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EEFFECTS OF COMPUTER AIDED INSTRUCTION (CAI) PACKAGE ON ACADEMIC ACHIEVEMENT AND RETENTION OF BIOLOGY STUDENTS IN MINNA METROPOLIS, NIGER STATE.

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ABSTRACT

The study determined the effectiveness of Computer Aided Instructional package (CAI) on achievement and retention of biology students in senior secondary schools in Minna metropolis. Four research questions were raised and four null hypotheses were tested. The study adopted the pre-test-posttest=control group design. A sample of one hundred and twenty (120) students from two intact classes from senior secondary two (SS II) of mixed gender were selected for this study. The researcher developed a computer assisted instructional package (CAI) on mitosis which was used as treatment for experimental group while control group were exposed to conventional lecture method (CLM). The instrument used for data collection was teacher made biology achievement test (TMAT). A 20-items multiple choice objective type achievements test covering four phases of mitosis was used. Reliability co-efficient of 0.89 was obtained using Kuder-Richardson (K-R 21). Analysis of Covariance (ANCOVA) was used to analyze the hypotheses. The findings revealed that the experimental group performed better than the control group. There was no significant difference in the performance of males and female students. The experimental group retained better than the control group while there was no significant difference in retention in male and female students in the experimental group. It was recommended that teachers should be exposed to the development and use of CAI; organize workshops and seminars and symposia on CAI to assist teacher deliver lessons through CAI packages to enhance learning among students generally.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Since the world is fast turning into a Global village, where the ability to use, manipulate and communicate using the computer has become a necessity to both learners and instructors, learning in the nearest future is visualized to be computer based through the use of Computer Aided Instruction (CAI) packages rather than the conventional lecture method (CLM). The study of science as a subject that investigates both living and non living things incorporates biology as the branch that studies the aspects of living things made up of plants and animals. Learning these days can only take place effectively when science and technology are used to impact knowledge to learners through the use of computers with the help of Computer-Aided-Instruction package (CAI) because, science and technology are the main agents of social and economic changes (Taiwo, 2008).

Since biology occupies a unique place in school curriculum, biology has been found to be central and related to many subjects such as Botany, Zoology, Medicine, Agricultural science, Nursing, Pharmacy, Biochemistry, etc. As a result of its significance to science, it has drawn the attention of many researchers as observed by Kareem, (2003). Biology as a science subject cannot be studied in isolation of today's scientific and technological progresses achieved in the use of observation, experimentation, recording, collection of data and its analysis (Ugwu, 2005). Other branches of biology include zoology, botany, microbiology, biochemistry, integrated science and health science. Jegede (1990) opined that biology, like other science subjects has distinctive traits as field of study that relies heavily on practical. Ajayi (1998) associated poor performance

of students in biology with their heterogeneous nature in terms of their ability level and the lack of properly equipped laboratories plus over loaded syllabus. Instructional models are in short supply (Adelekun, 2004). Technology in the information communication technology revolution (ICT) has provided many unique benefits to instructional programs.

Although traditional methods of instruction are widely accepted in teaching and learning environments, some educational institutions have started to implements computer technology as an instructions approach (McKethan et al., 2001). The introduction of computers into the business world in the mid fifties brought about significant changes in the way computers can be used since they were purely envisaged to carry out scientific functions. The early sixties saw the integration of computers into business and scientific functions though in a limited way. The invention of the microprocessor in the early seventies saw the introduction of personal computers for educational usage. Educational software was also developed to produce CAI packages.

Umaru (2003) defined CAI as a program of instruction or a package presented as software for instructional purposes. Several researchers have shown that the use of CAI has positive effect on students' achievement compared to CLM. Nwobi and Uwandi (2007), found that CAI have been used to teach various subjects in Junior Secondary Schools (JSS) and Senior Secondary Schools (SSS). The evolution of Computer-Assisted-Instruction (CAI) shows that CAI has existed for more than 50 years. The first CAI , was a flight simulator for pilots which was designed at the Massachusetts Institute of Technology in 1950 (Lockard, Abrams & Many, 1997) one of the first application of CAI for educational purposes was developed in 1960s at the University of Illinois called PLATO (Programmed Logic for Automatic Teaching). This program was designed to teach a variety of subjects such as pharmacology, nursing and geometry. In the seventies further developments occurred in computer aided instruction (CAI). The National Science Foundation in

the United States of America provided the sum of $10 million for funding PLATO and TICCIT (Time Shared Interactive Computer-Controlled Information Television System). The main aim of this project was to develop a better teaching and learning environment via computers and television. The result of a research conducted by the Educational Testing Service showed that PLATO improved achievement significantly in chemistry, biology, and English while TICCIT also showed a significant improvement in English and Mathematics. Moreover, both PLATO and TICCIT students showed positive attitude towards CAI. In the nineties, due to lower costs, faster processing power and better multifunctional performance capacity, microcomputers became an essential part of education.

CAI has been in use for more than five decades for educational purposes; although it is not new in the developed world, it is still new in the Nigerian context. It provides an instructional interaction between the learner and the computer in a variety of contents with or without the assistance of the teacher. It helps learner(s) by presenting the multimedia CAI materials as well as acting as a tutor. It uses the computer to facilitate and improve students' learning through interacting with the computer at their own pace. CAI directs the learners' attention to different sections in a learning sequence without the direct assistance of the teacher (Petrakis, 2000).

Some of the CAI features have originated from the learning theories of B.F. Skinner and E. L. Thorndike. The CAI principle uses the stimulus-response relationship, negative and positive reinforcement and the role of immediate feedback in a teaching and learning environment which has promoted the development of programmed instructions (Volker, 2001). Programmed instruction helps the teacher to plan and organize his lessons in a linear or branching model that allows sequential steps which provides immediate feedback as in the mitosis CAI developed for this study.

Achievement is defined by the oxford dictionary as the attainment of success in educational performance or the act of success in doing something. This determine the extent to which a student or teacher or institution achieves its academic goals. There is no known best method of measuring achievement which normally leads to procedural knowledge, skills, declarative knowledge such as fact, (Wikipedia 2014 web). Achievement is commonly measured through tests, examinations or continuous assessments (CA) but in California USA, it is measured by academic performance Wikipedia 2014, (web). Academic performance is usually influenced by individual difference as a result of different level of IQ. Other factors include parental socio-economic background and physical activities which enhances brain functions such as attention and working memory.

CAI is now the "in thing" for enhanced instruction and achievement in different subjects, biology inclusive. Handelsman, Ebert-may, Beichner, Bruns, Chang et al (2004) opined that "many exercises that depart from the traditional lecture method or CLM are now readily available on the web" (p.521) even though teachers hardly use them. Karper, Robinson & Casada-Kehoe (2005) found CAI to enhance performance than CLM. However, Mill (2001) findings reveal that CAI was found to be effective as the CLM in established facts but not as effective in topics requiring critical-thinking such as mathematical problem-solving. Akour (2006) found that students taught with CAI performed better than those taught with CLM. (Basturk 2005), showed that, how CAI is delivered can affect its effectiveness. Jenk & Springer (2002), Karron & Bryme (2005) noted that in Nigeria today, teachers, text books, chalkboards and traditional teaching facilities are no longer adequate to cope with types of skills and competences expected of students. Ogoni (2003) suggests that teachers, need resources that can assist them carry out their duties efficiently. Williams (2004), state that teaching methods over

the years have undergone several changes leading to the use of CAI package. Umaru (2003) defined CAI as a programme of instruction or a package presented as software for instructional purposes. Several researchers have shown that the use of CAI have positive effect on students' achievement compared to CLM. According to Ezeliora (2000), CAI has been used to provide learners with different background and characteristics. Okoro & Etukudo (2001), found CAI to be effective in teaching, Paul & Babaworo (2006) in technical education courses, Egwunjobi in geography and Karper et al (2005) on counseling education. They all confirmed that CAI is effective in enhancing students in most subjects than the CLM. Chang (2000) in Yusuf (2009), opined that "many exercises that depart from CLM are readily available on the web (p521), even though teachers hardly use those facilities". Orisebiyi (2007) investigated the effects of CAI on students' achievement and retention in biology and found CAI to be effective also in students' achievement in integrated science and some aspects of mathematics such as algebra, statistics, word problems and quadratic equations but not much on geometry using CAI package.

Several researches in CAI have found no effects on certain variables while others have had some effects on many variables. Some CAI programs have effected improvement in students' achievement in early academic skills of pre-school students with disabilities (Hitchcock & Noonan, 2000) and cognitive and psychomotor skills in collegiate basic instruction tennis course (Konukman et al, 2001). In contrast, other group of researchers have found results in contrast to no effect of CAI on achievement; critical-thinking skills of nursing students (Saucier et al, 2001); Mckethal et al (2001) found no significant effect of CAI on PHE students.

Though a lot of CAI programs are available in the market from pre-school to adult learning programs, a lot of discussion is on in the literature and learning environments about the effectiveness of CAI. Several studies have recognized the following advantages of CAI programs

(Lockard, Abrams & Many 1997, Petrakis 2000). Learning can occur at learner's pace and time frame. CAI enhances learning and retention rate of students; it motivates and develops sense of efficacy. Meta analysis of sixty-five studies concluded by Kutchler (1998) revealed that CAI has positive effect on retention of mathematical concepts and skills of secondary school students; it improves student's attitudes towards several aspects of schooling and towards learning. CAI makes learning interesting for students. Bunett (1999) and Albion (1997) asserts the need for CAI due to its flexibility and its potential to use skillful teaching techniques the minds of human instructors have developed over the years. Miller (1999) conducted a qualitative study of computer tutorial soft ware as a mode of instruction in intermediate algebra classes. Benefits of CAI that emerged from the studies were immediate feedback from the computer, the value of interaction with the computer and the individualization of instruction.

There is performance feedback immediately based on correct and incorrect responses and lessons are individualized. The rate of learning is paced and controlled by the learner. Learners can review mistakes. CAI programs have assessment and scoring of performance. Simulation and animation environments are provided by the computer. CAI can be timed to suit the time table needs of class work. Sounds, graphics and colour make it interesting to learners. Tutorials teach a lesson the way teachers give lectures. Instructional games can be simulated.

CAI usage isolates students from peers and school environment. CAI learning becomes individualized rather than group or cooperative learning. Instruction is programmed like in robots rather than as given by humans. Teachers take on passive roles as facilitators rather than instructors. Technical malfunctions can distract students easily. Electrical failures can also distract learning as well.

Retention in learning has been defined by Wikipedia as the ability to retain facts and figures in memory. However retention as defined by Hornbil (2001) as the ability to remember things. For the purpose of this study retention is thus defined as the ability to retain or remember knowledge in biology learned and be able to recall it when the need arises. Retention in biology is not acquired by mere memorization but through appropriate teaching methods (Chianson 2008). According to Iji (2002), students learnt more in experimental group than in the control group. Also, Obodo (2010), states that retention is measured in collaboration with achievement. His study of different effects of three teaching models on performance in JSS students in some algebraic concepts showed equal retention. This indicates that each of the models was effective in students' achievement in algebra, could as well help students retain algebraic concepts effectively. Retention is the preservative of the mind (Kundu & Tatoo, 2007), whatever touches consciousness leaves traces or impressions and is retained in the mind in form of images. Two types of memory have been identified as short and long term memories. However this study is aimed at investigating the effect of CAI package on retention in mitosis in biology in Minna metropolis.

Gender is normally defined as the segregation of the sexes into males and females. Gender issues have been linked to performance in students' academic achievement in sexual studies without definite conclusion. The concept of gender has attracted the attention of many researchers (Okpala & Onacha, 1995; Oyedeji 1996; Adesoji & Fisuyi 2001, Anekwe 2006; Anagbogu & Ezeliora, 2007; Poopola 2007; Iwendi 2007). There is a general imbalance by females in the use of computer, access to computer, career in computer and attitudes towards the computer. Some studies show that males perform better than females in chemistry, physics and biology (Olaofe, 2005; Adeniyi 2005; Paul, & Babaworo 2006) while others revealed that female students are

better off than males. Studies on the use of CAI has shown that female students perform better than males when introduced to individualized CAI package while other researchers observed that gender has no influence on the performance of students when exposed to CAI package (Paul & Adeniyi, 2005; Babaworo 2006). Ash (2005) Basturk (2005) & Dantala (2006) found no significant difference between males and females taught physics and history respectively. Russell (2003) noted that teachers are expected to provide assistance, equip the students, provide the technique involved and at the end clarify student worksheet. Hence, biology teacher should be involved in using CAI package. Spence (2004) found no significant influence of gender on the achievement of college students in mathematics when they were taught mathematics with mathematics course ware in online CAI package and CLM. However, female students were unlikely to complete their course compared to males and females. The present study is an attempt to determine the moderating effects of student's gender on learning outcome in mitosis in biology, that is whether gender is an important variable in students', achievement and retention when exposed to CAI package.

It is in view of the above that the researcher finds it necessary to search for an appropriate approach that is student-centered and that can enhance academic achievement and retention in mitosis in biology. Therefore, this study tends to find out if CAI package could be used to improve students' achievement and retention in mitosis in biology in senior secondary school II in Minna Metropolis. Hence, this study will develop a CAI package on mitosis and apply it as a teaching strategy to investigate its effectiveness on students' achievement and retention in mitosis in biology.

1.2 Statement of the Problem

In spite of the popularity of the subject, biology records poor performance in WAEC and SSCE examinations (Ahmed, 2008). The desire to find out why students perform poorly was attributed to over population in the classes, poor quality of science teachers, lack of suitable and adequate science equipment among others (Kareem, 2003). Other factors include heterogeneous ability level, ill-equipped laboratories and over loaded syllabus in biology (Ahmed 2003). Biology, being one of the basic requirements for admission to read medicine requires excellent grades by students to produce high quality doctors. Chief examiners' reports from previous WAEC 2004-2009, NECO 2000-2010 and NABTEB 2006-20012 examinations indicate that students score low marks in genetics question thereby leading to poor grades in biology.

Despite the perceived importance and role of biology in the world's science and technology development, students' achievement in West African Senior Secondary School Certificate examinations in the past decades have persistently been so poor in this public examinations (Asayai, 2005) in Aniodoh and Ngozi (2012). Based on the pivotal role of biology in every spheres of life, it has been noted that the enrolment of the students for the subject has been on the increase but achievement of the students, persistently diminishes dramatically on yearly basis.

This assertion is being supported by WAEC/SSCE biology results of 2004-2009 and NECO/SSCE biology results of 2000-2010 and the chief examiner's report of 2002 to 2010. Insufficient instructional materials have been identified as the key factor accounting for students' poor performance in biology in spite of large enrolment (Nwachukwu and Nwosu, 2007). Looking at the number of students that register for biology examination, it was observed that large number of students registered for it because it is in line with Federal Government National

Policy on Education that mandates all students to register for one science subject (Danmole and Adeoye, 2004). This resulted in high number of students that registered for biology as a result of their belief that biology is a "cheap" subject (Soyibo 1982) in Danmole et al, (2004). Hence, students' high failure rate may be due to the fact that biology is a difficult subject. This is of great concern to stakeholders. Could this poor performance be the outcome of teaching strategy? What will be the effect of Computer-Aided Instruction (CAI) on achievement and retention of SS II students in mitosis in biology? The search for a more efficient method of teaching mitosis in biology has necessitated the need for more interactive strategies for improved teaching and learning. An interactive strategy considered by this study for improvement is Computer-Assisted Instruction (CAI) package. Although CAI is purported to have the potential to enhance students, learning, it is not quite clear whether CAI may be more effective in achieving better learning outcomes and sustaining students' retention in mitosis in biology.

Based on the above questions, the most prominent question is: What will be the effects of Computer Assisted Instruction package on the achievement and retention of mitosis biology?

1.3 Purpose of the Study

The general purpose of this study was to determine the effects of Computer-Aided-Instruction (CAI) package on achievement and retention in mitosis in biology in senior secondary II in Minna Metropolis.

1 To develop a computer aided instruction package CAI on mitosis for the study.
2 To determine the effects of Computer Aided Instruction (CAI) package on students' academic achievements in secondary schools II mitosis biology.

3 To determine the influence of gender on mean achievement scores of SS II students taught mitosis using (CAI) package.

4 To determine the effects of Computer-Aided-Instruction (CAI) package on mean retention scores of SS II students in mitosis biology.

5 To determine the mean achievement scores of male and female SS II students taught mitosis biology with Computer-Aided-Instruction (CAI) package.

1.4 Research Questions

The following research questions guided the study:

1 Is there any difference in the achievement mean scores of students taught mitosis with Computer-Aided -instruction (CAI) package and students taught mitosis with Conventional Lecture Method (CLM)?

2 Is there any difference in the achievement mean score of male and female students taught mitosis with Computer-Aided-Instruction (CAI) package?

3 Is there any difference in the retention mean scores of students taught mitosis with Computer-Aided- instruction (CAI) package and students taught mitosis with Conventional Lecture Method (CLM)?

4. Is there any difference in the retention mean scores of male and female students taught mitosis with Computer-Aided-Instruction (CAI) package?

1.5 Research Hypotheses

The following null hypotheses were formulated and tested for the purpose of this study at 0.05 level of significance

HO_1: There is no significant difference in the achievement mean scores of students taught mitosis with Computer-Aided-Instruction (CAI) package and students taught mitosis with lecture method (CLM).

HO_2: There is no significant difference in the achievement mean scores of male and female students taught mitosis with Computer-Aided-Instruction (CAI) package.

HO_3: There is no significant difference in the retention mean scores of students taught mitosis with Computer-Aided-Instruction (CAI) package and those taught mitosis with lecture method.

HO_4: There is no significant difference in the retention mean scores of male and female students taught mitosis with Computer-Aided-Instruction (CAI) package.

1.6 Significance of the Study

This study is based on the framework that findings will have both theoretical and practical significance. It is expected that findings of this study will give credence to the mental load theory when the achievement and retention of the students changed positively as a result of the application of CAI package in mitosis in biology. This is because the mental load scientist such as Mayer, Heiser & Lonn, in 2001 emphasized that an audiovisual presentation will usually have lower extraneous load than a visual format only, since the audio modality is also being used to

convey information to the learner. These have been found to support learning which is in line with the development of computer assisted instructional (CAI) package technology as a teaching machine.This study focuses on finding out the effects of CAI package in mitosis in biology. It is expected that at the completion of this study, students, teachers, teacher training institutions, curriculum developers, policy makers, government and the nation at large will benefit from the findings in the following ways:

The result of this study is expected to have positive impact on teaching and learning of mitosis biology in SS II. The teachers will identify the mode of instruction that will be suitable for effective teaching and learning of mitosis in biology. Apart from increasing the number of instructional strategies at their disposal, it might make the teaching of mitosis in biology more interesting and hence improve achievement and retention of concepts in mitosis in biology. It will be useful to computer programmers and software designers by providing them with the appropriate programme for effective teaching and learning.

