning process. With regard to computer-based learning, computers have a general appeal to students. Many were introduced to computers by gaming and social networking. Using computer-based learning in the classroom is an important motivational tool that provides an alternative to more traditional pedagogy.

Humanistic theory, as described by Eggen and Kauchak (1999), is one of the best known theories of motivation. It is important in that it informs motivational strategy. Maslow believed that humans are driven to achieve their maximum potential unless obstacles inhibit this growth. Designers of instructional strategy, in order to best serve student needs, must consider these basic needs, as well as the obstacles. According to Maslow's theory, reaching self-actualization is a rare condition. Teachers are there to guide students toward self-confidence and academic achievement. Motivational theory is positioned to enable the instructor to enable students to get the most of an instructional experience. Motivational theories of learning are based on the educational psychology stance that motivation is a condition based on individuals' needs, desires, and wants. In Maslow's theory, motivation should not focus on the base drives or needs of a human, but instead on the specific goals of instruction.

The strength of humanistic theory is its focus on human good, which is a positive perspective to take when studying student learning. It assumes that all students have the power and the drive to learn. The value of this perspective is its use in changing lives for the better. A weakness of humanistic theory is that it assumes rather than proves human good and drive. It theoretically ignores variation in goodness or drive. Under the umbrella of humanistic tradition, Maslow's hierarchy of needs model greatly enriches the discussion of motivational instructional design and strategy. By using CBML the students are motivated to learn.

2.10.3 Maslow's Theory of Motivation

Abraham Maslow is a major theorist in the humanistic tradition. His specific focus was on humanistic psychology and self-actualization. He is best known for his "hierarchy of needs". Figure 2 shows Maslow's hierarchy of needs.

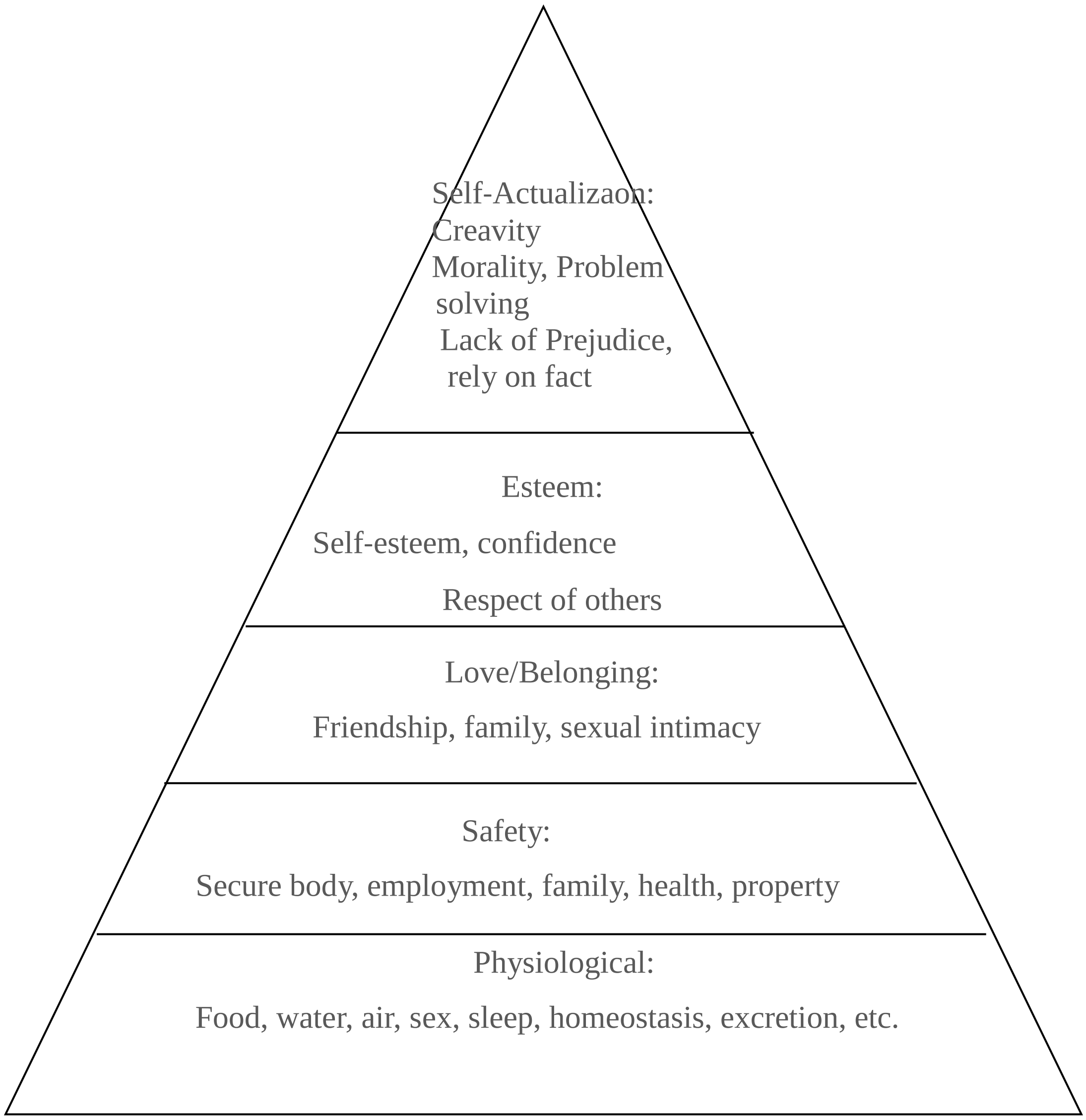

Figure 2: Maslow's Hierarchy of Needs

This model (figure 2) is useful in tracking basic psychological needs of humans in order to teach them effectively. According to Maslow, the lower needs (physiological, safety, belonging, self-esteem) must be met if a student is to experience self-actualization. With this theoretical assumption, if students are not properly fed, ensured safety or encouraged to feel self confident, it is difficult to engage or motivate them, regardless of the instructional strategies employed.

2.10.4 Classroom Technology and Motivation

According to Prensky (2001) today's students are "digital natives." Therefore by connecting technology with educational content across disciplines, teachers can capitalize on the prior experience within students as a resource. This is to apply the humanistic perspective with the student as centre. By connecting CBL as an instructional design strategy to student motivation, the teacher utilizes latent technological understanding to connect to learning activity.

With the relatively recent advent of accessible classroom technology, students and teachers can consistently find uses for modern technology in the learning process. Technology is not only revealing new applications in the classroom, but it is also redefining the concept of a classroom due to the increase of online and distance education. The prevalence of technology thus has motivational effects. In fact, one study indicates that e-learning, or learning via online computers, fosters stronger intrinsic motivation than traditional classroom learning (Rovai, Ponton, Wighting, & Baker, 2007). Technology in the classroom can be viewed from a variety of angles, depending on how one defines the classroom and the technology in use. E-learning and self-paced computer-based learning are just two of the many avenues available to teachers and learners in the area of technology.

Individual, self-paced learning in a computer-based environment is becoming more prominent. The learner may or may not be a part of a physical class, but the responsibility for learning rests solely upon him or her. The pace and efficiency of the learning is decided by the learner and is therefore a matter of individual motivation. According to intrinsic motivational theorists any learning environment, self-paced or regular classroom, that engages the students in the learning process yield better motivation (Lepper, Henderlong, & Iyengar, 2005). A self-paced environment relies almost solely on the students and should yield some motivation. However, involvement should be coupled with interest to produce the best motivation (Lepper et al., 2005). There in lies the challenge of self-paced learning environments. The use of a computer in these environments may provide the opportunity for interest in addition to involvement. Without the presence of an instructor, the constantly changing level of motivation may not be measured and adjusted. According to Keller (1999), in self-directed learning environments, this type of continuous adjustment is not a feature. Once the instruction has been designed and "packaged," everyone receives the same program, with the exception of limited branching and other learner control options.