The study will be of benefit to biology teachers because the CAI package will stimulate their innovativeness in their teaching and learning process. After being exposed to the package, they can develop other computer packages to teach difficult topics in biology. They can use what they have developed in CAI packages to achieve their objectives. CAI packages assist teachers in teaching abstract and complex topics in biology. This also reduces the stress of teaching since the package is interactive in nature. The use of CAI package assists in effective large class management since it can be projected on a screen.The result is expected to be useful to learners in biology because it will provide opportunities for students to practice basic skills in mitosis in biology. They will learn some basic concepts on their own, at their own pace and time. The use of CAI package developed for this study will raise learners' interest in mitosis in biology. The

CAI package will also increase the creativity level of learners which will help them generate ideas in solving biology related problems. With the use of CAI package in learning, the learner's interest in video games will now be shifted from irrelevant programs to a more learning-oriented-programs.

The listening skill of the learner is supposed to be greatly enhanced and the phobia or fear of the computer is also greatly reduced. The CAI package encourages individual and group learning habits where after the normal class work the learner can go home and study the CAI package at his will and pace or form a group of friends to study together at their leisure time. This procedure will provide for individual differences, eliminates tension and fear in learners, make learning easy, simple and enjoyable which leads to mastery of the subject matter. It is hoped that it will provide cognitive bridge to the students which will lead them from abstract learning to a concrete one. The result of study will encourage the use of the head, heart and hand to acquire skills necessary for harmonious interaction between the learners and the materials to be learnt.

To the curriculum developers, the study would keep them abreast of the new innovation in the use of CAI packages to teach as against the conventional lecture method. They will now draw up a master plan for the review of the National Policy on Education to reflect the development and the use of CAI in most of the subjects taught in our schools throughout the Federation. Workshops and seminars could be used to train teachers to be ICT compliant which will lead teachers to be able to develop and use CAI packages.

To the government, it expected that this study will be of great benefit to the government. It is expected that the cost of importing foreign CAI packages will be greatly reduced thereby conserving our scarce foreign reserve.

To the nation, the study would be of immense benefit because it could produce learners with ICT literacy that will be able to adapt to the "Global Village" syndrome where global citizens must be ICT compliant or will not survive as survival requires the ability to use computer for all their transactions. Teaching and learning in those days will be computer-based due to the advent of "Skype" software which enable both learners and teachers to interact with each other on computer screen as the teacher teaches from the classroom. One just needs to log-on to Skype and he will be connected to his teacher at another location say, Gidan Kwanu "GK" where the lecturer is delivering his lectures through Skype to his students in far away distances.

The learners so produced will be spurred to think logically geared toward producing a CAI package for future in different areas of professional endeavours. The use CAI packages will encourage scientists to produce CAI packages in Biology, Mathematics, Physics, Chemistry and Geology, Anatomy and Physiology and other science related courses.

1.7 Scope of the Study

The research study intends to cover two secondary schools in Minna Metropolis of Niger State. It is limited to only senior secondary two (SS II) in the area of study. They are Hill Top Model School, Minna (HTMS), Government Day Secondary School, Minna (GDSS) The topic of the research will be mitosis and the study will last for four weeks. Minna metropolis of Niger State comprised of ten Senior Secondary Schools, with the ten schools having well developed ICT facilities and infrastructural development. The population characteristics of the schools are homogenous in terms of student population in the classes, teacher's qualification, school programs etc. Based on the above, the choice of Minna became suitable for the study. The choice

of SS II is borne out of the fact the topic falls under their syllabus. The mitosis topic will include all the phases of mitosis; Interphase, Prophase, Metaphase, Anaphase and Telophase. The study will last for four weeks.

1.8 Basic Assumptions of the Study

In this research study, it is assumed that results of the effects of CAI program in mitosis will assist to bring about a change from the use of lecture method to the use of CAI programs. It is also assumed that due to the audio, graphics and simulations, students will be motivated to work hard to excel in their study of biology. It is assumed that students at the end of the treatment will acquire computer skills due to the embedded drills and practice in the CAI package.

1.9 Operational Definition of Major Terms

Biology: Bio in Greek means life, logy means study, so biology can be defined as the study of life or living things.

CAI-Computer Aided Instruction is the instructional package developed in mitosis for this study

Achievement: Scores obtained by learner.

MBAT: Mitosis Biology Achievement test.

CLM: Conventional Classroom Method

TMBAT: Teacher Made Biology Achievement Test.

Retention: Scores obtained by learner after 2 weeks delay after treatment.

Gender: Segregation of sexes into male and females.

Mitosis: Is the cell division that occurs at the apical meristematic region of plants.

Interphase: Cell has appearance of non dividing cell, chromosomes too thread like for visibility

Prophase: Chromosomes thickens, centromere visible, nucleolus disappears and breakdown of nuclear membrane

Metaphase: Chromosomes arrange themselves at the centre of the cell, chromatids draw apart and moves towards the opposites poles of the spindle

Anaphase: Chromosomes migrate to the opposite poles and the cell starts to divide at the centre

Telophase: Cell division is completed here forming two daughter cells containing the same number of chromosomes as the parent cells.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Introduction

This chapter deals with the review of related literature to this study. The review will be organized and arranged under the following sub- headings: Conceptual framework, theoretical framework and Empirical studies. The conceptual frame work will review related literature on computer aided instruction package and students achievement and retention in mitosis in biology. It will also review related literature on gender achievement and retention in mitosis in biology. Other related literature that will be reviewed will include that of science, technology and information communication technology and teacher education. Literatures of the split-half and modality effects will be reviewed under the theoretical frame-work while the empirical studies will review literature in achievement and retention by male and female students in computer aided instruction.

2.2 Conceptual Framework

- Computer Assisted Instruction
- CAI Package and Students Achievement in Biology
- CAI Package and Student Retention in Biology
- CAI Package in Mitosis Biology
- Influence of Gender on Academic Achievement and Retention
- Science, Technology and Mathematics
- Information Communication Technology and Teacher Education

2.3 Theoretical Framework

- Split Attention Effect
- Modality Effect

2.4 Empirical Studies

- Computer Assisted Instruction, Academic achievement and Retention
- Influence of Gender Characteristics on Students Academic Achievement and Retention in Science.

2.2 Conceptual Framework

2.2.1 Computer Assisted Instruction.

- **The Origin of Computer Assisted - Instruction. CAI**

The origin of CAI can be traced back to the twentieth century when behavioral theories were being embedded and implicated in educational institutions. Behaviorist approach emphasized individualization, self pacing and mastery learning concepts in education. This behaviorist approach was a teaching strategy called programmed instruction. The fundamental idea of programmed self-instructional material was described in 1912 by Hefzallah (2000):

> ….." If by miracle of mechanical ingenuity, a book could be so arranged that only to him who had done what was directed on page one would page two become visible, and so on, much that now requires personal instruction could be managed by print. Books to be given out in loose sheets, a page or so at a time, and books arranged so that the student only suffers if he misuses them, should be worked in many subjects" (p.81).

The Greek Philosopher Socrates is also said to be the first programmer who developed a program in geometry which was recorded by his disciple Plato in the dialogue memo (Chauhan 1994; Sampath et al 1998; Hefzallah, 1999).Socrates used to teach his followers by raising questions and then leading them towards facts, answers and insights through conversations. A conversation between Socrates and Memo, a disciple of the sophist Gargias was recorded by Plato. In the written form, conversation seems to have some characteristics of linear programmed text such as:-

- Questions are arranged so as to make students conscious of their ignorance and move them towards deeper understanding.
- Cues to illicit correct response.
- Immediate feedback.
- Praise for correct feedback.

During his conversations, Socrates behaved like a live "programmed machine". He posed every question in the light of the memo's response to the previous question. In this way he tried to correct memo's mistakes. Hence his dialogue can be labeled as a branching program.

2.2.2 Historical Overview of CAI

A multiple item scoring machine was invented by Sidney Pressey in 1924. This invention gave birth to the idea of CAI long before the birth of Computers. The first electronic digital computer was invented by John Vincent Atanasoff and Clifford Benny in 1939. It was called the Atanasoff - Benny Comp (The ABC). It was followed by the Electronic Numerical Integrator and calculator (ENIAC) which was commissioned by the US department of defense and completed in 1946. The first documented instructional use of computer was a computer driven flight simulator used for training US pilots in a Military training institute in 1950. The computer was first used in

the school in 1959. The IBM 650 (International Business Machine 650) was used to teach binary arithmetic in New York City Elementary School. By 1960's and 1970's, it was found that programmed instructions can be presented through Computers more successfully. Main Frames Computers and Medium sized Minicomputers were used for imparting instructions to students (Poole, 1999, Roblyer 2000; Bansal 2002). The intense development and research with mainframe based computer network in Schools, Colleges and University peaked in the early and mid 1970's, mainframe and minicomputer by (IBM) corporation, computer curriculum corporation (CCC) and data control corporation (CDC) dominated the field of computer in education. No historic overview of computer is incomplete without the mention of Professor Patrick Suppes of Stanford University.

2.2.3 Suppes the Pioneer of CAI Package

The 1st computer curriculum corporation (CCC) president Prof. Patrick Suppes led an extensive research and development of CAI that earned him the "Grand Father of CAI". Suppes developed CAI package at Stanford University for one of the first Micro computer in 1966. He predicted that Technology will transform Education but it will enhance the delivery of individualized instructions to students of all ages in most subject areas. In the University level, he believed that individualized instruction will improve learning and instruction. He conducted experiments and set initial standards for CAI package (Campbell, 2000; Roblyer Edward, 2000). Efforts by Government in funding projects initiated by Universities in collaboration with hardware manufacturers contributed a lot in the development of CAI package. Programmed logic for Automatic Teaching Operation (PLATO) and Time shared Interactive Computer Information Television (TICCIT) is two major projects dominating the field of CAI in 1960's and 1970's.

2.2.4 Programmed Logic for Automatic Teaching Operations (PLATO).

Don Bitzer, working at the University of Illinois in conjunction with Control Data Corporation (CDC) started the program known as Programmed Logic for Automatic Teaching Operations (PLATO). This system was designed to integrate text and graphics which was used to develop tutorial lessons and complete courses rather than just drill and practice lessons. CDC President William Norris had the belief that PLATO will revolutionize teaching/learning. He channeled some funding and personnel into the development of PLATO between 1965 and 1980 (Roblyer & Edward 2000; Campbell 2000). Plato was a mass of hundreds of tutorials, Gamers, simulations and drills and practice programs. Learners accessed PLATO through mainframe computers. A Comparism of conventional lecture method and PLATO showed that On achievement, PLATO grained more that lecture methods (Roblyer & Edwards, 2000) under National Science foundation (NFC) funding, PLATO courseware was produced for elementary skills in arithmetic, reading, community mathematics, English, Biology, chemistry and Accounting.

2.2.5 Time Shared Interactive Computer Controlled Information Television (TICCIT).

At Brougham Young University (BYU) Victor Binderson and Dexter Fletcher added color T.V to a comprehensive learning station and developed true shared interactive computer controlled information Television (TICCIT), Mitre Corporation introduced TICCIT in the beginning of 1972. The National Science Foundation (NSF) supported this project. Its distinguishing statistics was that it combined Television, graphics and testing (Roblyer & Edwards, 2000). From 1972 to 1980, the development and marketing of Educational Computer programs was documented by IBM, CCC and CDC. Stanford University used IBM 1500 as the first computer programmed for educational purposes e.g. research and instructions. Until 1975, 25 Universities and School were using the IBM 1500 systems. Stanford University later developed its CAI package for the first

Minicomputer. Roblyer & Edwards (2000) commenting on the success of PLATO and TICCIT argued that since mainframe computer systems were both expensive and technically complete, school district offices should control both the instructional package and Hardware of the computer and the applications (Software). Data processing specialist administered most of the systems. Teachers and Local school students were not involved in this process. This lack of control by the teacher resulted as a result of teachers not involved in developing the CAI package content while students also lost interest as a result of their isolation from the system.

2.2.6 Mastery Learning Models.

Two more programmed instructions were developed, at the same time PLATO and TICCIT were developed. They include Program for learning in Accordance with the needs of learners developed by American Institute of Research and Individually Prescribed Instruction (IPI) by the University of Pittsburgh. These programs focused on using computer systems to support mastery of learning models with Computer Managed Instruction system. IPI focused on diagnosis and development of curricular materials in reading and Arithmetic (Roblyer & Edwards, 2000).

2.2.7 Microcomputers in Schools.

The first microcomputer was introduced to schools in USA in 1977 and focus shifted from mainframes to desktops microcomputer systems. (Roblyer & Edwards, 2000) this shift in hardware technology transformed the computer's role in education. Before Microcomputer, courseware came formerly from hardware manufacturers such as IBM, CDC and CCC. As Microcomputer gained popularity, software market for education-driven by teachers emerged. Class room teachers could decide what they wanted to do with Computers (Roblyer & Edwards, 2000; Campbell, 2000). Works of Suppes for CAI, PLATO and TICCIT demonstrated that CBI would work, through much work needed to be done to make it cheaper, affordable and effective,

Although CAI packages worked, there was no real need for it in the classrooms and Suppes dream of individualized instruction for learning was not realised. The availability of relatively in-expensive computer revived the dream when Commodore Business Machine (CBM) one of the first personal computer manufacturers introduced Commodore pet and commodore 64 in the late 1970's. These computers were widely used in schools. Later the apple, Atare, Tandy and Radioshar computer invaded classrooms (Campbell 2000). Hardware and software technologies are developing with un-imaginable speed that new horizon for application of computer technology in all walks of life is now the "in thing" in learning.

2.2.8 Meaning of CAI

CAI is described and defined by Frenzel (1980) as the process by which written and visual information is presented in a logical sequence to a learner by a computer. The computer serves as an Audio Visual or multimedia device. Learners learn by reading the text or observing the graphic material displayed. The primary advantage of the computer over the audio-visual device is the automatic interaction and immediate feedback the computer can provide. Multiple paths through the course material can be taken, depending upon the learner's progress. Locatis and Atkinson (1984) describe CAI as a mode of instruction that involves student's interaction with the computer directly. Information is presented in bits; responses are immediately assessed and feed back immediately given, giving rise to drill and practice exercise, simulation and games.

Stenberg (1991) defines CAI as computer presented instruction that is individualized, interactive and guided. That CAI is not a method of instruction but many methods are implemented with it, including direct and exploratory lessons, drills, games and simulations. Menden (1996) defines CAI as educational medium in which instructional content or activities are delivered by a computer. Poole 1997 defines CAI as a computer based system designed to help students learn

subject matter of all kinds. (Roblyer & Edwards, (2000) defined CAI as software designed and programmed to help teach information and skills related topics also known as courseware.

2.2.9 Computer Managed Instruction (CMI).

This is computer software designed to keep track of learner's performance data, either as part of CAI program or by themselves. It makes teacher's work in the classroom easier ((Roblyer & Edwards, 2000). According to Madin, Johnson and Willis (1997) CMI refers to organizational and management role of set of computers. Students take examination on the computer, and it scores the exam, displays results, provides study limits for improvement, records passing grades, and prints out reports of individual student's standing at any giving point in time of semester.

2.2.10 Computerized Education.

Computerized Education is the latest acronym for CAI and is very wide in meanings. Computerized education includes all the uses of computer both as a tutor and a tool. It includes all the forms of CAI and all the functions of CMI. Searching the internet, E-mail, Video conferencing, Tele Conferencing, Skype are also within its arena (Bennet 1999).

2.2.11. Intelligent CAI (Artificial Intelligence) ICAI

Intelligent CAI is a branch of artificial Intelligence devoted to developing instruction in curricular areas. The distinction or difference between CAI and ICAI are subtle and profound. With CAI, instruction is controlled by the developer of the program who determines what is presented, how much information is presented, the order of presentation and the specific questions to which the students must respond. CAI programs cannot respond to learner's questions that are not specifically designed in advance to the programmer. ICAI programs on the other hand, increase learners control over the machine and allow them an opportunity to learn by active participation. Learners interact with the computer rather than merely respond to it in a pre-

specified way; tutoring is carried on in a dialogue form as a response to student input. In additions, ICAI is characterized by a far more, thorough and fine graced analysis of the skills, knowledge and proceedings involved in solving problems in a subject area. The strength of CAI is not only the substantially more precise and detailed understanding of the nature of learning and problem solving but also the capacity of the program to articulate the understanding to be acquired by the student. ICAI program specify in detail a mix of three types of knowledge: the declarative knowledge (what), the procedural knowledge (how), and Meta cognitive knowledge (thinking about what and how). ICAI also referred to as intelligent tutoring system, can generate and solve problems, store and retrieve data, diagnose student's misconceptions, select appropriate teaching strategies and carry on dialogues with students. Intelligent tutoring systems employ a wide variety of teaching strategies. These are likely to be found in a simple CAI program. Many intelligent tutoring programs incorporate simultaneous and or games that allow students to "try out" their evolving models of knowledge (US Congress office of Technology assessment 1988).

2.2.12 Types of CAI Programs:

There are many CAI programs; Each CAI program is appropriate under different instructional circumstances, therefore, takes a different pedagogical approach. Although the beginning of CAI was presentation of programmed instruction through computer and the initial CAI program were tutorials, drill and practice and games that were oriented to the behaviorist theories of learning, the new CAI programs are associated solely with a specific learning theories due to sophistication of computer language which has allowed modification of each type of CAI according to any theoretical frame work (Poole (1997); Cox (1995); Geisort and Futrell (1995); Maddux, Johnson & Willis (1997) and Bitter and Pierson (1999) have mentioned and explained

the following types of CAI software.

- Drill and Practice
- Tutorials
- Instructional games
- Simulations
- Microcomputer Based Lab. (MBL)
- Integrated Learning System (ILS)
- Problem Solving
- Reference Software

2.2.13. Software for Drill and Practice.

This software is used to provide report exercise for rote skills that have been taught through other programs. It is not the function of drill and practice software to impart instructional activities, rather, drills programs are useful for sustaining, refining or perfecting performance in some category of behavior already learnt by another method. It is used to increase the speed or accuracy of student's performance of certain task. It allows learner to solve problems, get feedback on correctness. It is a learning technique used for building basic knowledge and basic intellectual skills such as number manipulation, vocabulary, spelling, sentence construction etc. These skill, are usually found in higher intellectual activity. Good drill and practice package provides the user with an enjoyable opportunity for respective interaction and immediate feedback on the accuracy of response. Drill & Practice software is typically associated with behaviorism, because learners are usually given stimuli (questions), are required to make response to the stimulus and then receive some sort of reinforcement (Hsu, Chen & Hung, 2000; Roblyer & Edwards 2000).

2.2.14. Tutorials.

Tutorials act like tutors by providing all the information and instructional activities a learner requires to master a topic. All the conceptual or skill based body of knowledge is presented in the screen followed by quiz to assess the comprehension of the concept or acquisition of knowledge. The software monitors the learner's 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 feed back is immediate as appropriate. Interactivity is key to user involvement and perseverance (Roblyer & Edwards 2000). Tutorial software is more associated with cognitive learning theory because new learning is presented in a systematic way. Students are expected to learn principles and rules, comprehend them and apply 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).