Therefore it is necessary for instructors to implement options and opportunities for the self-paced learner to engage in that will increase interest. While specific and proven examples of these implementations are still being discovered and are not covered by this study, the opportunity for their usefulness is obvious. As the common trend towards individual, self-paced computer learning increases, so will the need for personal motivation. Teacher-directed classroom technology stands in contrast to the self-paced student directed classroom technology. Less autonomy exists when the teacher expects certain steps to be taken in the use of technology. However, from a motivational standpoint, similar results for using teacher-directed technology can be noted. The individuality of student learning is an important consideration for any teacher who wishes to use technology in the classroom. Furthermore, prior learning and personal assumptions will affect the motivational response to technology use (Jarvenoja & Jarvela, 2005).

According to Laurillard (2002), instructor-led teaching does not mean the instructor is imparting all knowledge. Instead, the instructor can lead by creating an environment conducive to learning. Therefore, teacher-directed technology use does not have to limit student use of technology. In this way, students can have input in setting their own learning goals, which can have intrinsic motivational effects. There is evidence that, in general, students respond positively to computer use by the teacher (Lowerison, Sclater, Schmid, & Abrami, 2006).

According to Becker (2000), students are generally more on-task and express more positive feelings when they use computers than when they are given other tasks to do. However, the positive response is linked to an active participation of the learner. If the learner is passive, the technology has less effect in increasing student interest and motivation to achieve.

Teacher-directed technology that is limited to a reproduction of old material using technology for example using PowerPoint to display written notes is not considered a beneficial use of technology by many researchers (Lowerison et al., 2006). In a study by Cordova and Lepper (1996), elementary students were subjected to three different abstract learning strategies designed to allow them to tailor the content to their own needs under direction of the teachers. The strategies utilized educational computer games and led to increased intrinsic motivation to achieve.

Similar results were found in a study with middle school students on their views on technology in school. Students valued the use of computers in school because computers and other technologies were such a big part of their lives outside of school (Spires, Lee & Turner, 2008). As Prensky (2007) contends, these students are digital natives and technology use is what they know and are comfortable with. Prensky (2006) goes as far as to say that all out-of-classroom technologies, including cell phones and game systems, should be used in the classroom as a motivator for digital natives to learn. However, according to Spires et al (2008), students prefer personal computer use and internet research over teacher explanation when encountering a task. In this study students learned from the computer in groups.

2.11 Achievement and Motivation

One classification of motivation differentiates among achievement, power and social factors (McClelland, 1985; Murray, 1943). In the area of achievement motivation the work on goal-theory has differentiated three separate types of goals: Mastery goals (also called ego-involvement goals) which focus on achieving normative- based standards, doing better than others, or doing well without a lot of effort; and social goals which focus on relationships among people (Ames, 1992; Dweck, 1986). In the context of school learning, which involves operating in a relatively structured environment; students with mastery goals outperform students with either performance or social goals. However, in life success, it seems critical that individuals have all three types of goals in order to be very successful. One aspect of this theory is that individual’s are motivated to either avoid failure (more often associated with mastery goals). In the former situation, the individual is more likely to select easy or difficult tasks, thereby either achieving success or having a good excuse for why failure occurred. In the later situation, the individual is more likely to select moderately difficult tasks which will provide an interesting challenge but still keep the high expectations for success.

Task-involvement activities more often results in challenging attributions and increasing effort than in an ego-involvement activity (Butler, 1999). Intrinsic motivation, which is defined as striving to engage in activity because of self-satisfaction, is more prevalent when a person is engaged in task-involved activities. When people are more ego-involved, they tend to take on a different conception of their ability, where differences in ability limit the effectiveness of effort. Ego-involved individuals are driven to succeed by outperforming others, and their feelings of success depend on maintaining self-worth and avoiding failure. On the other hand, task-involved individuals tend to adopt their conception of ability as learning through applied effort. Therefore less able individuals will feel more successful as long as they can satisfy an effort to learn and improve. Ego-invoking conditions tend to produce less favourable responses to failure and difficulty.

2.12 Gender and Computer Based Instruction

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, Bowman and Mertz (1997) in USA on gender and use of instructional technologies males rated their knowledge and experience with some innovative technologies higher than did females. Decades ago, the computer was observed to be male dominated and its usage belonged mostly to men (Huynh, Lee & Schuldt, 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, Lenzmeier and Hazen (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 indicate that women were less positive about computers than men and the use level of computers by women were less frequent than for men.

Achuonye and Olele (2009), 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 counter parts; 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. Shashaani (1997) using a sample of 202 College students to study internet using patterns in USA, found that females were less interested in computers and less confident than males; males were more experienced. A study by Bello (1990) on influence of gender on student's performance, found that gender has no influence 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. This study investigated the effect of gender on the use of Computer Based Mastery Learning.

2.13 Theoretical Framework

Constructivism is the theoretical framework that guided this study. Constructivists believe that what gets into the mind is not transmitted or poured by some external manipulator but has to be constructed by the individual through knowledge discovery or social interaction. Learning takes place when individuals participate actively in meaningful activities. They construct both a mechanism for learning and their own unique version of knowledge, coloured by background experiences and aptitudes (Roblyer & Edwards, 2000; Hsu, Chen & Hung, 2000).

From the constructivist perspective learning is an active process in which each learner is engaged in constructing meanings whether from text, dialogue or physical experiences (Osborne, 1983). Active learning occurs when learners are challenged to exert their mental abilities actively while learning (Hout-wolters, Simons & Volet, 2000). Learners are actively seeking meaning (Kirschner, Martens & Strijbos, 2004) and are expected to be the architects of their own learning (Glaser, 1991).

Dwyer (1991) asserts that this approach is learner centered rather than curriculum centered. CBML which is interactive would enable learners to control the pace and sequence of their learning is tied to this theory (Drillscol, 2000; Silverman & Casazza, 2000). In CBML learners study the lesson on their own with the guidance of the teacher and answer the assessment questions at the end of the lesson unit. They are allowed to proceed to subsequent unit upon attainment of 80%, otherwise they repeat until they attain the mark this will enable the learners to construct their own knowledge.

2.14 Conceptual Framework

Figure 3 shows the conceptual framework that guided the investigation on the effects of using CBML teaching approach on students' achievement and their motivation towards learning biology.