2.2.15. Software for simulation.

Simulation is a powerful tool for learning. Simulation models are real or imagined system to show how these systems work. They involve the learner in a kind of "trial run on reality". As such they fit nicely into the constructivist - philosophy of teaching. Learners experience life vicariously through simulations, constructing knowledge about the world for that experience (Roblyer and Edwards 2000). Simulations provide a means for learning about an environment that may otherwise not be available to learners to explore, for reasons of safety, time, expanse, or general practicality. It focuses on exploration and discovery learning. Although simulation programs are constructivist, they can have cognitive orientation also (Cox 1999). Allessi & Trollip (1999) identified two types of simulations:

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

These are further classified into 4 categories:

- **Physical simulation**
- **Process simulation**
- **Procedural simulation**
- **Situational simulation**
- **Physical simulation:**

  Users manipulate objects or phenomenon represented on the screen e.g. learners see how different chemicals are selected with the instructions on how to use them (Roblyer and Edwards 2000).

- **Process Simulation:**

  This type of simulation speeds up a process, it usually takes long time to complete e.g. seed germination and experimenting with natural laws like the laws of genetics by paring animals with given characteristics and showing the resulting offspring (Roblyer and Edwards 2000).

- **Procedural simulation:**

  It teaches the appropriate sequence to perform an experiment or identify the sources of a medical problem or cause of accidents (Roblyer and Edwards; 2000).

- **Situational simulation:**

  These gives learners a hypothetical situation and ask them to react e.g. buying and selling as in the game “Monopoly” it simulate how to invest in buying and selling (Roblyer and Edwards 2000).

- **Games:**

  Instructional games are courseware whose function is to increase motivation by adding game rule to learning activities. They are similar to drill & practice. Fun is expected from Games (Roblyer & Edwards 2000). Cox (1999), mentions that simulations are designed as games including role-playing. Learning is built up by discovery, enquiry and decision making. According to Hsu, Chen & Hung (2000), Instructional games are usually associated with behaviorism because of the variety of reinforcement mechanism inherent in game's environments with which students are motivated by competition and game rules to strive to reach the goal.

- **Problem Solving:**

  This requires the learner to apply higher-order-strategies and synthesize knowledge for multiple curricular areas in order to solve problems. Learners can test hypothesis, learn from mistakes and refine skills as they gain mastery of problem solving techniques. Software like this provides practice in solving problems by modeling general critical thinking steps by focusing on a specific subject area or by creating an open environment in which the learners can discover their own strategies. It gives users more freedom than drill and practice but does not present the real world context that characterizes simulation software (Bitter & Dierson 1999). Problem solving software is often associated with cognitivist learning theory because learners are taught specific cognitive strategies. A problem solving software is more sophisticated than the drill and practice software. It promotes learning through logic, reasoning, pattern recognition and strategies. As they interact with the program, they gradually move from simple trial and error to more logical and systematic complex thinking (Hsu, Chen & Hung, Roblyer and Edwards

2000).

- **Integrated Learning System (ILS):**

According to Underwood and Brown (1997) ILS are systems across computer network that provide a comprehensive, multiyear collection of CAI packages delivered primarily through a model of individual assessment and task assignment to record and report learner's achievement. It is good for research and is firmly rooted in behavioral school of learning theory. It has been used to address mathematical and language problem of instruction arranged hierarchically. The behaviorist approach is taken by ILS designer to produces any element of social interaction.

2.2.16. Software for Micro Computer Based Laboratories.

This software helps student to automate the process of gathering data from experiments, conducting relevant analysis and producing meaningful reports complete data can be stored in secondary memory for further analysis. Summary data are produced as text and in graphic format (Poole 1997).

2.2.17. Reference Software.

This can take the form of dictionaries, encyclopedia and thesauri in CD-Rom. The multi-media components of reference software present information in graphics, audio, video or other alternate formats that allows uniquely unlimited access to students who might not developmentally be able to contend with the text version of the information (Bitter & Pierson 1999).

2.2.18. Characteristics of CAI:

CAI can be characterized by many attributes suitable to enhance learning. Some of the special characteristics of CAI are:-

- **Individualization.**

A computer program can provide multiple instructional paths, tailored to

individualization needs (Stemberg, 1991). Students found multiple paths to proceed; learners finds option to proceed according to his needs i.e. according to his previous knowledge of the subject, ability, interest and intellectual capacity. Games add motivation, fantasy and maintain learner's attention. Concept can be presented in tutorials with the aid of illustrative animation, dynamically creating illustrations and interspersing verbal explanations and simulations can provide new insights into relationships on experiences that would otherwise not be possible.

- **Flexibility.**

  This means access to teaching materials at a wide range of fun or location, computers offer subject flexibility in the type of resources available to a student as well as increasing flexibility in education as a strategy for dealing with the number and diversity of learners. Computer programs can allow users to choose from a variety of instructional treatments. Instructional programs may use a variety of prompts and cues to produce correct learning responses (Sloane et al 1999).

- **Self Pacing.**

  Self-pacing enables learners proceed at a pace appropriate for their individual learning levels. Students using self-pacing can control the time allowed to solve problems as well as the rate of presentation. They can spend several weeks with remedial material or skip entire lesson until another time when they feel ready to be tested in the specific material, they can chose the testing cycle. Self-pacing can help to individualize learning. It can be combined with self-placement testing that directs the learner to an appropriate beginning point and to an optional instructional rate.

- **Remediation Options.**

The computer can vary instructional treatments and adapt to individual difference after analyzing learners' response. Learners' past records of performance determines sequence of instruction. In remediation, the instruction uses computer program to diagnose the learners' learning capabilities, achievement level and cognitive style. On the basis of diagnosis, the instructor chooses material that is geared towards the learner. CAI program may easily provide remediation by employing branching strategy and or through incorporating hyperlinks to present text, graphics or any type of material.

2.2.19. Graphics and Sound.

Graphics representation plays an important role in instruction. In addition to pictures, computer graphics include the use of formatting features such as arrows, boxes and illustrations to emphasize the concept. Sound with a program can prompt focus or reinforce students and this enhances instruction. At a more sophisticated level, some CAI programs include speech synthesizers that produce words or sentences. Synthesizers are especially applicable with software for the very young or handicapped users. Computer graphics and sound infuses movement, excitement and animation into a program.

2.2.20. Advantages of CAI:

A lot of evidence abounds on the effectiveness of CAI better than the traditional lecture method. Extra advantages of CAI as identified through research findings includes:

- **High Achievement Level.**

  A large number of research studies provide evidence for high achievement levels for students of different ages and abilities and for learning in different curricular areas through CAI modes of instruction (Bahr & Reith 1999; Gore et al 1991, Brown 1999).

- **Learning rate.**

In spite of CAI improving achievement levels, researchers have found that CAI enhances rate of learning. Learning rate is faster with CAI than with lecture method. In some research studies the learners learned the same amount of material in less time than the traditionally instructed learners. While most researchers don't specify how much faster CAI students learn, the work of Capper and Copple (1995) led them to the conclusion that CAI users some time learn 40% percent faster than those receiving traditional, teacher-directed lectures (Capper & Copple (1995; Kullik 1995; Kullik & Kullik 1997).

- **Retention of Learning.**

  If learners receiving CAI learn better and faster than learners receiving conventional lectures alone, do they retain their learning longer? The answer according to researchers, who have conducted comparative studies of learning retention, is yes. In such researches, learner scores in delayed tests indicate that the retention of content learned using CAI is superior to retention following the traditional lecture methods (Capper & Copple 1995; Nash & Ball, 1993).

2.2.21. Other Benefits of CAI (Related Literature)

The effects of CAI on the learners or student outcome have not been as extensively researched as effects of CAI on achievement, learning rate and attitudes. Some researchers have however investigated CAI's influence on other variables and found it to confer benefits on:

- **Locus of control.**

  Capper and Copple (1995), Kinaman (1999) and Louie (1995) found out that CAI users or students have more of an internal locus of control/sense of self efficiency than conventionally lectured students.

- **Attendance.**

Capper & Copple (1995) study, and demonstrated that student's attendance improved in CAI classes as compared with the classes where lecture method was employed.

- **Motivation/time on task.**

  Capper and Copple (1995) found out that CAI students (experimental group) had higher rates of time-on task than traditionally lectured students (control group) .Curtic (2000) hold that CAI incorporates adult learners, time perspective and utilization of past experiences. By using CAI the learner may work independently without fear of embarrassment. Learning occurs at learners pace and time frame. Macleans (2002) is of the opinion that CAI provides students with alternative to class-room settings and frees the instruction from rote process that is better handled by the computer. Using CAI as an instructor can develop or acquire a series of supportive and reinforcing software. Albon (1997) identified positive outcome of CAI as a result of his experiment. He found out that learning is none enjoyable for graduate and undergraduate students because they are provided with concise and constant information in a self paced manner.

2.2.22. Effectiveness of CAI in Various Subjects:

There is the need to review related literature to find evidence for the effectiveness of CAI package, technology or innovation of any kind in other subjects. CAI package has been in use since 1950's and it is one of the most researched technology applications in Education. There is a mixture of research findings in favour or against CAI package. Yet there is ample evidence that supports CAI as an effective mode of instruction in various subject areas and at various educational grade levels. Poole (1997) have exemplified some successful CAI programs and project and cited findings of research studies as an evidence for the effectiveness of CAI in "reading", "writing" "Arithmetic" and "problems solving", "Science" and "Social Sciences".

Different forms of CAI packages as a supplement to traditional method of instruction has borrowed their effectiveness to augment student's learning. Cotton (1992) reviewed fifty nine research studies exploring effectiveness of CAI and concluded that the simple, best supported findings in the research literature is that CAI, as a supplement to the teacher, directed instruction, produces achievement effects superior to those obtained by traditional lecture method. This finding holds time for students of different ages, abilities and for learning in different curricular areas. Christmans, Badgett and Lucking (1997) conducted a Meta analysis of the studies comparing CAI, Traditional methods of instruction, and Traditional method plus CAI. It was found that students receiving Traditional method of instruction supplemented with CAI attained higher academic achievement scores than those receiving only traditional instruction. Poole (1997) opines that computer as a tool in the hands of both the learner and the teacher; it's effectiveness as a tool depends entirely on the skills that the students and teacher bring to bear on the learning process.

2.2.23. Effectiveness of CAI in Sciences:

There is a great deal of evidence regarding the effectiveness of CAI in the subject area of Science. Research findings support CAI at all grade level from Primary to Secondary and University levels. In the Science classroom, students' interaction with computers running simulation of experiments enjoyed a more effective learning experience than students watching a demonstration accompanied by teacher - student interaction. Findings by Broophy (1999); Carter (1999); also supported effectiveness of CAI in Science. Bayrakter (2000) conducted a study employing meta-analytic research approach, the purpose of it were to determines whether CAI had an overall positive effect on student achievement in Secondary and College level science education when compared with traditional forms of instruction and to determine whether specific

study program characteristics were related to CAI effectiveness. CAI was found to be most effective in Physics education and had little effect on Chemistry and Biology achievement. Simulations and tutorials programs had significant effect on students' achievement with science education but drill and practice was found not effective. Another finding was that experimenter developed CAI was more effective than commercial CAI when duration of treatment was shorter than 4 weeks. Review of the Literature reveals that simulations are the most effective type of CAI packages in the subject areas of Science. Micro Computer based Laboratory (MBL) are also found to be effective for better learning of science concepts. Effectiveness of any CAI program depends on

- **Quality of instructional software**
- **Quality and functioning of hardware**

2.2.24. Effectiveness of CAI in Mathematics.

CAI is used most frequently in the teaching of methods than other courses. Effectiveness of CAI in Mathematics is no more latent. Wide spread and effective use of CAI package for all grade levels is evident in the availability of various CAI packages in the market. There are games for primary schools and tutorial, drill and practice software for high school students. Mutz (2000) and Campbell (2000) compared computerized and traditional instruction in the areas of elementary Mathematics and elementary reading respectively. Both studies examined the effective of CAI package in achievement and critical thinking of skills of fourth and fifth grades. It was found that critical thinking improved between those taught with CAI and those with traditional method.

2.2.25. Nature and Scope of CAI packages in Future:

Nature and scope of CAI packages has been changing with changes in hardware technology,

necessary sophistication with languages for software development and shift with theoretical paradigms for learning. Initially CAI meant delivery of programmed instruction through Computers. The early CAI program were provided through large mainframes, time-sharing computer systems operated and controlled from central location e.g. PLATO was operated from University of Illinois and Stanford University. Developments in the field of computer have been so swift that yesterday's miracle is today's obsolescent junk. With the advent of more powerful computer, seamless software suites, and advanced connectivity, conventional applications of computer in education are enhanced, and new creative application are discovered. Today the computer use in education means much more than the past. Computer can be used as interactive story teller, excellent means to provide and present multimedia programs, vehicles for interactive communications, among people, getting to the information world. Electronic publishing media tool for managing and assessing instruction; resources for teaching and learning; virtual-reality, and a private multimedia tutor. This evolution is not expected to go to extinction, hence findings of the past if any showing limited impact of CAI on student's learning are no more applicable or generalizable for the present or future. Micro-computers replaced mainframes, continuous replant of less advanced in more advanced and sophisticated computer languages and shifts in theoretical paradigms from the behaviorist learning themselves to cognitive learning theories and to the constructivist has changed the science of CAI, Science education of the future will certainly incorporate computer use including word processing; many form of CAI, Laboratory instrumentation, interactive video courseware and scientific data base searching will certainly improve the education process (Schrum,1997). Although educational software is improving in both function and content, one might argue that the available educational software is yet to meet the needs of teachers and students in the developed countries. In the developing countries, the

educational problems are so diverse and complicated that incorporation of CAI strategies in schools is still at bottom list of long lists of priorities. Government is paying attention, towards information technology education and colleges, prices of usual computer are falling day by day and PC are purchasable by common man, hence personal computers are necessary among masses with reasonable great speed. Poole (1999) claims that computer systems will be universally easy to use compared to what must be put up with in many computing environments today. They will be powerful, inescapable and intricately woven into the fabric of our lives. Multimedia technology such as computer based instruction interactive video discs, capable of storing all kinds of data, from text and still images to stereo quality sound and high definition video, will cause schools to re-affirm and teachers to rediscover, their commitment to audio visual aids in the learning process. As such it will take its place as a powerful new tool in the pedagogical process. Hence the changing nature and scope of computer and its applications in the form of CAI invites more researching in its various aspects. Kadhiravan, (1999) studied the effectiveness of CAI in relation to students' use of self-regulated learning strategies, he found out that, there is significant achievement in CAI in Physics and was more effective than the traditional lecture method. Meera (2000) studied the relative effectiveness among different modes of computer based instruction in relation to students' personality traits found out that different computer based instruction or drill and practice and simulations were more effective than conventional lecture method in realizing the instructional objectives of biology. The researcher also found out that computer based instruction was not influenced or affected by personality but there was a sign of improvement in enhancing the retention of cognition as revealed by learner's performance. Dalwadi (2001) studied the development of CAI in science for the students of standard IX and found out that CAI was an effective individualized instructional technique for

teaching science to standard IX. Students were found to have a positive opinion towards CAI, they also have a favorable opinion towards CAI and science teachers also had positive opinion towards CAI developed. Patel (2001) studied learning through CAI material in relation to selected production variables and contiguity and found out that teacher competency was positively related to post knowledge in CAI. CAI improved student's attitude towards computer education and use of computer. Versanthi & Hema (2003) studied the effectiveness of teaching chemistry for 1 year business education students through CAI and found out that there was no significant difference in achievement scores of experimental and control group. Sing (2005) found out that the use of CAI was effective in enhancing learning a lot in cell and tissue studies but that lecture mentioned was more effective than CAI for teaching the cell, while CAI was more effective than lecture method for teaching the tissues. Dange & Wahb (2006) studied the effectiveness of CAI on Academic Achievement of class IX student's physical science and found that there was no significant difference in achievement scores of students' of physical science when taught with CAI and the traditional lecture method. Patel & Kinnay (2008) studied the effects of CAI in physics for the students of standard IX and found out that CAI was significantly effective for improvement in achievement of learners and both gender improved upon the use of CAI while teacher's attitude revealed a favorable opinion towards the CAI developed. Zyoud (1999) studied the effects of CAI on English Language teaching of VIII standard students and found not that when computer is used to its potentials, it can create an atmosphere where the students can learn and interact with computer without being afraid of the teacher's presence. The computerized exercise can help the students become familiar with significant amount of vocabulary, grammar and comprehension because it provides effective individualized instruction. Das (2003) studied the effects of CAI in Secondary Schools of Assam

and found out that students have positive attitude and outlook towards computer education received in their respective schools. Some students have a revamping of the traditional models of teaching by introducing computers in teaching that they think will make their education more exciting and interesting. Teachers become confident of their knowledge of the subject and were devoid of anxiety. Most of the teachers and students recognized the important roles computer played in today's society. The English medium students were found to display higher level of confidence, a sense of competencies in their approach to and use of computers than the Assamese Medium students. Jothikani & Thiagarajan (2004) studied the effectiveness of CAI on B. Sc Mathematics degree students and found out that convectional lecture method is more effective than CAI method. Joy & Shaiju (2004) developed a CAI program in History at higher secondary level and found out that while both lecture and CAI were effective learning methods, CAI method was superior to the lecture method and interestingly there was no gender difference in the scores obtained. Suwana, (2004) studied the effectiveness of CAI for Primary School students and discovered that the study resulted in the development of CAI program in selected five units of Thai Language learning for the students of Pratom-3 and five unites of their language learning for the students of Pratom-6. The CAI developed by the investigation was found significantly effective in learning five topics of their subjects to the student's pratons-3. Mehra & Vandana (2007) studied teacher's attitude towards computer use implications for emerging technology implementations in educational institutions. The findings revealed that teachers possessed fairly positive attitude towards computer use but majority of the teachers need to be provided training for using computer in instructional settings. Patel (2009) studied the development and implementation of CAI to teach English grammar to standard VIII students in different modes and found out that the achievement of students taught with CAI was

significantly higher than those taught with traditional method. The achievement of students taught through only CAI was found significantly higher in English grammar than that of the students taught through traditional method. The teaching through CAI with discussion was significantly superior in comparison to other two modes. CAI has been generally seen to be superior over the traditional method, Meera (2000), Dalwadi, (2001), Versanthi & Hema (2003), Dange & Wahb (2006) Patel, Kinnary (2008). These research studies were related to topics of branches of science like Physics, Chemistry and Biology at higher secondary school as well as secondary level and it showed that a well designed CAI is profound in learning. Researches by Patel, (2001) were conducted to see the effectiveness of the different methods in science. These researches have been on network diagram, micro computer, multimedia package and CALM. Researches by Jothikani & Ihagarajan, 2004, Suwana (2004) were conducted to see the effectiveness of CAI presented in different modes and that too was for teachers' rhythms at lower standard. In an analysis of attitudes towards the use of CAI mostly all the students showed favourable attitude towards the use of Computer,(Dalwadi 20001, Joy & Manickam 2002, Das 2003, Suwana 2004, Mehra &, Vandana 2007, Patel & Kinnary 2008 & Patel 2009). Both CAI and lecture methods were effective in enhancing learning but on different topics relative effects were shown by both methods Sign (2005). Teachers showed positive attitude towards the use of computer as well as use of CAI with teaching learning process. Students' teacher recognition of the important role that computer plays in today's society. (Dalwani 2001, Joy & Manickam 2002, Patel & Kinnary 2008, Das 2003 Mehra & Vandana, 2007). Girls have positive attitude towards computer as being more users friendly and expresses less anxiety about the use of computers. Das (2003), Rivet (2001) studied the effects of CAI as achievement in middle school Mathematics CAI versus traditional method of instruction and found out that in spite of

variability in performance in individuals, types of fractions, the overall improvement scores were significantly greater in CAI classrooms than in the traditional classrooms. Furthermore, in spite of the achievement in different schools, the CAI classrooms performed better than the classrooms taught with traditional methods. Hodge (2002) studied the effects of Mathematics self-efficiency and CAI on the ability of undergraduate nursing students to calculate drug dosages and found out that although data analysis indicated that Mathematics anxiety was a factor in nursing students' ability to calculate drug dosages, it was not statistically significant. On the other hand, Mathematics self efficiency and CAI showed statistically significant relationships with undergraduate nursing students' ability to calculate drug dosages Hsu, Yun-Chen (2003) studied the effectiveness of CAI in statistics education: A meta analysis found out that the result indicate a small to medium positive effect of applying CAI in teaching college level introductory statistics on students' achievement. The result of the analogous analysis of the variance showed that different models of CAI program produced significantly different effects on students' achievement in learning statistics, expert system, drill and practice program were the most effective modes and were followed by multimedia, tutorials and simulation. Computational statistical packages and web-based program were the least effective mode. The teacher made CAI programs were significantly more effective than the commercially produced CAI programs. The effectiveness of CAI program in teaching statistics did not differ significantly according to the study and characteristics of the publication year, publication score, the educational level of participants, the level of interactivity of CAI program, the instructional role of CAI program and the sample size. Canon, (2005) studied the effectiveness of CAI on students' success when compared to traditional lecture method and find out that there was a significant difference in achievement, the lecture method showed higher significant achievement rate than those taught in