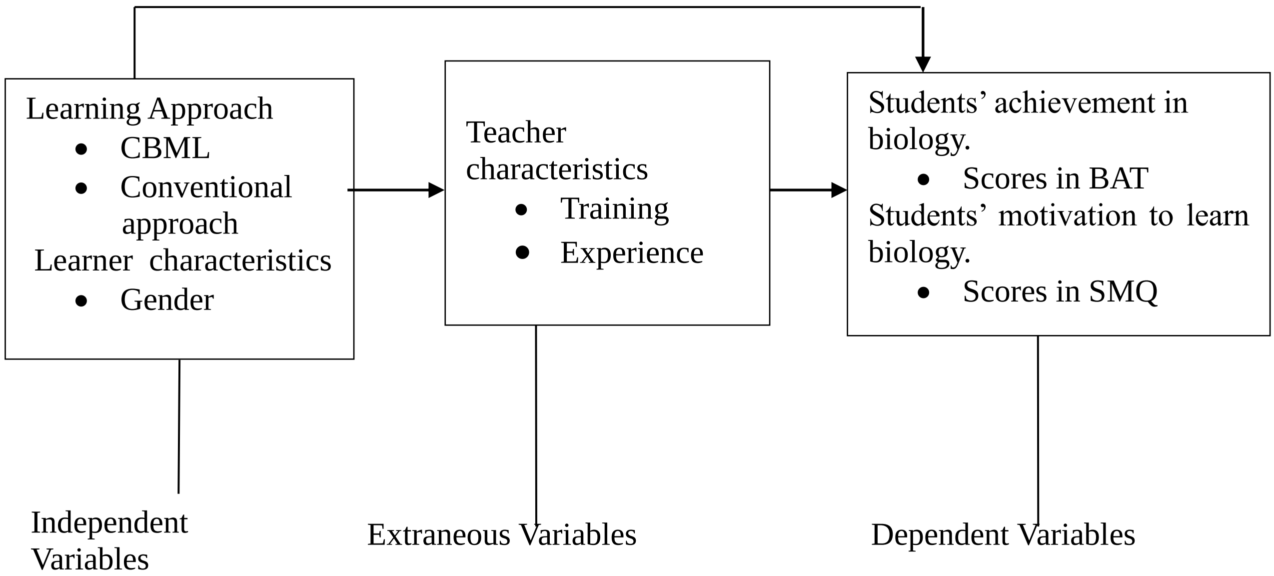

Figure 3: Conceptual Framework for Determining the Effects of using CBML Teaching Approach on Students' Achievement and their Motivation towards Learning Biology.

The conceptual framework shows CBML as an intervention in the teaching/learning approach of biology topic respiration, which aid achievement and motivation in the subject. The dependent variable in this study is the student's achievement and motivation towards topic respiration. The independent variables are CBML, Regular teaching/learning approaches and gender. The extraneous variables are teacher's training and experience. Teachers training was controlled by using teachers trained to teach biology at secondary school level with a minimum qualification of Diploma Certificate. Teacher's experience was controlled by using teachers who have been teaching biology at secondary school level for at least three years.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter documents the process which was followed to realize the objectives of the study. It includes the research design, target population and accessible population, sample size and sampling procedures, instrumentation, development and use of the instructional materials. Data collection and data analysis procedures are also discussed.

3.2 Research Design

This study used the Solomon's Four non-equivalent control group design. This design is appropriate for quasi- experimental studies (Ogunniyi, 1992). The design overcomes external and internal validity weaknesses found in other designs and also provides more vigorous control by having two control groups as compared to other experimental designs (Koul, 1984). This design involves a random assignment of intact classes to four groups. The study adopted a quasi- experimental design, as the subjects were already constituted and school authorities don't allow reconstitution for research purposes (Borg & Gall, 1989).

The design assigns respondents into four groups, two experimental groups and two control groups. In this study, groups E_1 and E_2 were taken to be experimental groups while C_1 and C_2 were taken to be the control groups. Prior to administering CBML, the experimental group E_1 and control group C_1 were exposed to the pre-test while experimental group E_2 and control group C_2 were not. The experimental groups E_1 and E_2 were then exposed to CBML while the control groups C_1 and C_2 were taught using the conventional mode of teaching the same topic of respiration. All the groups in the study (E_1, E_2 & C_1, C_2) were finally subjected to a post test. The design is shown in figure 4.

E_1	O_1	X	O_2	Experimental group
C_1	O_3	-	O_4	Control group
E_2	-	X	O_5	Experimental group
C_2	-	-	O_6	Control group

Key: Pre-tests: O_1 and O_3; Post- tests: O_2, O_4, O_5 and O_6; Treatment: X

Figure 4: Non-randomized Solomon's Four- Group, non- equivalent control group design

3.3 Target and accessible population

The study focused on all secondary school biology students in Bomet District as the target population. The accessible population was form two students in four county co-educational secondary schools in the District. County schools were preferred because they have a wider catchment area in enrolling students, their admission criteria are uniform and hence are of comparable academic abilities and are of comparable age range and hence suitable for study.

3.4 Sample Size and Sampling Procedures

A sample of 167 students was involved in the study. Purposive sampling was used to select four secondary schools which offer computer as one of the teaching subjects. Four schools were chosen because each school formed a group in the Solomon Four Group Design so that the interaction is minimized during the exercise. The selection of the schools and assignment of one form two stream per school selected to either experimental or control groups was done using simple random sampling. Balloting was used; this entailed assigning serial numbers to form two streams of the participating schools and picking one at a time respectively.

3.5 Instrumentation

The instruments that were used in this study are the Biology Achievement Test (BAT) and the Students' Motivation Questionnaire (SMQ). These instruments were used to measure the learners' achievement and motivation to learn biology.

3.5.1 Biology Achievement Test (BAT)

BAT was constructed by the researcher and used to measure students' achievement. The instrument had a total of 16 items. All the 16 items in the instrument were drawn from the topic respiration. The items tested knowledge, comprehension, application, analysis, synthesis and evaluation abilities. This same instrument served as a pre- test and post-test after reorganization of the items. This allowed for comparison between pre-test and post-test results. The test items had scores ranging from 1-6. A moderated marking scheme was used to mark the test. The minimum score in the BAT was zero and maximum score was 50 marks.

3.5.2 Students' Motivation Questionnaire (SMQ).

The SMQ was used to assess students' motivation to learn biology. The researcher adapted and modified the SMQ developed by Kiboss (1997) to suit the current study. The instrument had 20 items. The items were constructed on a five point Likert scale. The responses to questions include strongly agree, agree, undecided, disagree and strongly disagree. All the choices were abbreviated as SA, A, U, D & SD respectively. SA was assigned 5 points where else SD was assigned 1 point. The items tested interest and confidence towards learning biology. The rating scale's minimum score was 20 marks and the maximum was 100 marks.

3.5.3 Validation of the instruments

According to Kothari (2003) validity refers to the extent to which an instrument measures what it is supposed to measure. Both instruments were validated to ensure their appropriateness in addressing the research objectives. Five experts from Egerton University, Faculty of Education and five biology teachers who are Kenya National Examination Council (KNEC) examiners assessed the validity of the instruments. Validity focused on content validity and face validity.

3.5.4 Reliability of Research Instruments

To estimate the reliability of the SMQ and BAT, both instruments were piloted in two schools not included in the study. The purpose of the piloting was to assist the researcher detect weakness in the instruments, check clarity of the items and also elicit comments from respondents that would help in the improvement of the items. The Cronbach alpha coefficient was used to estimate their reliability because the items were not scored dichotomously as scores took a range of values (Mugenda & Mugenda, 1999). A reliability coefficient of 0.77 was obtained for BAT and 0.79 for SMQ. According to Fraenkel and Wallen (2000) an alpha value of 0.7 is considered suitable to make possible group inferences that are accurate enough.

3.6 Development of Instructional Materials

The researcher developed an instructional manual for the teachers involved in the use of CBML. The manual focused on objectives, content to be covered in the topic and teaching/learning activities. The manual was based on revised KIE, (2002) biology syllabus. Teachers of the experimental groups were trained by the researcher on how to use CBML for four days. This was to enable them master the skills of using CBML approach.