CAI while retention, persistence and success did not show any significant difference between the two. Rosales (2005) studied the effect of CAI on the Mathematics achievement of ninth-grade high school students in lower Rio Grande Valley and found out that there is statistically significant different between the mathematics achievement in ninth grade students who participated in the CAI programmed and those who did not participate. Barnett, (2006) studied the effects of CAI on the reading skills of emergent readers and found that students using distinction reading (Riverdeep, 2001) did not benefit significantly from the use of CAI compared to non users, the CAI group scored significantly lower on the initial sound fluency measure. Teacher attitude towards computer did affect students' acquisitions of reading skills as survey responses were in the positive range for all participants. Deck, Alan, Collins, David, Mc Crickard & Myra (2008) studied effects of CAI on students' evaluation and academic performance and find out that CAI improves final exam score. Generally group taught with CAI performed better than those taught without CAI Rivet (2001), Ralesees (2005). The teacher made CAI is more effective than the commercially developed CAI program. Hsu, Yung-chen (2003). Experimental group performed better and students' attendance was more in CAI group. Males performed better than females in terms of cognitive achievement (Mary, Lewis & Durnell, 1991). Most educators had positive attitude towards CAI and more than half of them use CAI in their teaching (Gao, Yong & Qiang 1992). Majority of students at the university class level showed positive co-operation on group work and positive attitude toward using computer in the classroom. Park, Insun Hwang (1993). Types of instruction have influence in academic performance of adult students on the mathematics and reading section Burton, Beatrice, Spencer, (1995). The overall improvement scores were significantly greater in CAI classrooms than in traditional classroom. The CAI classrooms performed better than the traditional class (Rivet,

2001). CAI showed statistically sign relationships with undergraduate nursing student's ability to calculate drugs Hodge, (2002). The Meta analyzing indicates a small to medium effect of applying CAI in teaching college level introducing statistics Hsu, Yung-chen (2003). The traditional lecture students' achievement rates were significantly higher than the students who received computerized instruction Cannon (2005). Soede (2001) showed that there is no statistical difference between CAI and traditional method. The students expressed more favourable attitude than control class. Rivet (2001) study support CAI can have a significant effect on the academic gains of students compared to traditional method. Rothman (2000) showed that non-traditional (CAI) method of instruction in science significantly improved students' attitudes towards science learning. Demerici (2001) study supported the web-based Physics program in traditional method have a sign effect on dispelling students physics misconceptions. Hsu (2003) study showed that different modes of CAI programs produced significantly different effects on student's achievement in learning statistics expert system and drill-and-practice programs were the most effective modes and were followed by multimedia, tutorials, simulations. Computational statistics packages and web page design packages were the least effective modes. Knack (2003) study indicates that all eighteen instruction designed were effective for learning. Students highly rated elements such as feedback, written help and audio guides because they perceived these elements to aid in their understanding and navigation of programs. Khrirwadkar, (1999) Zyoud (1999) and Barot (2004) study supported that CAI was found to be effective in terms of achievement of students and was superior to the traditional method. A large majority of the students have reported higher achievement in different subjects like sciences and mathematics. Sanjay (2010) showed that science teaching through CAI program was effective for boys than girls in rural areas. It was also effective for high 1Q than

low 1.Q. for students in rural areas. Prvan et al., (2002) showed that range of learning and assessment activities used in group discussion, 'real life' simulations, problem solving and worksheets. (Garfield & Gal, 1999; Prvan et al., 2002) showed they believed that "assessment activities usually focus on the task or statistic idea and learning activities also need to include emphasis on the students' knowledge, rather than on the lecturer's ideas of important content, that is, the characteristics of a flexible learning environment that encourages students to develop higher conceptions of learning" (Prvan et al., 2002). Basturk (2005) study showed that CAI is more effective in SPSS teaching than the traditional class room method. Imhanlahim and Imhanlahim, (2008) showed that both CAI and traditional method of instruction assisted learning strategy and expository and were effective in enhancing students' achievement in biology. Both the traditional method was more effective because of the presence of the teacher who explained the content while the CAI did lower due to absence of a teacher to explain the well structured contents. Filiz (2006) shows attitude to CAI at the university of Gaziantep is positive, CAI generally consists of drill and practice, simulation tasks, instructional games, and tutorials; instructions can contain new materials and can be used alone or as an enhancement to traditional instructional methods (Cotton, 2001; Kadiyala & Crynes, Koki & Chang 2000). Studies in the last 15-20 years have focused on the relationship between CAI and achievement with many different subject areas, such as mathematics, probabilities (Hsiao, 2001), Science (Chang 2002), reading. Technology can be very expensive to school distinctions, learning may stake holders questioning if the achievement result justifies the cost (Ross; Hoyabocm, Gay. & Hannay 2001) Drake (2001) find out that CAI is one of the best practices which support Literary learning at the elementary school level. Advocates of CAI (Chang 2002, Cotton 2001, Garcia & Arias 2000,) claim that using CAI enhances learning through the overall positive motivational factors

associated with Technology integration into the curriculum. These CAI supporters indicate that CAI improve achievement through increased motivations only a few researchers, such as Ashton, Bland, and Rogers (2001) reports conflicting research in student motivation in CAI. Cotton 2001, Software & Information Industry Association, 2000 found the most positive effects of CAI on students of elementary school age; however, it should be noted that the software manufacture who conducted some of these studies did not report any negative results. Another trend frequently addressed in the research is the potential for technology to decrease the time it takes for students to learn material and the time for instruction of the curriculum objectives. Cotton's (2001) synthesis of 59 research report yielded mixed results in time savings. Cotton notes that students learn material in either the same time or less time when CAI is used. Cotton (2001) determined that students learn up to 40% faster when taught using CAI, as CAI increases students time on task. Cottons (2001) interactive analysis indicates that students of lower socio-economic status benefits more from CAI than do students who are from a more advanced environment. Garcia and Arias (2000) compared the motivational levels of elementary and intermediate level second-language student's learning English through print and through CAI, concluding that CAI increases motivation for learning English in students whose primary language is not English. There is general consensus in the Literature that students who have disabilities or students at risk for literature benefit from CAI (Kim & Kamil, 2001). In a literature review of 15 years of research on CAI to teach or support Literacy for students with mild disabilities (Mc Arthur, Ferreti, Okolo & Cavalier, 2001) found that all students support the use of CAI to improve decoding skills and phonological awareness in these students. Cotton, (2001) Hal, Hughes & Filbert, 2000, Byrd, 2001; Hook, Macaruso & Jones, 2001) all studied different trends in the research about CAI having the potential to impact students' achievement in reading.

Phonological awareness training is only one discussion of reading instruction that facilitates the connection between oral language and written language, (Foorman & Torgesen, 2001, Gillette & Temple, 2001; Rasinsky & Padak 2000; Smith, Simmons Kameenini & Torgeson, 2002). Researchers also appear to agree that carefully planned instruction causes success in later reading skills. Most often defined as the ability to identify and manipulate the sounds of language. Phonological awareness involves an understanding that the sounds can be broken down into smaller components and then manipulated (Gillon 2000, Lane, Dullen, Eisele & Jordan 2002, Yopp, 2000). Flax, Realpe, Hirsch, Nanoyn & Talla (2000) suggested from their study of 200 participants that phonological reading abilities can only be used to predict later reading ability in males rather than females. Some researchers indicate that there is a negative or neutral relationship between CAI and reading achievement (Kadiyala, Crynes & Parr, 2000). Hook, Macaruso and Jones (2000) found out that there is no significant improvement of word identification word attack and phonemic awareness as compared to control group. Iboegwu (2012) found out that guided discovery method was significantly superior to the demonstration teaching method in enhancing cognitive achievement in chemistry for all levels of literacy students. Ayua (2012) assessed teaching expectations on what is an effective primary science teaching education program and found out that there is an imbalance between the two curricula leading to ineffective teacher production and performance. Olajide (2012) found out that little or no inquiry took place during integrated science lesson and contemplation by verbal interaction dominated both teacher and students' activities in the classroom. Ezeh (2012) studied the effects or influence of cognitive ability on JSS II achievement in Home Economics and found out that high cognitive ability students achieved higher than low cognitive ability students and that there was no significant difference in the cognitive achievement of males and females. Olurokooba,

Lawal & Jiya (2012) studied the effects of the use of analogy teaching strategy on academic achievement in evolution concepts among NCE biology students' and found out that analogy teaching strategy significantly improve student's performance and retention. Okobia & Oguumogu (2012) studied the activities of senior secondary school towards the teaching profession and found out that the senior secondary school students' exhibited positive attitude towards the teaching profession and that sex had no influence on students' attitude. Luka, Ezenwa & Wushishi (2012) analyzed the progression in secondary school chemistry students' understanding of the concept "Matter" and found out that secondary school chemistry students showed progression in understanding the concept matter. Yusuf (2012) found out that there is need for improved teacher education in Nigeria through Information Communication Technology (ICT). Ajasa & Aderigbe (2012) studied teacher and students' perception on the inclusion of social studies curriculum into the senior secondary school curriculum and found out that there were significant differences in the students', teacher's perception of social studies with its introduction into the senior secondary school curriculum. Sani (2012) studied the effects of digital video instruction in senior secondary school's achievement in chemistry and found out that it significantly improved the students' achievement in chemistry. Ogusanya & Idris (2012) studied skills improvement needs of auto-electrical technicians for effective repairs of automobiles and found out that auto-technicians were deficient in skills required to carry out repairs on automobiles. Koroka & Ezenwa (2012) studied the influence of gender on the use of analogy in biology students' understanding of the concept, osmosis, among senior secondary schools and found out that both males and females taught "osmosis" using analogy strategy performed better and there was no statistical difference between males and females. Ezenwa & Gambari (2012) studied the effects of current innovative instructional methods and technologies

for quality tertiary education and found out that there is need for new technologies and technological applications to meet the multiple challenges of the twenty first century. They also discovered that the introduction of the new technological innovations in teaching and learning have been shown to fruitful, effective and are fast gaining ground. Omiwale (2012) studied the relationship between students' prior knowledge and achievement in physics among senior secondary schools students and found that there was significant relationship between their prior knowledge and achievement in physics. Obiweluozo (2012) studied the health and nutrition in early childhood education: a good beginning and found that health and nutrition were essential good beginning in child hood education. Egbujuo (2012) studied the effects of reciprocal peer tutoring on students' academic achievement in chemical equilibrium and found that students taught using reciprocal peer tutoring had higher post-test mean scores in chemical equilibrium achievement test (CEAT) than those taught with the traditional method of teaching and the study showed gender had no effects in the academic achievement of student. Koroka & Ezenwa (2012) carried out a research on analogy: an instructional tool for identifying difficult topical areas in osmosis among senior secondary schools biology students and the study revealed that analogy was a more effective instructional strategy than the traditional lecture teaching method in identifying student's misconceptions on the concept of osmosis in biology. Ayodele (2012) studied the appropriateness of science teachers association of Nigeria (STAN) text books used in teaching basic science and technology and found that they were not appropriate for the target readers. Orji (2012) studied the correlation between the students' attitudes and achievement in chemistry with teacher class room management behavior and found that teacher class room management behavior (TCMB) had no significant correlation with attitudes and achievement. However the TCMB boosted interest, students' involvement and varying instructions were found

to have a strong, positive and significant correlation achievement in chemistry. Kazeem & Gazali (2012) assessed the effects of automobile emission on health of drivers and commuters and discovered that some of the health effects include running nose, sneezing, headaches, dizziness, fatigues, skin cancer, chest problems and eye irritations among the respondents. Salako & Muhammad (2012) studied the impact of computer as a resource in the learning process in academic achievement of student's and found there was positive impact of computer as a resource in the learning process on student's academic performance. Gimba & Agwagah (2012) studied the importance of mathematics to science and technology and found that mathematics is very important to physics, chemistry, biology, agricultural science, engineering, medicine, geology etc. Ofili & Amaka (2012) studied the effects of video compact disc instructional package on academic performance of senior secondary school's biology students and found that there was a significant difference between the academic achievements of students taught with the package and those taught with the traditional lecture method. Orosanya, Ahmed & Oputa, (2012) studied the impact of multimedia package for teaching introductory technology and found that the package used is a better approach to embark upon by introductory technology teachers for meaningful teaching than traditional lecture method. Orji (2012) studied the effects of the relationship between student's task engagement and learning outcome in chemistry and found no significant improvement in attitudes towards chemistry task engagement. Dantani (2012) studied students' perception of the cause and penalties of examination malpractices and found that examination malpractices are very common and penalties very light. Obineluozo, (2012) studied ways of enhancing listening in children for effective teaching and learning in primary schools and found that listening is essentially important for effective teaching and learning for children in primary schools. Shittu, Olawale; Yisa & Baba, (2012) studied the challenges of missing results

of e-examinations and found that there is a correlation between the responses of selected candidates and the researcher's hypothesis. Basharu & Hassan (2012) investigated the strategies towards improving informal apprenticeship training program in wood trades and found that training program is not backed-up with well integrated knowledge of theoretical knowledge about the field concerned, lack of adequate training in facility and non accreditation of the program in order to sustain standards. Tayo & Adedapo (2012) studied job involvement and organizational commitments as determinants of job performance and found that job involvement and age were correlated with job performance. Falode, & Onasanya (2012) studied the impact of instructional video package on improving the parboiling and milling practices of locally processed rice and found parboiling, milling and cleanliness quality of rice after watching the video package were improved respectively. Iwendi, & Oyedun (2012) studied the correlation analysis of teacher's characteristics and instructional practices for quality teaching and learning of physics and found most teacher characteristics and practices and other variables considered had positive relationship and impacts on teaching and learning of physics. Gambari, Gbodi & Olumba, (2012) studied the effects of audio and video compact discs instructional packages on students' performance in senior secondary school's phonetics and found that students taught using video compact disc instructional packages (VCDIP) and those taught with audio compact disc instructional packages (ACDIP) performed better than those taught phonetics with conventional lecture method, however those taught with VCDIP performed better than those taught with ACDIP.

2.3 Theoretical Framework

The theoretical base for this study is anchored on Mayer's cognitive load theory. Within the trends of CAI, there has been an increased focus on the effectiveness and efficiency of instructional design strategies in education and training. Some of the most important advances come from the field of cognitive science, which deals with the mental processes of memory and learning.

2.3.1. Mayer's Cognitive Load Theory

Cognitive load theory is an instructional model fashioned from the field of cognitive science research. It describes learning in terms of an information processing system made up of long term memory, which stores knowledge and skills on a more or less permanent basis, and working memory, which performs the intellectual tasks associated with learning (Cohen & Hill, 2000). Information may only be stored in long-term memory after first being dealt with by working memory (Mayer, 2001).

Working memory is limited to both capacity and duration and these limitations will, under some conditions, hinder learning, (Mayer, Heiser & Lonn, 2001). The fundamental principle of load theory is that the quality of instructional design will be greater if attention is paid to the role and limitation of working memory. The total amount of mental activity imposed on working memory in an instance of time is known as cognitive load, which has been found to have three distinct parts (Mayer & Moreno, 2003).

- Intrinsic load includes the inherent complexity of the subject matter and reflects the level of difficulty of the material to be learnt. For example , the mental calculation of 2 plus 2 has lower intrinsic load than solving an advanced algebraic equation, due to a higher

number elements that must be handled simultaneously (element interactivity) in working memory. Here mitosis in biology has this inherent complexity of the subject matter and reflects the level of difficulty of the subject to be learnt.

- Extraneous load is the load imposed by the element of instructional design itself. For example, an audiovisual presentation will usually have lower extraneous load than a visual-only format, since the audio modality is also being used to convey information to the learner. This is the main thrust of adopting the CAI package on mitosis used for this study. Since the package contain an animated concretized abstract concepts that might assist learners to have lower extraneous load.
- Germane load relates to the effect involved in processing and automating new information. Automation helps overcome working memory limitations and decreases cognitive load. For example, knowledge and skills that are used frequently, such as reading, may be accessed automatically without high levels of conscious efforts even though the associated task may be complex. While intrinsic load is integral to the subject matter and therefore largely unchangeable, the instructional designer can manipulate extraneous load to increase learning efficiency and effectiveness (Mayer & Moreno, 2003). Cognitive load theory highlights several practices that can be applied to training and performance improvement. The most fundamental of these include methodologies for reducing extraneous cognitive load of instructional materials to ensure optimal learning. These effects include Split-attention, Redundancy and Modality.