3.7 Data Collection Procedures

Research permit was sought from the National Council for Science and Technology (NCST) through the Director, Board of Post Graduate Studies of Egerton University. Prior to the start of the topic, the experimental groups E_1 and E_2 had to undertake an orientation course using the CBML manual under their teachers' supervision to familiarise with the computers and the CBML software. The Biology Achievement Test (BAT) and Students' Motivation Questionnaire (SMQ) was administered to the experimental group (E_1) and control group (C_1) as a pre-test.

The experimental group E_1 and E_2 were taught using CBML approach within a period of two weeks with the help of cooperating biology teachers while control groups C_1 and C_2 were taught using the conventional methods of teaching. Biology Achievement Test (BAT) and Students' Motivation Questionnaire (SMQ) were administered as a post test to all the four groups at the end of the topic respiration. Scores were coded and quantitative data generated that was then analysed.

3.8 Data Analysis

In this study quantitative data was generated and hypotheses were tested. ANOVA was used to test the first and second hypothesis; t- test was used to test the third and fourth hypothesis with the help of statistical package of social sciences (SPSS). ANOVA was used to identify the difference in post test mean scores between experimental and control groups. A t-test was used to test differences between the pre-test mean scores because of its superior quality in detecting differences between two groups (Borg & Gall, 1989). ANCOVA was used to cater for initial differences in the treatment and the control groups. The covariate was the KCPE marks. All tests of significance were performed at alpha level 0.05. The results are presented and discussed in chapter four.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of the study on the use of Computer Based Mastery Learning on students' achievement and motivation to learn biology. Conclusions have been made by either accepting or rejecting the hypotheses at a significance level of 0.05.

4.2 Results

Quantitative data was generated by administration of BAT and SMQ to control and experimental groups. Data was then analysed using inferential statistics *t*- test, ANOVA and ANCOVA. *t*- test was used to test difference between pre-test mean scores. ANOVA was used to identify the difference in post test mean scores between experimental groups (E) and control groups (C) while ANCOVA was used to cater for initial differences in the experimental (E) and control groups (C).

To establish whether the experimental (E) and the control groups(C) were similar at the beginning of the study the pre-test scores of BAT and SMQ were analysed using independent sample t-test. The results are shown in table 5.

Table 5

Independent sample t-test of pre-test scores on BAT and SMQ based on groups E_1 and C_1

Scale	Group	N	Mean	*SD*	*df*	*t*-value	*P*- value
BAT	C_1	47	20.54	6.12	82	11.894	0.000*
	E_1	37	7.26	4.09			
SMQ	C_1	37	2.76	0.55	78	0.631	0.530
	E_1	43	2.82	0.46			

Table 5 shows that the pre-test mean scores in BAT for control group 1 (C_1) was (M = 20.54, SD = 6.12) while for experimental group1 (E_1) was (M = 7.26, SD = 4.09), t (11.894) = 0.000, p<0.05. This showed there was significant difference in achievement between the experimental group1 (E_1) and control group 1 (C_1). This implies that the two groups were not similar at entry point. ANCOVA procedure was therefore used to cater for this difference using KCPE marks as covariate. Table 6 shows the ANCOVA results.

Table 6

ANCOVA of the pre-test BAT scores with KCPE marks as the covariate.

Scale	Sum of squares	*df*	Mean square	*F*	*P*- value
Contrast	2364.38	2	748.94	19.47	0.000*
Error	7143.15	147	44.39		

Table 6 reveals that the difference between the two groups (E_1 and C_1) is highly significant, F (2,147) = 19.47, $P < 0.05$. This therefore implies that the groups were suitable for study.

In SMQ the pre-test mean scores for control group 1 (C_1) was (M = 2.76, SD = 0.55) while for experimental group 1 (E_1) was (M = 2.82, SD = 0.46), t (0.631) = 0.530, $p > 0.05$. This showed that there was no significant difference in motivation between the control group 1(C_1) and experimental group 1(E_1). This implies that the two groups had similar characteristics in respect to motivation and were therefore suitable for study. Table 7 shows the results of pre-test scores on BAT and SMQ based on gender.

Table 7

Independent sample t-test of pre-test scores on BAT and SMQ based on gender

Scale	Gender	N	Mean	*SD*	*df*	*t*-value	*P*- value
BAT	Male	53	12.11	8.14	82	1.437	0.154
	Female	31	14.81	8.53			
SMQ	Male	50	2.83	0.43	78	1.026	0.308
	Female	30	2.73	0.36			

Table 7 shows that the pre-test mean scores in BAT for male students was (M = 12.11, SD = 8.14) while for females was (M = 14.81, SD = 8.53), t (1.437) = 0.154, $p > 0.05$. This showed there was no significant difference in achievement between male and female students.

In SMQ the pre-test mean scores for males was (M =2.83, SD = 0.43) while for females was (M = 2.73, SD = 0.36), t (1.026) = 0.308, $p > 0.05$. This shows that there was no significant difference in motivation to learn biology between male and female students.

4.3 Effects of CBML approach on students' Achievement in biology

To determine whether there is a difference in achievement in biology between students exposed to CBML and those exposed to conventional teaching/learning approach post-test scores of the BAT were analysed. Hypothesis Ho1 sought to establish whether there were significant difference in achievement in biology between students exposed to CBML and those exposed to conventional teaching/learning approaches. Table 8 shows the post-test BAT mean scores obtained by the four groups.

Table 8

Post-test BAT means scores obtained by students in the study groups

Group	N	Mean	*SD*
E_1	47	16.98	6.52
C_1	37	26.43	7.39
E_2	38	21.11	6.09
C_2	45	16.27	6.51

E_1=experimental group 1, C_1= control group 1

E_2=experimental group 2, C_2= control group 2

Table 8 shows that mean scores for E_1 was (M = 16.98, SD = 6.52), C_1 (M = 26.43, SD =7.39), E_2 (M = 21.11, SD = 6.09) while C_2 (M =16.27, SD = 6.51). This shows that means scores for E_2 (M = 21.11, SD = 6.09) and C_1 (M =26.43, SD =7.39), are higher compared to those of E_1 (M = 16.98, SD= 6.52) and C_2 (M = 16.27, SD = 6.51). A one-way ANOVA procedure was used to establish whether there was a statistically significant difference in mean scores among the four groups. The results are shown in table 9.

Table 9

One way ANOVA of the post-test scores on the BAT

Scale	Sum of squares	*df*	Mean square	*F*	*P*-value
Between Groups	2628.17	3	876.06	19.937	0.000*
Within Groups	7162.44	163	43.94		
Total	9790.61	166			

Table 9 shows the ANOVA results of the post-test scores on BAT. The difference in achievement between the four groups was significant, F (3, 163) = 19.937, $P < 0.05$.

To show which groups had significant mean differences in achievement in biology, a post hoc test of multiple comparisons using scheffe's method were used. Scheffe's method was preferred since the sizes of the samples selected from the different populations were not equal; moreover, comparisons other than simple pair-wise between two means were not of interest (Kleinbaum & Kupper, 1978). Table 10 shows the results of the Scheffe's post hoc comparisons.

Table 10

Scheffe's post hoc multiple comparison of the post- test BAT means for the study groups

Groups	Mean difference	*p*- value
E_1 vs C_1	-9.45*	0.000
E_2	-4.13*	0.025
C_2	0.712	0.955
C_1 vs E_1	9.45*	0.000
E_2	5.33*	0.004
C_2	10.17*	0.000
E_2 vs E_1	4.13*	0.025
C_1	-5.33*	0.004
C_2	4.84*	0.006
C_2 vs E_1	-0.71	0.955
C_1	-10.17*	0.000
E_2	-4.84*	0.006

*Mean difference is significant at $p < 0.05$

The results in table 10 indicated that the pairs of BAT scores of experimental groups 1(E_1) and control group 1(C_1), experimental groups 1(E_1) and experimental group 2(E_2), control groups 1(C_1) and experimental group 2(E_2), control groups 1(C_1) and experimental group 2(E_2) and experimental group 2(E_2) and control group 2(C_2) were not significantly different at the alpha level 0.05. However the mean scores of experimental group 1(E_1) and control group 2(C_2) were significantly different at the alpha level 0.05. This implies that the treatment contributed to improved achievement.

ANCOVA procedure was used to confirm if the experimental group 1(E_1) and control group 1(C_1) scores were significantly different. The results are shown in Table 11.

Table 11

ANCOVA of the post test BAT scores with KCPE marks as the covariate

Scale	Sum of squares	*df*	Mean square	*F*	*P*- value
Contrast	2623.48	3	874.49	19.47	0.000*
Error	7143.15	159	44.93		

Table 11 reveals that the difference between the two groups is highly significant, F (3, 159) = 19.47, $p<0.05$. The adjusted mean scores in the ANCOVA using KCPE marks are shown in Table 12.

Table 12

Adjusted BAT means scores obtained by students

Group	Mean	*SD*
E_1	16.98	6.52
C_1	26.43	7.39
E_2	21.14	6.31
C_2	16.27	6.51

The results in table 12 shows that experimental group 1(E_1) had mean of (M = 16.98, SD = 6.52), control group 1(C_1) had (M = 26.43, SD = 7.39), experimental group 2 (E_2) had (M = 21.14, SD = 6.31) while control group 2 (C_2) (M = 16.27, SD = 6.51), this confirms that the differences in mean scores in the experimental group 1 (E_1) and control group 1 (C_1) are statistically significant.

A further comparison was needed to check the mean gain of the students in the pre-test and post-test for the experimental group 1 (E_1) and control group 1(C_1)

Table 13

Comparison of the mean scores and mean gain obtained by students in BAT

Scale		C_1	E_1
Pretest	N	37	47
	Mean	20.54	7.26
	SD	6.12	4.09
Posttest	N	37	47
	Mean	26.43	16.98
	SD	7.39	6.52
	Mean Gain	5.89	9.72

The results in table 13 shows that E_1 in pre-test had (*M* =7.26, *SD* =4.09) and in post-test (*M* = 16.98, *SD* = 6.52) hence mean gain of 9.72 which is higher than that of C_1. C_1 in pre-test had (*M* =20.54, *SD* = 6.12) and in post-test (*M* = 26.43, *SD* = 7.39) hence a mean gain of 5.89. In order to establish whether the difference in mean gain scores of E_1 and C_1 were significant a paired sample t-test was used. Table 14 shows the results of independent sample t-test of mean gain scores obtained by students in BAT.

Table 14

Independent sample t-test of mean gain scores obtained by students in BAT

df	*t*-value	*P*-value
82	2.995	0.004*

Table 14 shows that mean gain scores of E_1 and C_1 are significantly different, t = 2.995, $p<0.05$. This suggests that the CBML enhanced achievement. Thus the group that was taught using CBML had a higher mean gain score than the control group. The hypothesis that there is no statistically significant difference in achievement in biology between students exposed to CBML and those exposed to conventional teaching/learning approaches was rejected at the alpha level 0.05. Therefore, using CBML approach, enhance students' achievement in biology more than when the students are taught using the conventional teaching/learning approaches.

4.4 Effects of CBML approach on students' motivation in biology

To determine the relative effects of the CBML approach on students' motivation in biology, an analysis of students' post-test mean scores in SMQ was carried out. This was to test hypothesis Ho2 which sought to establish whether there was significant difference in motivation to learn biology between students exposed to CBML approach and those exposed to conventional teaching/learning approaches. Table 15 shows post-test SMQ mean scores obtained by students in the study groups.

Table 15

Post-test SMQ means scores obtained by students in the study groups

Group	N	Mean	*SD*
C_1	37	3.31	0.49
C_2	36	3.61	0.50
E_1	42	3.88	0.35
E_2	41	3.93	0.33

Table 15 shows that E_1 had ($M = 3.88$, $SD = 0.35$) and E_2 had ($M = 3.93$, $SD = 0.33$) which is higher than that of C_1 ($M = 3.31$, $SD = 0.49$) and C_2 ($M = 3.61$, $SD = 0.50$). Hence CBML approach enhanced students' motivation to learn. In order to determine whether the difference in experimental groups (E_1 and E_2) and control groups (C_1 and C_2) were significant a one way ANOVA was used. Table 16 shows the results of the post-test scores on the SMQ.

Table 16

One way ANOVA of the post-test scores on the SMQ

Scale	Sum of Squares	*df*	Mean Square	*F*-ratio	*P*-value
Between Groups	9.291	3	3.097	17.506	0.000*
Within Groups	26.89	152	0.177		
Total	36.18	155			

The results on table 16 indicate that the difference in motivation between the four groups were significant, F (3,152) = 17.506, $p < 0.05$.

To determine where the differences occurred, post-hoc multiple comparisons were carried out. The results are shown in Table 17.

Table 17

Post hoc multiple comparison of the post- test SMQ means for the study groups

Group	Mean difference	*p* - value
C_1 vs C2	-0.294*	0.017
E1	-0.567*	0.000
E2	-0.612*	0.000
C_2 vs C1	0.294*	0.017
E1	-0.274*	0.024
E2	-0.319*	0.006
E1 vs C1	0.567*	0.000
C2	0.273*	0.024
E2	-0.045	0.963
E2 vs C1	0.612*	0.000
C2	0.318*	0.006
E1	0.045	0.963

The results in table 17 show that the pairs of SMQ scores of groups C_1 and C_2, groups C_1 and E_1, groups C_1 and E_2, groups C_2 and E_2, groups C_2 and E_1 were significantly different. However no significant differences occurred between experimental groups (E_1 and E_2) and control groups (C_1 and C_2). From table 15, it was evident that the mean score of experimental groups were much higher than those of control groups. This means that experimental groups were highly motivated than control groups. It was necessary to carry out ANCOVA to help in confirming the results obtained in table15. The SMQ mean scores were adjusted for ANCOVA with KCPE scores as covariates. Table 18 shows the results of adjusted SMQ mean scores obtained by students.

Table 18

Adjusted SMQ means scores obtained by students

Group	Mean	*SD*
C_1	3.32	0.49
C_2	3.61	0.50
E_1	3.88	0.35
E_2	3.92	0.32

Table 18 shows that when SMQ mean scores are adjusted groups E_1 (M = 3.88, SD = 0.35) and E_2 (M = 3.92, SD = 0.32) had higher means than C_1 (M =3.32, SD = 0.49) and C_2 (M = 3.61, SD = 0.50). ANCOVA procedure was used to confirm if the experimental groups and control groups scores were significantly different. Results are shown in Table 19.

Table 19

ANCOVA of the post test SMQ scores with KCPE marks as the covariate

Scale	Sum of squares	*df*	Mean Square	*f*-ratio	*P*-value
Contrast	9.078	3	3.026	16.752	0.000*
Error	26.735	148	0.18		

The results in table 19 indicates that the difference between the two groups is significant, *F* (3, 148) = 16.752, *P* < 0.05. This confirms the one way ANOVA results. This means that the use of CBML approach resulted in higher students' motivation than the regular teaching/learning approaches since the experimental groups obtained scores that were significantly higher than the control groups. Hypothesis Ho2 which states that there is no statistically significant difference in the level of motivation to learn biology between students exposed to CBML and those exposed to conventional learning approach was rejected.