2.3.2. Split Attention Effect

A Split-attention effect holds that the use of materials that require learners to split attention between two sources of information causes a higher cognitive load on working memory and

therefore impedes the learning process (Meyer & Moreno 2003). Because distinct items must be considered separately, the learner is forced to integrate them mentally, a process that is cognitively demanding and usurps mental resources that could otherwise be used or allocated to the learning process (see fig 3)

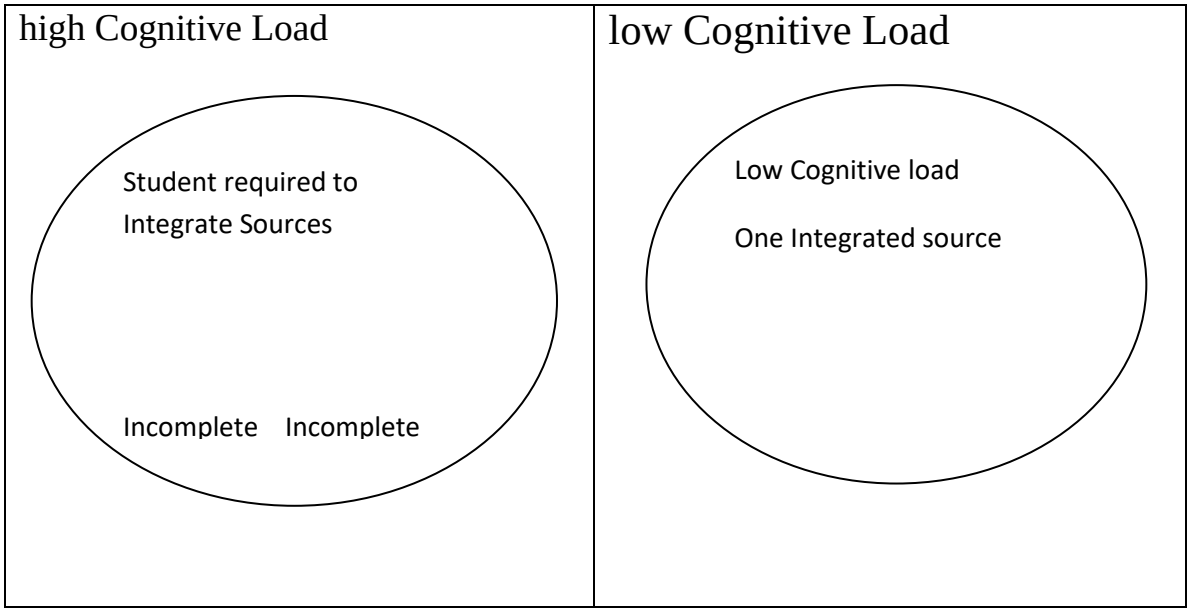


Figure 2.1 Split-attention effects

Multiple sources of information will especially induce a split-attention effect if two or more sources must be considered simultaneously. For example, this is likely to occur in the cross-referencing of documents or even cross referencing within a single document. However, this effect can be diminished by more closely integrating textual piece, or text and diagrams, to eliminate the unnecessary load factor. For example, the placement of text adjacent to an illustration produces less cognitive load for the learner, since less efforts is involved in the

integration of pictures and text when they are placed physically close to each other on the page or screen (Mayer & Moreno, 2003). It is in view of the split-half that the CAI package is designed such that the mitosis animation is synchronized with audio and text in quick succession so that the learners can benefit maximally.

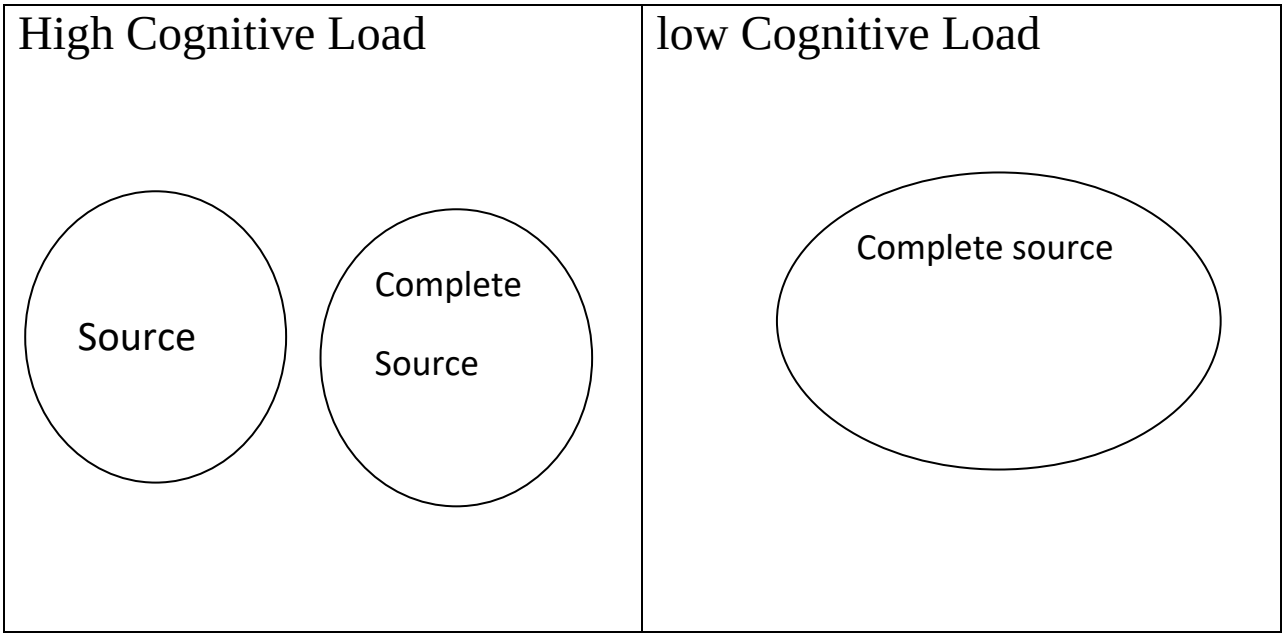


Figure 2.2 Redundancy Effects

2.3.3 Modality Effect

Several studies have concluded that learning is more efficient when multiple sensory pathways are used to present information (Ayers, Sweller, Mayer, Hegarty; Mayer, Campbell, Low & Sweller, 2005). According to cognitive theory, the addition of audio narration to a visual presentation enhances understanding and related problem solving. For example, it is more

effective to use spoken words (audio) to describe a graphic or visual component than to display a graphic with same words in written form. The limited capacity of working memory is maximized by coordinated inputs into the visual and auditory subsystem rather than just the visual subsystem, as is the case when text alone is used to describe visuals see fig below:

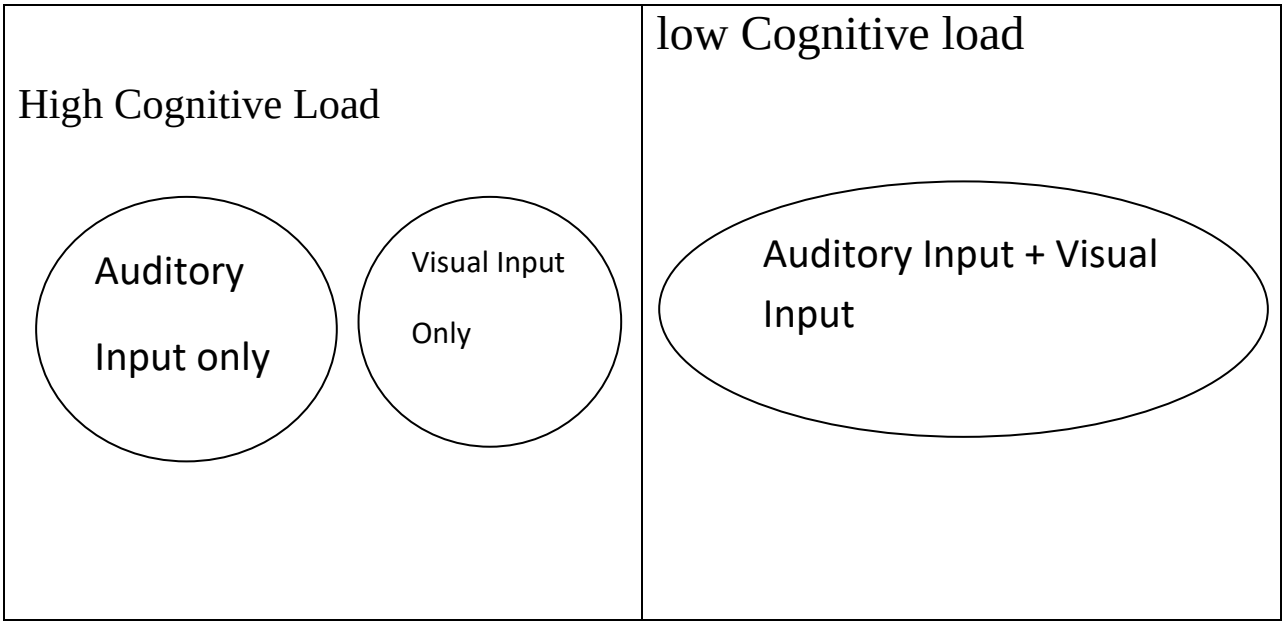


Figure 2.3 Modality Effects

2.3.4. Application of Mayer's Theory

Mayer's theories are best applied in the area of instructional design of cognitively complex or technically challenging material. His concentration is on the reasons that people have difficulty in learning materials of this nature. Cognitive load has many implications in the design of learning materials which must, if they are to be effective, keep cognitive load of learners at a

minimum during the learning process. While in the past the theory has been applied to technical areas, it is now being applied to more language-based discursive areas.

2.3.5. Example of Mayer's Theory

In combining an illustration of how blood flows through the heart with text and labels, the separation of the text from the forces the learner to look back and forth between the specified parts of the illustration and the text. If the diagram is self explanatory, research data indicates that processing the text unnecessarily increases working memory load. If the information could be replaced with numbered arrows in the labeled instruction, the learner could concentrate better on learning the content from the illustration alone. Alternatively, if the text is essentially to intelligibility, placing it on the diagram rather than separated will reduce cognitive load associated with searching for relation between the text and the diagram (Sweller 1999).

Principles of Mayer's Theory

Specific recommendations relative to the design of instructional material includes:

- Change problem-solving methods to avoid means-end approaches that impose a heavy working memory load, by using goal-free problems or worked examples.
- Eliminates the working memory load associated with unnecessarily processing repetitive information by reducing redundancy.
- Eliminates the working memory load associated with having to mentally integrate several sources of information by physically integrating those sources of information.
- Increase working memory capacity by using auditory as well as visual information under conditions where both sources of information are essential to understanding.

It is against this background that the present study is anchored on this theory, since computer assisted instruction package (CAI) consists of both audio and visual sections in the package that

supports the mental theory views. All information presented has implications for teaching. The extraneous and germane load indicates that the teacher should make his teaching interesting to his students through the use of appropriate strategy and methodology. Teaching should be made meaningful, concrete, interesting, acceptable, to motivate the students. The teacher should also endeavor to present his or her lesson in a way that students can remember easily so as to reduce their mental load as much as possible to increase their rate of understanding and retention or recall.

The process of acquisition of knowledge through teaching and learning starts from the day human being comes into existence after conception in the womb. As we grow so also the knowledge grows bigger and bigger with varied dimensions, the process of teaching and learning becomes formal and systematic. Need for methods and strategies to enhance the quality of learning originated. Over the centuries, educators have been concerned with the issue of increasing the efficiency of learning experience. The theorists proposed innovative methods and techniques to enrich teaching and learning process. Researchers conducted researches to examine the effectiveness of various modes of instruction. The present study is a continuation of this practice. The main purpose of the present study was to develop a computer-assisted–instruction program ”CAI” and ascertain its effectiveness in terms of academic achievement scores, of students and learning. The review of the related Literature starts with a brief account of predominant learning theories which lays the foundation of computer assisted instruction “CAI” followed by the historic review of CAI in schools. The review continues to explore meaning, classifications, and characteristics, advantages and disadvantage of CAI. There after the review focuses on research related to the use and effectiveness of CAI.

2.4 EMPIRICAL STUDIES

2.4.1 Computer Assisted Instruction Strategy and Academic Achievement and Retention.

There has not been any major research carried out in this area of teaching mitosis in biology in Niger state using CAI packaged with animation, synchronized with audio since its introduction. However, there are some related works. Yusuf & Afolabi (2010) investigated the effects of computer assisted instruction (CAI) on secondary school students' performance in Biology. The sample of the study comprised of 120 students in senior secondary one (SSSI) from three private secondary school in Oyo State, Nigeria. The study adopted a quasi-experimental research design involving a 3 by 2 factorial design. The students' pre-test and posttest scores were subjected to analysis of covariance (ANCOVA). The findings of the study showed that the performance of students exposed to CAI either individually or cooperatively were better than their counter parts exposed to conventional lecture methods (CLM). However, no significant difference existed in the performance of male and female students exposed to CAI in either individual or cooperative settings.

Daramola, Onasanya & Asuquo (2006) examined the effectiveness of Computer Assisted Instruction in teaching Introductory Technology. A quasi-experimental design was used for the study. Reviews of participants' identical mid-term and final exam scores demonstrated that participants in Lecture-plus-CAI section obtained higher average scores on mid-term and end of final exams than participants in the Lecture only section and these higher averages were likely as a result of the use of better performance on concepts and practices that were taught in both regular Lecture and CAI course. In addition when the topics of Introductory Technology course moved from descriptive statistics to inferential statistics, the learning gap between Lecture only and Lecture-plus-CAI increased. Findings suggest participants learning capacity of the

introductory Technology could be successfully when CAI was used as a supplement to regular lecture in teaching introductory statistics course. This review is similar to to the present study in the design of the study and the independent variable used.

Adebayo (2008) investigated the effect of combining lecture method with digital video and computer assisted instructional packages on students' achievement in mathematics. Eighty (80) SS II students were randomly selected. The researcher adopted the pre-test-posttest experimental control group design. Four schools were randomly selected. Twenty students were selected from each of the four schools. Two experimental groups and a control were composed. The experimental group II was exposed to video instruction. The result of the data analysis revealed the experimental and control group with the experimental group performing better than the control group.

Thomas & Tinu (2008) studied the effects of two programmed instructional strategies on science students on a computer assisted and videotaped mediated instructional analysis showed that the experimental group exposed to video instruction performed significantly better than the control group who were exposed to conventional lecture method. The present study is similar to this reviewed literature in the use of strategy of computer assisted instruction.

Adeosun & Ayodele (2008) examined the relative effects of demonstration and video tape mediated instructional strategies on Nigerian Secondary School students' achievement and retention in Yoruba language. Quasi-experimental pre-test, posttest control group design was used. The sample consisted of one hundred and thirty five (135) junior secondary school class two (JSSII) were used for this study. The study had two experimental groups and a control group with the experimental group exposed to video instruction. Pre-test, posttest and retention were used to collect data. The data collected were analyzed using ANOVA, ANCOVA and t-test. The

findings showed that the experimental group exposed to video instruction performed significantly better than the experimental group exposed to demonstration alone and better than the control group. The findings also showed the same pattern of effectiveness on retention. The present study is similar to this reviewed literature in that the researcher adopted the pre-test-posttest control group design and the data was analyzed using the ANCOVA.

Ford & Biola (1994) performed two separate studies on the use of CAI programs in Bucks county community college in Newton, PA. The first in 1994 was a semester long study on the effects of the using of a CAI supplemental to a classroom instruction in basic and intermediate Algebra. The students had to have at least 80% mastery of one module before moving to the next. If after three attempts they did not make the 80% mastery, the program locks them out and they have to meet the instructor for tutoring before they can be re-installed. In basic Algebra, there was a significant difference ($p < 0.05$) between the experimental and control groups. In the case of intermediate algebra, there was not a significant difference between the groups; in fact the mean for the control group was slightly higher than the mean of the experimental group. The researcher remarked that the pre-test scores in the inter-mediate Algebra were not homogenous and that there were fewer modules for the intermediate than for basic Algebra. They also noted that the students had different Professors with different midterm test and grading policies or systems and therefore, different withdrawal rates.

Ford & Klicka (1998) investigated a four semester analysis of the difference in the achievement of students enrolled in basic Algebra and fundamentals of mathematics between traditional instruction and CAI without a lecture component and CAI with lecture component. The participant in the CAI classes did not take tests until they had an 85% mastery of the material. If they did not complete enough chapters to receive credit for the class, they could enroll in the

class the next semester and start where they were left off by the students in the fundamental of mathematics, there was not a significant difference in the percentage of student who passed their class, passed the final exam, or that passed their next mathematics class between the traditional group and the two CAI sections in the percentage of students who passed the final with the CAI sections both being higher.

There was a significant difference between the traditional and the two CAI sections in the percentages of the students who passed the class, but the traditional group had the highest percentage of students passing. There was not a significant difference between the traditional group and the CAI/non lecture with respect to the percentage of students who passed their next Mathematics class. The number from the CAI/lecture section who passed their next class was not available. Technological advancement has been in the spotlight for educational research for over 25 years. Qualitative research has shown us that without sufficient administrative support and training, technology will not be used at full capacity in the classroom. The quantitative research in this field has revealed a variety of levels of effectiveness at all grade levels (Ford & Klicka 1998).

Gamze (2010) studied the effects of problem-based learning on pre-service teachers, achievement, approaches and attitudes. The purpose of this study was to evaluate the effects of Problem-Based-Learning method on students, achievement in approaches and attitudes towards an introductory physics course. With the control group, a quasi-experimental pretest-posttest design was used. A total of 25 fresh students majoring in mathematics teaching in a five year pre-service teacher education program in Turkey participated. There were one control group and one experimental group namely, the PBL group. The PBL group (n=12), who received physics instruction in line with traditional teaching methods. Data were collected via the pre and post

administration of the Magnetism test (MT), the Approaches to Learning Scale (ALS), and the Scale of Attitude towards Physics (SAP),. The results indicated that the problem-based learning method not only encouraged the students' deep approach to learning, but also improved interest (a component of attitude) towards the physics course. The results also signaled that PBL-based physics instruction impacted the students' achievement in physics positively. The study ends with some implications for the instruction of physics.

2.5.1 Influence of Gender on students Academic Achievement and Retention in Biology.

Gender influence on biology achievement is a controversial matter. Studies conducted in other subject areas have corroborated above statement as follows. Gambari (2010) showed that the most comprehensive reviews of research in the area of gender differences have shown very few true differences between physics and quantitative abilities between men and women. Olson (2002) also noted that research has shown only two gender-differences in specific sub-areas of special and quantitative abilities, three-dimensional mental rotation (favouring men) and mathematical problem solving (favouring women). Other researches show a decline in the difference between gender in the past few decades on standardized test, suggesting that the more exposure women get to mathematics and science class, the better their scores. They thus, believed that achievement alone cannot be the reason for career choices in women. Thus, popoola (2008) documented that the under representation of women in mathematical, scientific (Biology) and technical fields is a national concern in the United States of America. Citing the National Science Foundation (1992), they said that women make up 45% of the work force in the USA but only 16% are in the Science and Engineering profession. The US department of labour

predicted that nearly 80% to 90% workforce will be women by the year 2000. They remarked that the US workforce is traditionally science and technology oriented but women and minorities have traditionally not been attracted to these areas.

Ingear (2008) noted that from research suggestions, girls and women are systematically discouraged from course of study in higher-level mathematics and science biology inclusive. Supporting this, a report from the office of Technology Assessment (1985) described a pipeline in the Natural Sciences and Engineering in which the number of women in the pipeline decreases rapidly more than the number of men. According to the report, given an initial cohort of 2000 male and 2000 female students at the ninth grade level, 280 men and 220 women have physics background needed to pursue a technical career. Upon entering college, 140 men and 44 women chose scientific careers, 44 men and 20 women eventually earn a Bachelor of Science degree in a science related fields. Continuing, the report said that out of the original 400 students, only 5 men and 1 woman would earn a PhD in a science related field (Widnall, 1988).