4.5 Effects of Gender in achievement in biology

Hypothesis Ho3 states that there is no statistically significant gender difference in achievement in biology when students are exposed to CBML approach. To test this hypothesis, t-test was used to test post BAT scores of control and experimental groups. Table 19 shows the t-test results of control groups.

Table 20

Independent sample t-test of the post-test BAT scores of male and female students exposed to conventional teaching/learning approach.

Gender	N	Mean	*SD*	*df*	*t*- value	*p*- value
Male	29	17.38	7.57	43	9.148	0.004
Female	16	14.25	3.26			

Table 20 shows that there is no significant difference in achievement between male and female students exposed to conventional teaching/learning approach, t (43) = 9.148, $p > 0.05$. To establish whether there was improvement when CBML was used, the data in table 21 was generated.

Table 21

Independent sample t-test of the post-test BAT scores of male and female students exposed to CBML.

Gender	N	Mean	*SD*	*df*	t-value	*P*-value
Male	57	19.28	7.03	83	0.907	0.367
Female	28	17.89	5.72			

To generate the data in table 21, the means of male and female students of the experimental groups (E_1 & E_2) were compared. The results in table 21 show that there is no significant difference in achievement between male and female students who were exposed to CBML approach, t (83) = 0.97, $P > 0.05$. Hypothesis Ho3 which states that there is no statistically significant gender difference in achievement in biology when students are exposed to CBML was thus accepted.

4.6 Effects of Gender on motivation to learn biology

To find the gender difference on motivation when students were exposed to the CBML approach, the SMQ mean scores for male and female students were computed and then compared to determine whether there were significant differences, the results were also compared with those of control groups. The results are shown in table 22.

Table 22

Post-test SMQ mean scores and independent sample t-test for male and female students exposed to conventional teaching/ learning approach.

Gender	N	Mean	*SD*	*df*	*t*-value	*p*- value
Male	18	25.89	7.23	35	0.002	0.963
Female	19	26.95	7.69			

Table 22 shows post- test SMQ mean scores and the independent sample t-test for male and female students exposed to conventional teaching/learning approach. A comparison of the two scores using a t-test yielded a t (35) = 0.002, $p > 0.05$. This therefore means that there is a statistically significant gender difference in motivation to learn biology when students are exposed to conventional teaching/learning approach. This is because teachers tend to give more attention to female students than male students.

Table 23

Post-test SMQ mean scores and independent sample t-test for male and female students exposed to CBML approach.

Gender	N	Mean	*SD*	*df*	*t*-value	*P*-value
Male	39	3.50	0.52	71	0.807	0.422
Female	34	3.41	0.51			

Table 23 shows post-test SMQ mean scores and the independent sample t-test for male and female students exposed to CBML. A comparison of the two scores using t-test yielded a $t(71) = 0.87$,$P > 0.05$. These, therefore means that there was no gender difference in the level of motivation to learn biology at the end of the CBML intervention.

Hypothesis Ho4 which states that there is no statistically significant gender difference in motivation to learn biology when students are exposed to CBML approach was therefore accepted.

4.7 Discussion

4.7.1 Effects of CBML on secondary schools students achievement in biology

The findings of this study indicate that the CBML approach resulted in higher student achievement in biology test scores than the regular teaching/learning approaches. The significant achievement of CBML taught groups over the control groups are in consonance with the results of many experimental studies demonstrating effectiveness of CBI for better student achievement in science and mathematics such as Brophy (1999), Cater (1999) and Bayrakter (2000). Review of studies determining the effectiveness of computer assisted instruction by Helgeson (1998) found precedents in support of CBI for science.

Previous findings also suggest that computers provide realistic learning contexts and results in greater problem-solving skills for elementary school students (Lazakidou & Retalis, 2010). Consequently, the findings of this study are consistent with previous findings that demonstrate positive effects of computer use on student biology outcomes.

In a study by Augustine (2000), on effectiveness of teaching mathematics online, the researcher used computer based learning (CBL) approach and compared with achievement of students exposed to traditional methods. The researchers found that there was a significant difference on achievement of both groups. The CBL group scored significantly higher. The findings of Augustine's study support the results of present study where the CBML group scored significantly higher than the control group on achievement test.

4.7.2 Effects of CBML on secondary school students motivation to learn

The findings of this study showed that there was significant difference in motivation to learn between students exposed to CBML than those exposed to conventional teaching/learning approaches. CBML approach group scored significantly higher.

Lowerison, Sclater, Schmid and Abrami, (2006) notes that, in general there is evidence that students' respond positively to computer use by the teacher. According to Becker (2000), students are generally more on a task and express more positive feelings when they use computers than when they are given other tasks to do. However, the positive response is linked to an active participation of the learners. If the learner is passive, the technology has less effect in increasing student interest and motivation to achieve. Teacher directed technology that is limited to a reproduction of old material using technology (e.g using power point to display written notes) is not considered a beneficial use of technology (Lowerison et al 2006).

Findings of this study agrees with a study by Cordova and Lepper (1996), where elementary students were subjected to three different abstract learning strategies designed to allow students to tailor the contents to their own needs under direction of the teachers. The strategies utilized educational computer games and led to increased intrinsic motivation to achieve. Similar results were found in a study with middle school students and their views on technology in school. Students valued the use of computers in school because computers and other technologies were such a big part of their lives outside school (Spires, Lee & Turner, 2008). As Prensky (2007) contents, these students are digital natives, and technology use is what they know and are comfortable with. Collete and Collete (1989) explain that using computers increases motivation and desire for the lectures and laboratory in the process of learning.

4.7.3 Effects of Gender on achievement in biology

Most studies show that, on average, girls do better in school than boys. Girls get higher grades and complete high school at a higher rate compared to boys (Jacobs, 2002). Standardized achievement tests also show that females are better at spelling and perform better on tests of literacy, writing and general knowledge (National Centre for Education Statistics, 2003).

Part of the explanation can be traced to gender differences in the cognitive abilities of students. For example in late elementary school, females outperform males on several verbal skills tasks: verbal reasoning, verbal fluency, comprehension and understanding logical relations (Hedges & Nowell, 1995). Males, on the other hand, outperform females on spatial skills tasks such as mental rotation, spatial perception and spatial visualization (Voyer, Voyer & Bryden, 1995). Males also perform better on mathematical achievement tests than females. Performance in mathematical reasoning and geometry shows the greatest difference (Fennema, Sowder & Carpenter, 1999).

The findings of this study showed no significant gender differences in achievement in BAT scores. This could have been as a result of immediate feedback. Collins (1984) and Jackson (1988) in separate studies attributed increase in student achievement in computer based science tasks to the availability of immediate feedback.

As pointed out earlier CBML programme provided feedback on students' assessment, which might have contributed to narrowing any gender gaps. According to research, the quality of feedback has an effect on the 'self- confidence' of females (Lenny, 1977) and consequently their performance in science learning tasks (Rowe, 1994).

4.7.4 Effects of Gender on Motivation to learn biology

The Motivation mean score for boys who were exposed to CBML was found to be 3.50 while the mean score for girls also exposed to CBML was 3.41. The difference between the two means was found not to be statistically significant $t(71) = 0.807$ $p>0.05$. This indicates that girls were as equally motivated as boys to learn during the treatment period.

Wachanga, (2002) notes that in regular teaching male and female teachers give more attention to boys than to girls in secondary schools. This makes teachers more likely to use positive reinforcement on boys than they do on girls. This practice makes girl's feel that they are less capable compared to boys. In his study the effects of traditional and cooperative class experiment teaching methods on students' achievement and motivation in chemistry were compared. The findings were that cooperative class experiment as a teaching method enhanced girls' confidence in learning chemistry. Girls' motivation was comparable to that of boys and no statistically significant difference was found (Wachanga, 2002). Wachanga ensured that teachers gave equal attention to boys and girls during teaching and reinforcement was uniform. He also ensured that there was positive interdependence and individual accountability in the learning process. Wachanga's findings, therefore, support the findings of the current study in regard to motivation of learners.

In this study, boys and girls of mixed abilities were placed together in different groups and all were treated equally by their teachers. Every student was given an equal chance to contribute during the biology lessons (Johnson & Johnson, 1992). This made girls feel that they were also capable and raised their motivation. The CBML teaching approach therefore raised the level of motivation of girls to learn biology.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

5.1 Introduction

The purpose of this study was to investigate the effect of using CBML approach on students' achievement and motivation in biology. This chapter presents the major findings of the study, conclusions and recommendations emanating from the results of the study. The implications are discussed and suggestions made on possible areas for further research.

5.2 Summary of Major Findings

From the data analysis presented in chapter 4, the major findings of the study are:

(i) There is a statistically significant difference in achievement in biology between students exposed to CBML and those exposed to conventional teaching/ learning approach.

(ii) There is a statistically significant difference in motivation to learn biology between students exposed to CBML and those exposed to conventional teaching/learning approach.

(iii) There is no statistically significant gender difference in achievement in biology when students are exposed to CBML.

(iv) There is no statistically significant gender difference in motivation to learn when students are exposed to CBML.

5.3 Conclusion

Based on the findings of the study, the following conclusions have been reached.

(i) Teaching biology topic respiration using CBML approach enhanced students' achievement more than the conventional teaching/learning approach.

(ii) Students taught using CBML approach have a higher motivation to learn biology than those taught using conventional teaching/learning approach.

(iii) Gender does not affect the students' achievement in biology when they are taught using CBML approach.

(iv) There is no gender difference in motivation to learn biology when students are taught using CBML approach.

5.4 Implications of the Study

The findings of this study have indicated that the use of CBML in the teaching of biology in secondary schools results in higher students' achievement and motivation to learn biology. When this approach is used, the students' gender does not affect their achievement and motivation to learn. This would, therefore, imply that its incorporation in teaching would boost the learning of biology in schools. This in turn would improve the low achievement at KCSE biology examinations.

Educational administrators and designers of computer based learning programmes should emphasize the use of CBML in biology lessons and possibly other science subjects in their effort to boost students' motivation. This will in turn lead to better achievement in biology. Teacher training institutions such as universities should also incorporate the CBML concepts in their training curriculum in order to empower teachers to use the new approach.

5.5 Recommendations

The results of the study indicate that the use of CBML approach in teaching biology has a positive influence on students' achievement and motivation compared to the conventional teaching/learning approaches. This implies that the problem of low achievement in biology may be addressed by incorporating the use of CBML approach in teaching biology at secondary school level. Based on this study the following recommendations are made:

(i) Teacher education curriculum developers should include the teaching of biology using CBML as part of the teacher education syllabus during the training of biology teachers.

(ii) Education stakeholders like education inspectorate should encourage biology teachers to use CBML in their teaching. If secondary schools in Kenya implement this teaching strategy in biology teaching, the students' achievement at KCSE biology examination is likely to improve significantly.

(iii) Teachers should be encouraged by education stakeholders to use CBML in teaching biology topics where it is applicable.

(iv) Government should offer incentives for teachers who increase their proficiency in computer studies and contribute to enhance CBI.

(v) In-service teachers should be given computer literacy training through refresher courses.

(vi) Parents should know that they can get rid of private and substandard helping books by utilizing educational software.

5.5.1 Recommendations for further research

(i) A study on other types of CBML and their effects on achievement and motivation to learn biology should be carried out.

(ii) A comparative study should be conducted on the students' attitudes towards teaching using CBML versus when taught by conventional teaching methods.

(iii) Research on the topics that can be taught effectively using CBML should be identified from biology curricula.

(iv) A study to determine the teachers' and students' perceptions of the classroom environment while teaching and learning using CBML approach.

(v) A study into other science subjects (chemistry and physics) to determine effects of CBML approach.

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APPENDICES

APPENDIX A

BIOLOGY ACHIEVEMENT TEST (BAT)

School…………………………….. Age………………… Sex……………..

Instructions

a) **Attempt all questions**
b) **Write your answer in the spaces provided**

1. What do you understand by the term respiration? (1mk)

2. Distinguish between aerobic and anaerobic respiration (2mks)

3. Give equations that summarizes (2mks)
(a) Aerobic respiration.

(b) Anaerobic respiration.

4. Give the products of anaerobic respiration in plant cells? (1mk)

5. Under what conditions does the following process occur in muscle cells?
(a) Anaerobic respiration (1mk)

(b) Aerobic respiration (1mk)

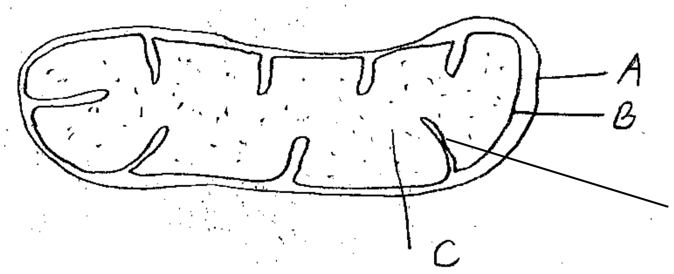
6. What is respiratory Quotient? (1mk)

7. The fat tristean has the molecular formula $C_{57}H_{110}O_6$
(a) Write a balanced equation to represent its complete oxidation to carbon (iv) dioxide and water (1mk)

(b) Calculate the RQ for the complete oxidation of the stearic acid (2mks)

8. In man, aerobic breakdown of glucose yields 2880kj of energy whereas anaerobic breakdown yields 150kj. Give an explanation to account for this difference (2mks)

9. Below is a diagram of an organelle that is involved in respiration.



D

(a) Identify the organelle (1mk)

(b) Name the parts labeled A,B and C (3mks)

A

B

C

(c) What is the purpose of the infoldings labelled D (1mk)

(d) Name the chemical compound found in the organelle that forms the immediate source of energy for biological activities (1mk)