Retraining women in biology, physics, mathematics, science and technology is a problem between early elementary school and high school. During this period, many girls lose interest in physics and mathematics and also lose confidence in their ability to succeed in these areas. Though girls start elementary school even with boys in their interest and ability in physics, mathematics and biology, by grade level 12, girls find themselves behind (Sadker &Sadker, 1994). To confirm this, the researcher said girls score lower than boys in standardized test such as GPAT, PCAT, LSAT and GBAT. On SAT specifically, they said that girls scored 56 to 60 points lower than boys, but on ACT, girls scored one point higher than boys in English, but lower in every other areas. Girls also scored lower than boys on the GIRE. On the quantitative aspect, girls scored 80 points lower than boys. Ingear (2008) advised that there is the need to

work to reduce this gap and encourage all students to persevere and succeed in biology, mathematics and physics in order to retain more women in physics.

Reviewing research suggestions on attracting more women to biology, mathematics and physics, science and technology, Ingear recommended that changes should be made in the ways these subjects are taught. Many researchers such as Damarin (1990: 1995), Harding (19860, &Keller (1985) believed that mathematics, science (biology) and technology are traditionally taught and that this traditional teaching and practice may reflect a masculine approach to the world that tends to marginalize women. Teachers and Teacher educators are advised to examine the contents and pedagogy of biology and science courses and work to make those courses more female friendly (Rosser, 1990; 1993). Recent studies aim at examining teaching approaches in biology that can offer equal benefit to both male and female students should be encouraged.

Magone (19970 carried out a study on gender difference in response to a mathematical performance. Assessment instruments consisting of extended constructed response tasks for an ethnically diverse of middle school students who enrolled in innovative instructional programme in which mathematics was taught with emphasis on problem solving, reasoning conceptual understanding and communicating. Mathematically, gender difference was examined using a performance assessment instrument consisting of 35 extended constructed response tasks. From the study, the result suggested that males and females seem to have the same response style to the assessment. However females attempted more tasks and displayed the work and justification more completely than males. Little gender difference existed in rubric scores of 35 tasks, one favoured male students and other one favoured females.

Voogt (1987) examined performance and engagement in computer literacy of boys and girls (N=873). Performance and engagement in a computer literacy are established with CAST.

Computer Alfabetisme Schalen Twente, a Dutch version of the Minnesota Computer Literacy Awareness Assessment. The results of the study show that girls perform lower and are more engaged in computer literacy than boys. Research on sex difference in mathematics and science education shows that three factors are important for the design of action programs for girls, viz, the expectations and behavior of significant others, the `perception of the usefulness of the subject for a future career and a positive attitude towards the subject. This study shows that these factors seem to be relevant to for computer literacy too. It has been found that a positive attitude towards mathematics biology and physics is positively related to a positive attitude towards computer literacy. An examination of the relation between performance in computer literacy and attitude towards mathematics and physics shows no difference in performance between boys and girls with negative attitude towards mathematics and physics. For boys and girls with positive attitude towards mathematics and physics, however, a difference in performance in computer literacy has been found in favour of boys.

Ifamuyiwa (2004), examined the relationship between students' performance in JSS mathematics and SSS mathematics, further-mathematics and physics. 288 senior secondary school students comprising 164 boys and 124 girls were selected from public secondary schools from Eti-Osa Local Government Area of Lagos State. Analysis of the collected data for the study showed that a significant correlation exists between students, performance in JSS Mathematics and their performance in SS Mathematics, further mathematics and physics respectively. A positive relationship was found between JSS Mathematics and SS physics (r=0.59), further-mathematics (r=0.52), and mathematics (r=0.50) respectively. The study further found that while there is no significant gender difference in students' performance in JSS Mathematics, their performance in SS-mathematics is significant in favour of the boys.

Iwendi (2007) investigated the influence of gender and age on the mathematics achievement of secondary school students in Minna Metropolis, Niger State. 195 students in intact classes were selected stratified random sampling technique from purposively selected schools were used.50 items Mathematics Achievement Test (MAT) was administered to the students. Means, standard deviation and t-test statistical analysis were used to analyze the data. They findings showed that:

- Younger male students performed better than younger female students
- The older male students performed better than the older female students and
- No significant difference in the performance of younger and older students (overall).

Orabi (2007) examined the gender differences in students' performance and attitudes toward their education and themselves in an introductory engineering course. Students' academic performance and attitude of 52 males and 49 female students enrolled in an introductory engineering course taught by the same instructor was carried out in four semesters. The result showed that there was no significant difference between mean scores in the academic performance of genders in the course, and this result also indicated that academic performance in the course was not affected by several factors such as student ability, motivation, the quality of secondary education obtained. The female students had a slightly higher overall course grade average than males and outperformed the male students on all class assignments except the final design project. The attitude survey showed that men reported higher gains than women on technical skill; female students were able to the material as effectively as the male students. This work is similar to study since gender is considered and the performances of the students.

Anagbogu and Ezeliora (2007) conducted a research to examine sex differences in scientific performance of boys and girls in some selected secondary schools in Awka educational zone of Anambra State using the study of Anagbogu (1988). The research instrument was assigned to

experimental and control groups respectively. The research instrument was a combination of three level tests namely, cognitive skills test, affective skills test and psychomotor skills test. The three levels were predominantly visual materials related to school science practical materials capable of eliciting students' attention. In order to test the hypotheses, the scores of boys and girls were subjected to Analysis of Covariance (ANCOVA) on the pre-test and posttest scores. The study showed that girls performed better than boys using strategies that were human oriented.

Further studies on gender difference by Eccles, Lord, Rosser, Barber & Jozefowiez (1997) found out that gender differences in enrolment in advanced physics courses in higher schools are meditated by gender differences in expectations for success in mathematics and physics and perceived value of competence in physics (biology). On the contrary, Jacobs, Lanaz, Ozgood, Eccles & Wegfied (2002) also showed no significant difference in the concepts using videotaped instruction. 40 students from two schools in Ilorin were used for the study. Haluk (2008) investigated the effects of CAI on conceptual understanding of chemical bonding and attitude towards chemistry. The study employed a quasi-experimental design involving the 11 grade students; 25 in an experimental and 25 in a control group. The Chemical Bonding Achievement Test (CBAT) consisting of 15 items were the principal data collection tools used. The CBAT and CAS instruments were administered in the form of a pre-test and posttest. Analysis of scores of the two groups in the posttest was compared and a statistical significant difference was found between groups in favour of experimental group. The result of this study suggests that teaching-learning of topics in chemistry related to chemical bonding can be improved by the use of computer-assisted teaching materials.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter involves research design, research population, sample and sampling techniques, type of instruments and development of the instruments: computer aided instruction (CAI) and teacher made biology achievement test (TMBAT), validation of instrument, reliability of test instrument and methods of data collection plus data analysis.

3.2 Research Design

Quasi-experimental design was adopted for this study, in which the non-equivalent control group design was specifically used. This design was used because there was no randomization of subjects into groups. Both the experimental and control did not have pre-experimental sampling equivalence. The quasi experimental design was chosen because it controls the internal threats of the initial group equivalence and researcher's selection bias, since there was no randomization of the subjects into groups.

The dependent variable is the achievement and retention of the students while the independent variable is the Computer-Assisted Instruction in mitosis in biology. The moderating variable is the gender which is measured at two levels (males & females). The specific design is symbolically represented in figure below.

Table 3.1 Research Design Illustration

Grouping	Pretest	Research condition	Posttest	Retention test
Group 1 Experimental	O1	Treatment (X) CAI	O2	Q3
Group 2 Control	O1	Conventional Lecture method (CLM)	O2	Q3

Source: Nwachukwu et al 2007

Figure 3.1 Research Design Layouts.

Key: 01-04 represents observations in all the groups, that is, during pre-test, posttest and retention test since the same mitosis biology achievement test (MBAT) was used at different times in the cause of the study.

Key: 01 and 01 = Pre-Test, 02 and 02 = Posttest 03 and 03 = Retention Test, X = Treatment.

3.3 Population of the Study.

The population of the study comprised senior secondary school two (SSII) students in Minna Metropolis of Niger State. The total population of this study was 3,640 (source: Zonal Directorate of Education Minna, 2013). The study was restricted to only SS II students of public Government Secondary Schools and co-educational in nature excluding the private and single sex schools in the metropolis.

3.4 Sample and Sampling Techniques

The sample population thus drawn comprised of 58 students in B arm of school A (Experimental) and 62 students from E arms of school B (Control) totaling (120) students.

The research design adopted for this study does not allow for randomization of samples. The sample size used for this study was captured from the number of students in each intact class used for the study. Two schools were randomly selected and designated as experimental and control schools respectively. A simple random sampling technique was used in the selection of the classes to be used for the study in each of the sampled schools.

3.5 Instrumentation

The instruments for data collection are the Mitosis Biology Achievement Test (MBAT) and Mitosis Biology Retention Test (MBRT). The instrument has 20 multiple choice test items developed by the researcher (see appendix). Each of the multiple-choice instruments has five options (A-E) as possible answers to each question. For each option only one of the five options is the correct answer (See appendix). The items were developed to reflect the concepts treated and in reference to the objectives of the lesson on which instrument was based. The students were expected to respond to the test instruments in two sections. The first part (section A) elicited information on the students' class, school, and sex while the section B part elicited information on the achievement and retention of the students in the contents area. The questions were reshuffled in a different random order in the posttest and retention test to reduce retest effects. The 30 questions were shared into two and question 1-15 replaces 16-30 that is the first fifteen to be the last fifteen while the last fifteen becomes the fifteen in the posttest. For retention test the question of the reshuffled posttest were shared into three where questions 1-10 replaces

question 11-20 and questions11-20 replaces 21-30 and finally questions 20-30 replaces 1-10. The interval between the administration of pre-test and posttest was six (4) weeks. While that of posttest and retention was two (2) weeks. Students were required to answer all the questions by ticking the correct option out of the four options (A-D) provided the correct answer was scored one and a wrong response was scored zero. The scores were then converted to hundred percent (100%) before using it for analysis.

3.5.1 Development of the Learning Package.

Mitosis Biology Achievement test CAI package was developed by the researcher and a programmer (Appendix A). The reason that propelled the researcher to develop a CAI package is based on the fact that commercially produced CAI packages are not common in Nigeria. When available they do not bear direct relevance to the topic or objectives of the main content of the lesson. Moreover, the use of imported CAI package in biology in Nigeria may be culturally relevant, as such; the development of a CAI package in mitosis biology for the use by the researcher became inevitable.

The CAI package consists of the topic mitosis in biology which was subdivided into five units. The package was written in “Macromedia Flash” with “Swish” and “Microsoft front page” as other software for programming. The main menu consists of “Introductory page”, “Main Contents” of the package and finally the exit button (See Appendix A). It adopted the tutorial modes of CAI. It is an individualized package in which the individuals who react to the computer are to make some entries. The computer records the achievement and progress of the students separately.

The CAI package in mitosis in biology was burnt on a CD ROM and presented to the client computer with input device on the computers and through which the learner responds to the computer prompts. The computer presents the learner with information and display animations to the learner on each sub units after which the learner attempts the multiple choice objective questions. Each of the sub unit was presented by the computer through interaction mode, that is, exposure to information, facts and practice on the topic and immediate response/feedback to the application question. The student could only proceed further if he gets the right answer or he is directed back to the sub unit to re-study the sub unit, try again. This tries to eliminate guessing by engaging the learner. The learner can progress at his pace on each of the sub units.

The production of the package was done with the help of a team of experts and professionals in biology, system programmers, and the instructional designer who is the researcher.

3.5.2 Validity of the Instrument

The validity of the developed CAI package and the 30-item objective mitosis in biology achievement test instrument were ascertained by four experts. These include: one expert from Educational Technology who also comes from the Department of Science and Science Education, Federal University of Technology Minna, one expert from Department of biology Federal University of Technology Minna, one expert from biology department of Ibrahim Badamasi Babangida University Lapai and lastly one expert from Educational Test and Measurement Department of Niger State Ministry of Education Minna. The experts were asked to critically examine the content validity of all the items in the test instrument with reference to the appropriateness of the item to the content, relevance of the test item to the content and the extent to which the contents cover the topics or units they are meant to cover and measure the

objectives. The test items were corrected and modified on the basis of suggestions and recommendations by the experts.

3.5.3 Reliability of Research Instrument.

A trial or pilot test was conducted to ascertain the reliability of the objective test items. The pilot testing was carried out using 20 students who were randomly selected from Government Day Secondary School Tunga, Minna using random sampling technique (Hat and Draw). The result of the test was analyzed using the Kuder Richardson formula (K-R 21) for MBAT. A reliability coefficient of 0.89 was obtained which shows that the test instrument was reliable.

3.5.4 Experimental Procedure

The researcher visited the schools before carrying out the study to seek official permission from the principals of the three schools selected for the study. A letter of introduction by the head of department was issued to the researcher for the three principals seeking permission to use their schools for the study.

There were series of meeting between the researcher, head of biology departments and the biology teachers to fashion out how to carry out the study without the students realizing that a study is about to be carried out with them. The biology teachers were computer literate so they were easily taught how to install the package and use it without difficulty. The School Net coordinator had been adequately briefed and he made sure that adequate computers were available and working excellently to cover the number of selected students for the sturdy. The experimentation in the study commenced. Pre-test was administered to the two groups using MBAT before treatment to determine the equivalence of the subjects assigned to experimental and control groups. Instruction then commenced in the groups where experimental group was

taught using the CAI package in mitosis in biology. This lasted for 4 weeks. Thereafter, MBAT was administered to the two groups as posttest. Finally, after 2 weeks interval MBAT was re-administered to test the student's level of retention. The scores of the experimental and control groups on pre-test, posttest and delayed posttest were computed and were used as data for analysis.

3.6 Method of Data Collection

Mitosis Biology Achievement Test (MBAT) was administered to the students before the commencement of the experiment as pre-test. The score obtained by the students served as pre-test scores of the study. Immediately after the pre-test, treatment was administered for the period of four weeks. After the treatment, posttest was administered to measure the achievement of each student in each group. The posttest was administered on the last day of the experiment. The retention test was administered after two weeks. The test was conducted at the same time and the scripts were collected immediately for marking. The pre-test scores, posttest scores and retention scores were subjected to data analysis. For scoring purpose the total scores were converted to percentage scores. It is this percentage scores that was used for data analysis.

3.7 Method of Data Analysis

Data collected using the instruments were analyzed with respect to the research questions posed and the hypotheses formulated for the study. Means and Standard Deviations were used in

answering the research question, while Analysis of Covariance (ANCOVA) was used to test the hypotheses formulated for the study at 0.05 alpha levels.

CHAPTER FOUR

RESULTS

4.1 Introduction

This study investigated the effects of CAI package in mitosis in biology on achievement and retention of senior secondary two (SS II) students. In this chapter, data for the study were analyzed and presented based on the research question and hypotheses that guided the study. The four hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 alpha levels.

4.2 Presentation of Results

4.2.1 Pretest results

Before the administration of the treatment, a pretest (PREBAT) was administered to the two groups of students (Experimental and Control) to determine the entry knowledge of the students with regards to the content to be learnt (Mitosis).

Table 4.1t-test analysis of Pretest Scores of Experimental and Control Groups.

Variable	**N**	**df**	$\bar{x}$	**SD**
Experimental Group	58		35.250	6.242
		118		
Control Group	62		36.166	7.035

Table 4.1 revealed that the mean score of the Experimental and Control Groups before the treatment did not vary significantly. The Experimental Group has a mean score of 35.250 while the control group has a mean score of 36.166 and marginal mean score of 1.084 which is not significant at 0.05 alpha level of significance. Hence the two groups of students were thus considered suitable for the research study based on the aforementioned marginal difference in the mean scores or PREBAT

4.3 Posttest Results.

4.3.1 Test of Hypotheses

This presents the results collated after the administration of the treatment to the group with (CAI) strategy and the control group with Conventional Lecture Method (CLM).

Ho_1: There is no significant difference between the mean achievement scores of the students taught mitosis with Computer Aided Instruction (CAI) package and those taught with Conventional Lecture Method (CLM)

Table 4.2. Analysis of Covariance of Posttest Mean Achievement Scores of Experimental and Control Groups.

Variable	N	df	$\bar{x}$	SD	t-cal	sign.(2-tailed)
Experimental Group	58		41.166	2.656		
		118			5.373	.000*
Control Group	62		38.233	3.290		

*Significant at $p < 0.05$

Table 4.2 revealed that the experimental group taught the concept of mitosis through the use of computer aided instruction (CAI) package did better than the control group taught through the use of conventional lecture method (CLM). The experimental group has higher mean score of 41.166 on the posttest achievement score compared to 38.233 of the control group. This shows that the experimental group had better understanding of the concept mitosis through CAI than the students in the control group and with a marginal difference of 2.933 which is significant. However the test of hypothesis revealed that the t-value calculated 5.373 is significant at 0.000 less than 0.05 alpha level, df = 188, SD = 2.656 and 3.290 respectively. Hence hypothesis one was rejected and the alternative upheld, that is, there is significant difference between the achievements of students taught mitosis through the use of CAI as against the use of CLM.

Ho_2 There is no significant difference between the mean achievement scores of male and female students taught mitosis with CAI package.

Table 4.3 Analysis of Covariance of Posttest Scores of the Experimental Male and Female Taught Mitosis with CAI.

Variable	**N**	**df**	$\bar{x}$	**SD**	**t cal sign(2 tailed)**	
Experimental males	30		35.583	3.271		
		58			.658	.512 NS
Experimental Females	30		35.833	3.387		

*Not significant at p<0.05

Table 4.3 shows that the mean scores of the male students and female students in the experimental group taught mitosis with CAI package did not differ significantly (35.583 and 35.833). The females in the experimental group had a marginal mean difference in the posttest of 0.250 over that of the males in the same group. The test of the hypotheses two revealed that the t.cal = .658, df = 58, SD = 3.271 and 3.387 is not significant at (p>.512). Therefore hypothesis two not rejected. That is there is no significant difference between the achievement of male and female students taught mitosis via CAI.

Ho_3: There is no significant difference between the mean retention scores of students taught mitosis with CAI package and those taught with CLM.

Table 4.4 Analysis of Covariance of Posttest Delayed Scores of Experimental and Control Group Taught with CAI and CLM Respectively.

Variable	**N**	**df**	$\bar{x}$	**SD**	**t-cal**	**sign(2-tailed)**
Experimental Group	58		38.316	2.432		
		118			0.078	0.012*
Control Group	62		36.966	3.319		

*Significant at p<0.05 level

Table 4.4 indicates that among the two groups, the CAI led instructional group has the highest mean score of 38.316 on retention compared to 36..966 of the control group. This suggests that the CAI led instruction group had better opportunities in retaining what was learnt compared to the CLM group. The t-value calculated of 0.078, SD = 2.432 and 3.319 is significant at 0.12 less

than 0.05 alpha level. Therefore hypothesis three was rejected, that is, there is significant difference between the mean retention scores of students taught mitosis with CAI and those taught by CLM.