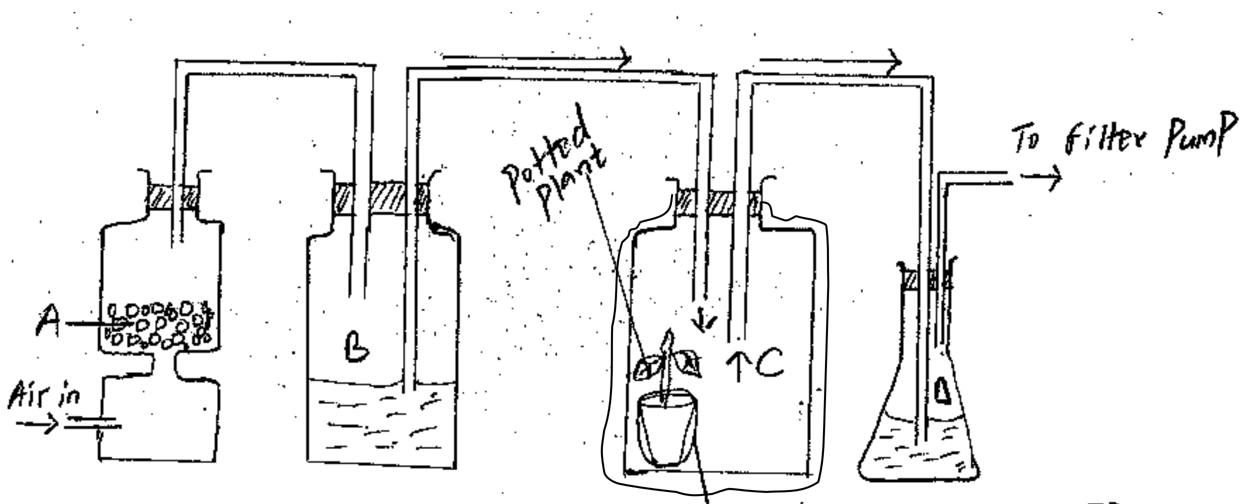
10. Explain the term basal metabolic rate (BMR) (1mk)

12. Name the two stages of aerobic respiration and state what happens in each stage (4mks)

13. Compare anaerobic and aerobic respiration (3mks)

14. Distinguish between obligate and facultative anaerobes (2mks)

15. The diagram below illustrates an experiment to demonstrate some aspect of respiration in a potted plant.



Black cloth

(a) What aspect of respiration is being demonstrated in the set up above?(1mk)

(b) Name the chemical compound labeled A and state its role.(2mks)

(c) Name the liquids in vessel B and D (2mks)

(d) What would you expect to observe in vessels B and D after the experiment has run for

some time? (2mks)

(e) Explain the observations in (d) above.(2mks)

(i) Why is it necessary to enclose the pot with a polythene bag.(2mks)

(ii) What is the role of the black cloth covering the bell jar (2mks)

16. Explain three factors that affect the rate of respiration (6mks)

APPENDIX B

MARKING SCHEME

1. (a) process through which food is broken down in cells to produce energy.

2. (a) breakdown of food in the presence of oxygen to produce energy

(b) Breakdown of food in the absence of oxygen to produce energy

3. (a) $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$ +288O kJ Energy

(b) $C_6H_{12}O_6 \longrightarrow C_3H_6O_3$ +150kJ e

4. (a) Ethanol

(b) $C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$+210 kJ

5. (a) during rest and during mild exercise

(b) occurs during vigorous exercise.

6. (a) Glucose is completely oxidized to carbon(iv)oxide, water with release of large amounts of energy.

(b) Glucose is partially oxidized to lactic acid this releases only part of energy present in glucose molecule.

7. Is the ratio of volume of carbon(iv)oxide produced to volume of oxygen consumed by an organism at any given time.

8. (a) $2C_{57}H_{110}O_6 + 163O_2 \longrightarrow 114CO_2 + 110H_2O$ + Energy.

(b) 114/163 =0.699

9. (a) Mitochondrion

(b) A- Outer membrane

B- Inner membrane

C- Matrix

(c) To increase the surface area for the attachment of respiratory enzymes in involved in respiration.

(d) Adenosine triphosphate (ATP)

10.

Aerobic respiration	anaerobic respiration
Oxygen is used	Oxygen not used
High amounts of energy released	Low amounts of energy released
Water molecules produced	Water molecules not produced

.

11. Energy that is used up per kg weight of a person in one hour for basal metabolism

12. Obligate -only respire anaerobically

Facultative- respire both aerobically and anaerobically

13. Glycolysis - breakdown of glucose to pyruvic acid with release of small amount of energy

Krebs cycle- decarboxylation of pyruvic acid to acetyl coA

14. (a) Carbon(iv)oxide is produced during respiration.

(b) Soda lime; absorbs carbon(iv)oxide from the air entering the apparatus

(c) Limewater

(d) Limewater in B stays clear; limewater in D turns milky

(e) Air entering vessel B has no carbon (iv) oxide has been absorbed by sodalime; plant in belljar respires releasing carbon (iv)oxide which turns limewater in D milky.

(f) (i) to prevent carbon(iv)oxide produced by micro-organisms from interfering with the results and to prevent soil water from condensing in the belljar.

(ii) To prevent photosynthesis from taking place as this would consume the carbondioxide produced.

APPENDIX C

STUDENT'S MOTIVATION QUESTIONNAIRE (SMQ).

School…………………………….. Class……………………………….

Gender……………………………..

The purpose of this questionnaire is to find out what you think about the Biology course. Please indicate what you think about each item.

INSTRUCTIONS

Read the items carefully and try to understand before choosing what truly agrees with your thought

Circle around the letter that corresponds to your feelings towards the Biology course. Circle only one of the choices.

The choices are:

SA= Strongly Agree A= Agree

D= Disagree SD= Strongly Disagree

U= Undecided

If you change your mind about an answer, you may cross it neatly and circle another.

Example: A student who disagrees with the following statement would answer as follows:-

Biology is not a very interesting subject.

SD D (D) U A SA

STUDENT'S MOTIVATION QUESTIONNAIRE

Learning Biology course through the use of CBML Approach was:-

1.	Fun	SD	D	U	A	SA
2.	Satisfying	SD	D	U	A	SA
3.	Informative	SD	D	U	A	SA
4.	Useful	SD	D	U	A	SA
5.	Boring	SD	D	U	A	SA
6.	Frustrating	SD	D	U	A	SA
7.	Hard	SD	D	U	A	SA
8.	Challenging	SD	D	U	A	SA

After learning biology using CBML approach

1.	I can now study and solve problems in biology on my own	SD	D	U	A	SA
2.	I expect to perform better in other science subjects	SD	D	U	A	SA
3.	I expect to achieve higher in biology test	SD	D	U	A	SA
4.	I find it hard to study biology alone	SD	D	U	A	SA
5.	I am contended with the way I learn biology	SD	D	U	A	SA
6.	I do not expect to be successful in biology tasks given by the biology teacher	SD	D	U	A	SA

The biology lessons taught using CBML were:-

1.	Difficult	SD	D	U	A	SA
2.	Useless	SD	D	U	A	SA
3.	Interesting	SD	D	U	A	SA
4.	Clear	SD	D	U	A	SA
5.	Unfriendly	SD	D	U	A	SA
6.	Meaningful	SD	D	U	A	SA

APPENDIX D

CBML INSTRUCTIONAL MANUAL FOR LEARNERS

NB: To be used under an instructor's supervision and guidance

1. Ensure all computer parts are correctly connected i.e the system unit, the monitor, the keyboard and the mouse.
2. Switch on the power button on the system unit
3. Wait for the machine to boot
4. Check the screen for a **RED** icon labelled **CBML**. Use the mouse to double click the icon and wait until the programme loads on the screen.
5. The first page displays the title '**COMPUTER BASED MASTERY LEARNING**' and after a few seconds a dialogue box pop up and asks you to choose your name.
6. Choose your name and another dialogue box will prompt you to confirm if the name shown is yours by either clicking '**Yes**' or '**No**'
7. This launches a topical menu in the topic respiration.
8. Click on the first subtopic e.g. introduction to launch introduction sub menu. When through with introduction click on next to proceed to next page.
9. Repeat this procedure for each subtopic until all concepts or subtopics are covered. In case of any difficulty consult the teacher.