Ho_4: There is no significant difference between the mean retention scores of male and female students taught mitosis with CAI package.

Table 4.5 Analysis of Covariance of Posttest Delayed Retention Scores of Male and Female Students in the Experimental Group.

Variable	**N**	**df**	$\bar{x}$	**SD**	**t-cal**	**sign(2-tailed)**
Experimental Males	29		37.783	2.992		
		58			0.520	0.640 NS
Experimental Females	31		37.500	2.977		

*Not significant at alpha p>0.05

Table 4.5 shows that males had only a marginal mean difference of 0.283 in the posttest delayed over those of their female counterparts (37.783 - 37.500 = 0.283). The male students had a mean score of 37.783 and the females 37.500, df = 58, SD = 2.922 and 2.977, t-calculated = 0.520 and 0.604 significance. Hence .604 > 0 .05 alpha level, hypothesis four was therefore not rejected. That is there no significant difference between the retention scores of students according to gender when taught mitosis with CAI.

CHAPTER FIVE

DISCUSSION, SUMMARY, CONCLUSION, IMPLICATIONS AND RECOMENDATIONS

5.1 Introduction

The findings of the study were discussed in this chapter. Conclusions were also made and its implications to education were discussed. Furthermore, recommendations were given based on the implications of the study, limitations of the study outlined, suggestions for further study were made and summary and conclusions of the research presented.

5.2 Discussion of Findings

Tables 4.1 show the mean and standard deviations of the experimental and control groups in the pretest.

The experimental group has a mean score of 35.250 and a standard deviation of 6.242, while the degree of freedom (df) = 118; while the control group has a mean score of 36.166 and standard deviation of 7.035 respectively. Both groups did not differ significantly, with a marginal mean difference of 0.916 which is not significant. Therefore the two groups mean scores show that the experiment and control groups have similar entry knowledge of the subject biology before the treatment, hence the two groups were considered suitable for the research study.

Table 4.2 Indicates the Analysis of Covariance of the Posttest Mean Achievement Scores of the Experimental Group exposed to the Treatment using the CAI Package and those exposed to CLM.

From the table it can be deduced that the experimental group has a mean score of 41.166, SD = 2.856, df = 118 while the control group has a mean score 38.233 and SD = 3.290. This signifies that the experimental group exposed to CAI did better than the control group with a marginal mean difference of 2.933 which is significant. The t-value calculated 5.373 is significant at less than 0.05 alpha level of significance. Therefore hypothesis one was rejected. That is there is significant difference in the mean achievement scores of students taught with CAI than those exposed to the CLM. This result is therefore in agreement with the findings of Bayrakter (2000), Mutz (2000), Campbell (2000), Ezeogo & Awagah (2000), Ozofor (2001), Kurumeh (2004), Iji & Harbor-Peters (2004), Deck, et al (2008), Agommuoh (2010), Sani (2012) among others found out that students exposed to CAI did significantly better than the control group that were exposed to conventional lecture method (CLM) of instruction, showing that CAI enhances learning of concepts in students.

Table 4.3 shows the Analysis of Covariance of the Posttest Scores of the Experimental Males and Female Taught Mitosis with CAI Package.

The table indicates that the experimental males and females taught mitosis with CAI package. The table indicates that the experimental males has a mean score of 35.583, SD -3.271, df = 58 while the experimental females in the same group have a mean score of 35.833 and SD = 3.387 with a marginal mean difference of 0.253 which is not significant. The test of hypothesis reveals

that the t-calculated is .658 and significant 2tailed value 0f .512, df = 58 which is not significant at p.

Table 4.4 shows the Analysis of Covariance of the Posttest-Delayed Scores of the Experimental and Control Groups after a Period of Two Weeks.

The experimental group has a posttest delayed score 0f 38.316 SD = 2.432, df = 118, while the control group has a mean score 36.966, SD = 3.319 and a marginal mean difference of 1.350 which is significant. This shows that the experimental group did better than the control group in the posttest delayed. The t-value calculated 0.078 is significant at 0.012 less than 0.05 alpha levels of significance. Hence hypothesis was rejected, that is, there exists a significant difference in the posttest delayed mean scores of the experimental and control groups in retention of mitosis concept when exposed to CAI package and CLM. The finding from this result is in agreement with the findings of Obodo (1990), Madu (2004), Ezenwa (2005) Nwamuo (2006) Ogbonna (2007), Agomuoh (2010) who found out that after two weeks of posttest, a posttest administered to the same group of students showed that the experimental group did better than control group significantly.

Table 4.5 shows the Analysis of Covariance of the Posttest-Delayed Retention Scores between the Males and Females in the Experimental Group Exposed to CAI Package.

The experimental males have a mean score of 37.783, SD = 2.992 and that of the females 37.500, SD = 2.977 and df = 58, marginal difference of 0.283 which is not significant. The test of hypothesis four reveals that, the t-value calculated is 0.530, not significant at $p > 0.05$ alpha level. Hence hypothesis four was not rejected. That is there is no significant difference between the males and the females in the posttest delayed scores of students exposed to CAI package. The

finding is in agreement with earlier findings of Sadker (1994), Okonkwo (1997), Alio (1997), Praat (1999), Aiyedun (2000), Aguele (2004), Kurumeh (2004), Browning (2008) Ezenwa & Gambari (2012), Ezenwa & Koroka (2012) among others who found out that there was no significant gender influence between the achievement scores of males and females students exposed to the same CAI treatment in the experimental group.

5.3 Summary of the Study

This study compared the effectiveness of CAI package with the CLM in mitosis in biology. This study was carried out in Minna Metropolis. Four research questions guided the study and were answered using mean, and standard deviation while the four research hypothesis were tested using the analysis of covariance (ANCOVA). A sample of 120 students made up of 60 male and 60 females SSII students from Hill Top Model School and Government Day Secondary School Minna were used for the study. Intact classes were used and two groups were randomly assigned as experimental (treated with CAI package) and control (treated with CLM) groups.

The design of this study was quasi-experimental. Macro-media software, Swish and Microsoft front page was used to programmed the CAI package. The instrument used for data collection was the Mitosis Biology Achievement Test (MBAT) developed by the researcher made up of 20 objective questions. The same questions were used for the MBAT retention achievement test. The only difference is that the questions were reshuffled to avoid the effects of posttest on retention test. A single lesson note was prepared for the two groups. The research instrument was validated by experts in biology education department, test and measurement evaluation and educational technology department of the federal University of Technology Minna. It was pilot

or trial tested to estimate the internal consistency and stability. Data were collected for pre-test, posttest, and retention test. The data collected were analyzed using the mean to answer the research questions while analysis of covariance was used to test the hypothesis.

Results showed that students taught with the CAI package in mitosis in biology performed better than those taught using the conventional lecture method CLM. It also showed that students taught with CAI package did or performed better than those taught with conventional lecture methods. The package was found to be gender friendly because there was no significant difference from the performance of males and females in the experimental group.

The results have implications for the teachers, students, educators, parents, computer programmers, software developers, state and Federal Ministries of Educations and other research institutes and researchers. Workshops and seminars should be organized for teachers to educate them on the use of the computer during teaching and learning process. The study recommended among other things that teachers should adopt the CAI package for their teaching approach in most subject areas.

5.4 Major Findings of the Study

The followings were the major findings arising from the study

- The experimental group exposed to CAI package method did significantly better than the control group exposed to CLM of teaching mitosis.
- That the males and females in the experimental group had equal tendency to excel when they exposed to CAI package.

- The experimental group in the posttest-delayed did better than the control group after a period of two weeks of administering posttest to the two.
- There was no significant difference in the retention of mitosis concept by the males and females exposed to CAI method.

5.5 Contributions of the Study to Knowledge

Among the objectives for studying biology in Senior Secondary School is to equip students with reasonable and functional scientific attitudes. Learning from available sources and resources would provide more opportunities to lead the way for their own learning. Some of the contributions would include:

- CAI package would enhance the learning achievement in students if available for instruction at lower grade level.
- Provide more opportunities for students to learn individually and collectively among peers at their own pace.
- Interest and attitudinal changes would be stimulated towards the subject leading to cognitive development.
- More materials/topics would be covered within a given time frame of studies as students learn at their own pace and time.

5.6 Conclusions

The following conclusions are made based on the findings of this study. The result of this study provided empirical evidence that the use of computer assisted instruction enhanced students' achievement and retention in mitosis in biology more than the conventional lecture method.

Male and female students taught mitosis with computer aided instruction perform better than male and female students taught mitosis in biology with the conventional lecture method. There was no significant difference between the mean achievement scores of males and females taught mitosis with the computer assisted instruction. Gender has no significant influence on achievement and retention the use of CAI package in mitosis in biology.

5.7 Recommendations

The following recommendations were made based on the findings of the study

- Since the use of computer aided instruction enhances achievement and retention in mitosis in biology, biology teachers should be encouraged to use it as a strategy to employ in the classroom.
- Computers need to be made more available in government schools all levels so that learners can access it and use it without stress.
- Seminars and Workshops should be organized for teachers, authors and curriculum planners on how to use computer to produce CAI packages as this will go a long way to reduce the cost of purchasing from the market or importing from abroad.

Suggestions for Further Studies:

- Experiments should be conducted to isolate the latent and overt traits that accounts for better performance of the males than the females. The traits when identified should be emphasized for every student who wants to register for biology.
- Longer research study period (say 11-12 weeks) should be conducted on the use of CAI package and its results and findings compared with the present one.
- Individualized computer learning study should be conducted on the same topic to determine the interaction effects of CAI package and gender.

REFERENCES

Abhang, R. Y. (2005) Making introductory quantum physics Understandable and interesting using computer assisted instructional strategy, Classroom-Resonance. *Journal of Science Education* 10, 63-73

Abilu, R. A (2005). Factors Militating against Students with Visual Impediment Participation and Success in Science Education. *Unpublished M.Ed. Thesis. University of Ibadan*

Abimbade, A. (1996a). Computer Assisted Instruction (CAI) and the Teacher. *Nigerian Journal of Computer Literacy* 1 (1), 74 81

Abimbade, A. (1996b). Computer Literacy and the Nigerian School System. *Nigerian Journal of Computer Literacy* 1(1) 1-9.

Abimbade, A. (1998). Information Technology: The Current Strategy for Effective Science and Technology Instructions. *Bichi Journal of Education*. 2(1), 33- 39.

Abimbade, A. (1999). Principles and Practice of Educational Technology. International Publishers.

Abolade, A. O. (2000). Comparative effectiveness of video mediated and traditional classroom instructional methods in secondary school student's achievement in ecology. *Nigeria Association for Educational Media and Technology (NAEMT) 21ST Proceedings. The Millennium Convention, 190-195*

Adamu, A. U. (2001). Computer Assisted Teaching and Learning. In K. Ishaku, C. M. Anikweze, A. Maiyanga and M. Olakun (Eds) Teacher Education in the Information Technology Age. Abuja: NCCE.

Adamu, S. H.and Bello, A. S. (2002). Computer Education in Nigerian Schools: Problems and Prospects. *Nigerian Journal of Computer Literacy* 3(1), 96- 102.

Adebayo, A.O. (2001). The Place of Mathematics in Nigerian Secondary Schools: Course on Effective Teaching of Mathematics. Phase 2 Magodo Lagos: 1-7.

Adebayo, S. I. (2008). Effects of Combining Digital Video Computer Assisted Instructional Package and Lecture Method on Students' Achievement in Mathematics in Minna Metropolis. *Unpublished B.Tech. EducationProjectFederalUniversity of Technology Minna.*

Adeniyi, E.F. (2005).Determinants of help Seeking Behavior.*Journal of Educational Research and Development.* 3(1)

Adeosun, O. V. (2002). Relative Effects of Three Multi- Media Packages on Students Achievement and Retention in Social Studies. Unpublished Ph.D Thesis Ado-Ekiti: University of Ado- Ekiti.

Adeosun, O.V and Ayodele, C.A. (2008).Relative Effects of Demonstration and Video Mediated Instructional Strategies on Secondary School Students Achievement and Retention in Yuruba language .Paskistan. *Journal of Social Sciences, 5(6)634-638.*

Adesoji, F. A. And Fisuyi (2001). Analysis of Problem Solving Difficulties of Students in Volumetric Analysis According to Gender. *Ibadan Journal of Educational Studies,* 1(1), 106- 117.

Adetona, A. A. and Rafiu, A. A. (2006). Application of M. learning to Distant Learning Programmes. A Case Study of Open University System of Nigeria. Book of Proceedings, 2nd SSSE Annual Conference, FUT Minna.

Adewoyin, J. A. (2000). Introduction to Educational Technology. Johns- LaD Publishers Lagos.

Adewoyin, J. A. (2006). Enhancing Rural Women Access to Information and Communication Technology (ICT): A key to Family Economic Empowerment. A Paper Presented at the 7th Annual National Conference of Home Economic Research Association of Nigeria (HERAN); Nsukka 6th – 9th September.

Adeyemi, S.A (2003). Studies of the effect of aptitude instructional leadership styles and learning environment on student's achievement in physics *unpublished Ph.D. thesis, university of lagos, Nigeria.*

Afolabi, E.R. (2004). Mandatory Computer Education in Nigeria Secondary Schools: Prospects and Problems. *Journal of Educational Research and Evaluation.* 3(2), 32-38.

Agomuoh, P. C. (2010). Effect of Prior Knowledge, Exploration, Discussion, Dissatisfaction with Prior Knowledge and Application (PEDDA) the The Learning Circle (TLC) constructivists' instructional models on students' conceptual change and retention in Physics. *Unpublished Ph.D Thesis,* UNN.

Aguele, L. I. (2004). Remediation of process errors committed by senior secondary school students in sequence and series. *An unpublished Ph.D Thesis,*University of Nigeria, Nsukka.

Agwagah, U. N.V. (2004). Sustaining Development in Secondary School Mathematics Through Constructivist Framework: A Model Lessen Plan. *Journal of Mathematical Association of Nigeria* 29(1), 92- 98.

Agwagah, U. N.V. (2005). Teaching Mathematics for Critical Thinking, Essential Skill for Effective Living, ABACUS, Journal of the Mathematical Association of Nigeria 30(1) 38-45.

Ahmadu, H. And Raji, M. A. (2004). The Effects of Computer – Based Teaching Method on Senior Secondary School Students Performance for Sustainable Development in Nigeria. In G. A. Ashituabe and I. A. Kolo (Eds). Education for Sustainable Development in Nigeria. Book of Readings 1(1). 400- 408.

Aiyedun, J. O. (2000). Influence of sex difference of students on their achievement in secondary school mathematics. *ABACUS. Journal of the Mathematical Association of Nigeria.* 25 (1), 102-113 mathematics education series.

Ajagun, G.A (2003). The Development of ICT Skills through the Nation Computer Education Curriculum for primary schools, *STAN proceedings off 44th Annual Confrence*.

Ajayi, O. (2001). Highlights of Best Practice in Information Technology (IT) Assisted Teachers Training. In M. Kabiru (Editions). Teacher Education in the Technology Age. Abuja NCCE Publication, 52- 57.

Akinsola, M. K. And Popoola, A. A. (2004). A Comparative Study of the Effectiveness of Two Strategies of Solving Mathematics Problems on the Academics Advisement of Secondary School Students, ABACUS, *Journal of Mathematical Association of Nigeria (JMAN)*, 29 (1).

Akpan, G.A., Ndem, U.D. & Usoro, E.B.(2004). Effective utilization of information and communication technology: Implication for teacher education .*Journal of Educational Technology Instrument (JETI). 11(2) 58*

Akpan,I.O. & Abia, D.U. (2009).ICT and Attainment of Educational Goals in Nigeria. *Journal of Educational Technology Instrument (JETI). 1 (1) 93-104.*

Akpinar, E. (2006). Computer Assisted Instruction in Constructing of Abstract Concepts in Science Teaching: The Unit Electricity of our Life. Unpublished PhD Thesis Turkey: Dokuz Eylul University.

Alebiosu, K. A. (2001). Cooperative Learning and Students' Affective Learning Outcome in Nigerian Chemistry Classrooms. Ife Psycho logia: An Inter- National journal. 9(2), 135-142.

Ali, B. C. and Harbor-Peters, V. F. (2000). The effect of Polya's problem solving Technique on Secondary School Students Achievement in Mathematics. *ABACUS 25 (1) 12-25.*

Alio, B. C. And Harborpeters, V. F. (2001). The Effect of Polycis Problem Solving Technique on Secondary School Students Advisement in Mathematics. *ABACUS, JMAN, 25, (1) 26- 38.*

Altin, K. (2002). The Effectiveness of Computer Assisted Environmental Method and Concept Mapping with Regard to Some Cognitive Process and Level of Retention. Unpublished Ph.D Thesis Turkey: Marmara University.

Aluko, K. O. (2004). Effects of Cooperative and Individual Instructional Strategies on Students' Problem Solving Abilities in Secondary School Chemistry in Ilesa. Unpublished Ph.D Thesis Ilorin: University of Ilorin.

Alutu, A.N. and Erauikhuemen, L. (2004). The Short fall of Female Mathematics Lecturers in Nigerian Universities; Strategies for Promotion and Retention of Prospective Female Mathematics Lectures. Journal of International Women Studies 1(5), 72-73.

Amanda, M. (2005). The Effect of Computer Assisted Instruction on College Algebra Students at Texas Technology University. Unpublished M. Tech Thesis Texas: Texas University.

Anagbogu, M. A. & Ezeliora, B. (2007). Sex differences and scientific Performance Women. *Journal of Science and Technology. 4(1)10-20.*

Anekwe, J. U. (2006). Effects of Constrictive Based Instructional Model on Students Interest and Academic Achievement in French Language in AnambaraState .*Unpublished PhD thesis, university of Port-Harcourt, RiverState.*

Arbab, S. (2003). Effects of Cooperative Learning on General Science Achievement of 9- Class Students. A Master Level Thesis. PAF College of Education for Women Caklala, Rawalpindi, Pakistan 95p.

Ash, J. E. (2005). The effectiveness of computer-assisted instruction on middle school

Asika,(2002). Research Methodology in the Behavioural Sciences. Longman Nigeria Plc Lagos.

Augustine, M. P. and Hahn, E. L. (2002). Three component spin echo generation by radiation damping, *J. Chem.Phy.107,3324-3328*

Ausubel, D. (1968). Educational psychology: A cognitive view. *New York: Holt, Rinehart, and Winston.*

Ausubel, D.P (1969). Educational Psychology. A cognitive view. *New York Holt. Rineham and Winston*

Aydin, S. (2004). The Effects of Computers on the Test and Inter-Ratter Reliability of Writing Tests of ESL Learners. The Turkish Online *Journal of Educational Technology (TJECT).* 5(1) Article 9. Retrieved from www.tojet .net /articles on 9/4/09.

Azuka, B. F. (2001). Mathematics in Technological Development: Focus on the Next Millennium Implications for Secondary Education. *Journal of the Mathematics Association of Nigeria,* 25(1), 74-82.

Azuka, B. F. (2002). Teach Yourself Senior Secondary School Mathematics, National Mathematics Centre Abuja, Nigeria P 58.

Bakie, A. (2000). Enriching Science, Technology and Mathematics Education in Nigeria: Problems and Prospects. 41st Annual Conference Proceedings of the Science Teachers Association of Nigeria. 2000. 3- 8.

Barton, R. And Haydn, T. (2004). Trainee Teachers and "Impact" Learning. A Study of Trainees Views on What Helps Them to Use ICT Effectively in Their Subject Teaching. BERA Annual Conference, University of Manchester, 16- 18 September. Retrieved on 7th May 2007 from http://www. Leeds.ac.uk/educol/documents/00003808.htm.

Basturk, R. (2005). The effectiveness of Computer-Assisted Instruction in teaching

BBC, English Dictionary (1992). Africana FEP Publishers, P.M.B 1639 Onitsha, Nigeria.

Becta, (2003). What the Research Says About ICT and Whole School Improvement Coventry: Becta.http://becta.org.uk/pagedocuments/ research/wtrs ws improvement.pdf.

Becta, (2005). Personalized Learning with ICT. Coventry: Becta http://www.Becta.org.uk/corporate/publications/documents/ personalised learning.pdf.

Braimoh, D. S. (2000). Sociological Effects of Gender Differences in the Accessibility to Science, Technology and Mathematics (STM): A Blue Print for the Implementation of the University Basic Education; Abuja, UBE.

Brower, G. H and Hilgard, E. R. (1981). Theories of Learning. Prentice-Hall. Englewood Cliffs, N. J. USA Pp113.

Brown, F. (2000). Computer assisted instruction in mathematics can improve students test scores: *A study. (ERIC Document Reproduction Service NO. ED443688)*

Brown, K.C. (2001). Using computers to deliver training: which employees learn and why? *Personnel psychology, 54, 271-296.*

Budde, M., Niedderer, H., Scott, P. and Leach, J. (2002).Electronium: A quantum atomic teaching model, *Physics Education* 37, 197-203

Cazden, C. B. (2001). Classroom discourse the language of teaching and Learning (2nd Ed.) Portsmouth: Heinemann, 92.

Cepni,S. , Ozsevgec, T. , Saydkan, F. And Emre, F. B. (2004). The Comparison of Achievement Levels of Science Teaching Program Students at Two Universities International Science and Mathematics Education Congress Report. Volume 11 Ankara. 1241- 1246.

Chado, M. I (2009). Development and Use of a Computer- Assisted Instruction Package for Teaching Metal Forging Technology at Nigerian Certificate of Education (Technical) Level. Unpublished Ph.D Thesis Bauchi: Abukar Tafawa Barewa University.

Chang, J.C. (2000). A field test of CAI software: *Magic Tree, Masters Abstracts international, 38(6).*

Chinweze, F. o. (2001). The Relative Effectiveness of Projected and Non Projected Median in the Teaching of Biology in Secondary Schools in Minna. Niger State. An Unpublished M. Tec. Thesis Minna: Federal University of Technology.

Christmann, E.P, & Badgett, J.L. (2000). The comparative effectiveness of CAI on collegiate academic performance. *Journal of computing in Higher Education, 11(2), 91 – 103.*

Chukwu, A. C. (2000). Factors Affecting Science Development in Nigeria. *Wice Panstin Journal 1*(1), 149- 156.

Chunamthiang (2007). Effects of Team Assisted Individualization on Mathematics Learning Achievement of Prathom Suksa 4 Hill Area Students. Retrieved 5th January, 2009 from http://www.grad. Cmu.ac.th/abstract 11998/edu980754.html.

Cohen, D., & Hill, H. (2000). Instructional policy and classroom performance: the mathematics reform in California. *Teachers College Record, 102(2), 294–343.*

Cotton, K. (2001). Computer Assisted Instruction, *Retrieved April 14, 2002*

Damirel, O. (2004). Planning and Evaluation in Instruction. Art of Teaching Pegem Publication.

Dantala, M. (2005). Effect of Computer Aided Learning Package on Senior Secondary School Students' Achievement in History in Minna, Niger State. Unpublished Thesis Minna: Federal University of Technology.

DAP (2011). Development Action Plain for Niger State, Niger State Ministry of Education, PRS Division, Minna.

Daramola, F.O., Onasanya, .S.A. & Asuquo, E.O. (2006). Effects of Computer Assisted Instructional Package on secondary school students' performance in Introductory Technology in Ilorin. *The Nigerian Journal of Educational Media and Technology, 12(1)*

Delialiogiu, O. And Yildirim, Z. (2008). Design and Development of a Technology Enhanced Hybrid Instruction Based on MOLTA Model: Its Effectiveness in Comparison to Traditional Instruction, Computers and Education, doi: 10. 1016/ j. Compedu 2007. 06. 006. Retrieved from http://www. The freelibrary. Com/The –effect-on-retention-of-computer.

Dickson, W. M. (2003). Physics, Quantum. Encyclopedia of Science and Religion. *Retrieved September 10, 2012 from Encyclopedia.com: http://www.encyclopedia.com/doc/1G2-3404200396.html*

Doramola, S. O. (2006). Research and Statistics Method in Education for Students and Researchers in Tertiary Institutions. Ilorin Bamitex Printing and Publishing.

Egbezor, D. E. (2004), Teaching as a science: The challenge of knowledge, technology and communication Nigeria. *Journal of curriculum studies (CON), 11(2), 25*

Eguavon, O. J. (2002). Mathematics the Heart-Beat of Information Technology; Implication for Secondary Education. ABACUS: JMAN, 27(1), 10- 12.

Erinosho, T. Y (2005). A review of school science curriculum for developmental needs of Nigeria. U.M.O Izowi (ed) science and technology education for development. *Lagos NERDC press 198-204),*

Etukudo, U. E. (2002). The Effect of Computer Assisted Instruction on Gender and Performance of Junior Secondary School Students in Mathematics. ABACUS, 27(1) 1- 8.

Etukudo, U. E. (2009). The Effect of Interactive Basic Program Package on Students Performance on Graphs of Linear and Quadratic Inequalities. ABACUS, 34(1) 7-18

Etukudo, U. E and Utin, A. Y. (2006). The Effect of Interactive Basic Programme Package on Secondary School Student Performance in Graphs of Quadratic Expressive ABACUS, 31(1), 1-7.

Ezeh, S. I. (2011). Effect of Using Computer as Tutor and Tool on Students' Achievement and Retention in Quadratic Equation in Enugun State.

Ezeh, D. N. (2005). What to Write and How to Write. A Step by Step Guide to Educational Research Proposal and Report. Pearls and Gold, Ogui Rd, Enugu, Nigeria.

Ezeliora, M. A. (2007), Sex Difference and Scientific Performances. *Women Journal of Science and Technology* 4, 10-11.

Ezeugo, N. C. and Agwagah, U.N.V. (2000). Effect of concept Mapping on Students' achievement in Algebra. Implication by Secondary Mathematics education, in the 21st century. *ABACUS. Journal of the Mathematics Association of Nigeria*25(1) 1-12.

Fagbemi, P.O. (2004). Effect of Self- Instructional Computer- Based Package on Social Studies Achievement among Senior Primary School Pupils in Niger State. Unpublished M.Tech, Thesis Minna: Federal University of Technology.

Fajola, O. O. (2000). Effect of Three Models of Computer Based Instructional Strategies on Students Learning Outcomes in Biology. Unpublished Ph.D Thesis Ibadan: University of Ibadan.

Fapohunda, A. (2000). Computer Basic and Operating System Manual. Abuja: Aflon Limited.

Federal Ministry of Education (1998). Federal Republic of Nigeria, National policy On Education. *F.M.E Printing Division Lagos*

Federal Ministry of Education (FME) (1985). Science, Agricultural Science, Biology, Chemistry, Physics and Mathematics. National Curriculum for Senior Secondary Schools. Lagos. *Federal Government Press.*

Federal Republic of Nigeria (2004), National policy on Education. *Yaba. NERDC press*

Federal Republic of Nigeria (2004). National Policy on Education Lagos: Federal Government Press.

Frankel, J. R. and Wallen, N. E. (2003). How to Design and Evaluate Research in Education, (fifth edition). New York. McGraw – Hill Companies Inc.

Gagne, R. M and Briggs, L. J. (1979). Principles of Instructional Design. Holt, Rinechart and Winston, New York, USA Pp148.

Gagne, R. M. (1970). The condition of learning. *New York: Holt Rhinehart and Winston Ltd.*

Gagne, R. M. (1982). Development in Learning Psychology: Implications for Instructional Design and Effects of Computer Technology in Instructional Design and Development. Educational Technology. 22, 11, 15

Gambari, A. I and Gbode, E. B (2006). Accessibility and Effectiveness of Information and Communication Technology Facilities as Perceived by University Students: A Case Study of Federal University of Technology Minna, Niger State 2nd Annual Conference Proceedings of School of Science and Science Education FUT, Minna, 302- 308.

Gambari, A. I. (2004). The Development of Computer Aided Instruction (CAL) Software for Individualised Instruction of Physics in Senior Secondary Schools in Niger State, Nigeria. Unpublished M. Tech Thesis Minna: Federal University of Technology.

Gambari, A. I. (2010). Effect of Computer Supported Cooperative Learning Strategies on the Performance of SeniorSecondary School Students in Physics in Minna, Nigeria. *Unpublished PhD Thesis.* Department of ScienceEducationUniversity of Ilorin. IlorinNigeria.

Gambari, A. I. and Fagbemi, P. O. (2008). Effect of Computer-graphics on Instructional Package on Mathematics Achievement among Primary School Pupils in Niger State, *Nigeria Journal of Science Education Technology 1,* (2), 141- 147.

Gamze, S. S. (2010).The effects of problem-based learning on pre-service teachers' achievement, approaches and attitudes. Towards learning physics *International Journal of the Physical Sciences.*5 (6), 711-723, Available online at *http://www.academicjournals.org/IJPS* ISSN 1992 - 1950 ©2010 Academic Journals

Gana, C. S. (2000). Design and construction of a ticker-timer for teaching of Physics in secondary schools. *Journal of Alied Research Minna* 7(10), 32-38.

Gana, C. S. (2008). Effects of Using Improvised mathematical chalkboard in teaching vectors in some Senior Secondary Schools in Bosso Local Government Area in NigerState. *Journal of Science Technology and Mathematic Education 7(19-33)*

Gana, E. S. (1997). Effects of Using Designed Visual Teaching Models on the Learning of Mathematics at Junior Secondary School Level Unpublished Ph.D Thesis Ibadan: University of Ibadan.

Gbodi, E. B and Nnwaorgu, V. N. (2006). Relative Effectiveness of Video Tape, Computer-Assisted Instruction and Realia Instruction on Biology Achievement of Secondary School Students in Abuja Municipal Council. *Journal of Research in Education, 3(3), 10- 17.*

Gimba, R. W. (2003). Effects of Using Cube and Cuboids in Solving Ordinary Level Geometrical Problems in Minna Metropolitan Secondary Schools. Unpublished M. Tech Thesis Minna: Federal University of Technology.

Gimba, R. W. (2006). Effects of 3 – Dimensional Instructional Materials on The Teaching and Learning of Mathematics among Senior Secondary Schools in Minna 2nd Annual School of Science and Science Education Book of Reading, Federal University of Technology Minna, 406- 413.

Global Information Technology, (2005).

Gronlund, N. E. (1976). Measurement and Evaluation in Education. New York: Macmillan Publishers.

Habor-Peters, V. F. (2001). Aspects of Further Mathematics that Present Difficulties to Graduating Senior Secondary Students. ABACUS: JMAN, 22(1) 74- 78.

Haluk, O. (2008).The influence of Computer-Assisted Instruction on students conceptual understanding of chemical Boarding and Attitude Toward Chemistry: *A case study of Turkey. Etsevier Science Ltd Oxford.UK.*

Hassan, A. A. (2001). Relationship between Visual Perceptions of Geometric Shapes and Students Achievement in Junior Secondary Schools in Minna Metropolis. Unpublished M. Ed Thesis Zaria: Ahmadu Bello University.

Henderson, L. Eshet, Y. ,and Klemes, J. (2000). Under the Microscope: Factors Influencing Student Outcomes in a Computer Integrated Classroom. *The Journal of Computer in Mathematics and Science Teaching* 19(3) 211- 236.

Hennessy, S, Deaney, R and Ruthven, K. (2005). Emerging Teacher Strategies for Supporting Subjects Teaching and Learning with ICT. Cambridge: University of Cambridge. Retrieved 10th January, (2008) from http://www.edu.cam.ac.uk/ist/Tipso52. pdf.

Ifamuyiwa, A. S. (2004). The Predictive Validity of Junior Secondary Mathematics on Senior Secondary Mathematics, Further Mathematics and Physics. STAN 45th Annual Conference Proceedings.

Iji, C. O. & Horbor- Peters, V. F. A. (2005). Effects of Logo and Basic Programmes on the Achievement in Geometry of Junior Secondary Schools Students. ABACUS, *Journal of the Mathematics Association of Nigeria* 30(1), 67- 77.

Iji, C. O. (2010). Actualizing Mathematics Achievement and Retention Among Primary School Pupils Using Interactive Logo Programming Package *ABACUS 35(1) 80- 90.*

Imoko, I. B and Agwagah, U. N.V. (2006).Improving Students Interest in Mathematics through Concept Mapping Technique: A Focus on Gender *Journal of Research in Curriculum and Teaching (JRCI*) 1(1) 30- 38.

introductory statistics. Educational Technology and Society, 8 (2) 170-128.

Iqal, M. (2004). Effect of Cooperative Learning on Academic Achievement of Secondary School Students in Mathematics. Unpublished Ph.D Thesis University of Arid agriculture, Rawalpindi, Pakistan.

Isiyaku, K (2006). Teacher education in Nigeria: focus on EFE implementation: *The UNESCO teacher training initiative for sub-saharan Africa BREDA, Dakar, Senegal retrieved 5/10/2006 from http://www.ncce.edu.ng.*

Iwanski, G. E. (2000). Undergraduates Student Attitude and Acceptance of Computer Enhance Instruction in a College Nutrition Course. Unpublished M.Sc. Thesis Wisconsin- Stout: University of Wisconsin- Stout.

Iwendi, B. C.(2007).The Influence of Gender and Age on The Mathematics Achievement of Secondary School Students in Minna Metropolis, Niger State. *Unpublished M.Tech. Thesis, Science Education Department FUT, Minna, Nigeria.*

Ja'afaru, O. A (2008).Use of Computer Assisted Instruction (CAI) in Teaching and Learning of Statistics in Some Selected Secondary Schools in Minna. Unpublished B. Tec. Project Federal University of Technology.

James, P. S. and Barbara, P. (2002). A Web Enable Graduate Course: Two Perspectives: Technology Tools for Use in the Classroom. Proceedings of the Seventh Annual Mid-South Instructional Technology Conference, Middle Tennessee State University. April 7-9.

James, T. (2000). Effects of Combining Reflective Writing with Concept Mapping and Lecture Method on Pre- Service N C E Teacher's Attitude and Achievement in Biology. Unpublished Ph. D Dissertation Zaria: Ahamadu University Zaria.

Javed, A. (2005). Importance of Physics Highlighted in the International Seminar on Physics in Developing Countries: Past, Present and Future 27-28, July 2003 Islamabad. Pakistan.

Johnson, D. W; Johnson, R. T and Stanne, M. B. (2000). Cooperative Learning Methods; A Mental –Analysis. Retrieved January 28, 2007 from University of Minnesota, cooperative.

Julius, O. U. (2007). X- Raying the Influence of Secondary School Students Understanding of the Language of Mathematics and Achievement in Mathematics.

Kara, I. (2008). The Effect on Retention of Computer Assisted Instruction in Science Education. Retrieved from http://www. The freelibrary.Com/the –effect-on-retention-of-computer.

Kara, I. and Kahraman, O. (2008). The effect of Computer Assisted Instruction on the Achievement of Students on the Instruction of Physics Topics of Seventh Grade Science Course at Primary Schools. Journal of Applied Science 8(6). 1067-1072.

Kareem, L. O. (2003). Effects of Audio-graphic self Instructional Package on Senior Secondary School Students Performance in Biology in Ilorin, Nigeria. Unpublished Ph.D Thesis Ilorin: University of Ilorin.

Kehinde A and Emmanuel M (2011) The African Symposium: *An online journal of the African Educational Research Network. Volume 11, No. 2*,

.Kirk,D.(1992).Gender Issues in Information Technology as found in Schools; *Education Technology.28-31*

Kulbir, S. S. (2005). New Approaches to Measurement and Evaluation, Sterling Publishers Private Limited.

Kurumeh, M. S. (2004). Effects of Ethno-Mathatics Approach in Teaching on Students' Achievement and Interest in Geometry and Menstruation. *Unpublished Ph.D Thesis,* University of Nigeria, Nsukka.

Kurumeh, M. S. (2006). Effect of Ethno- Mathematics Approach on Students Achievement in Geometry and Mensuration. ABACUS, 31(1), 35- 44

Lasisi, A. R., Daniel, T. A & Abdulazeez, S. A. (2010). Effect of Computer Simulated Experiment on Students' Level of Practical Skills Acquisition in Physics. *Journal of technological research, 7 (2) 16-21.*

Liao, Y. C. (2005). Effects of Computer Assisted Instruction on Students Achievement in Taiwan A Meta- Analysis. Retrieved 24th December 2008 from http://www. Sciencedirect.com/ science? ob= Article URL& udi= B6VCJ- 4FDMY9V.

Linver, M. R, Davis-Kean, P. E. and Eccles, J. E. (2007). Influence of Gender on Academic Achievement. *A paper funded by a grant* (ITWF Award 0089972).

Liverpool, L. S. O. (2002). Information and Communication Technology in Teacher Education. A Paper Presented at Teachers Summit, 25th Anniversary Celebration of National Teachers Institute, Kaduna February.

M O E, (2009). Ministry of Education Minna, Niger State.

Maboe, K. A. (2006). Computer assisted instruction in nursing education. Unpublished MA Thesis.

Mac- Ikemenjima, D. (2005). The Integration of ICT into the School System: Our Roles. Paper Presented at the Student Leaders IT Conference.

Mac-ikemenjima, D. (2005). E-education in Nigeria: Challenges and prospects: *8th UN ICT task force meeting April 13-15, 2005 Dublin, Ireland*

Macrae, M. F; Kalejaiye, A. O; Chima, Z. I; Garba, G. U; Channon, J. B; McLeish, S. A; and Head, H. C. (2001). New General Mathematics, 3rd Edition for Senior Secondary

Schools (SS1) England and Associated Companies throughout the World. Longman, Pearson Education Limited.

Maruf, O. I. (2007). ICT: An Indispensable Tool for all Mathematics Teachers. *Journal of Educational Research and development.* 2(1), 15-17.

mathematics achievement. Retrieved on 30th March, 2011, from http://www.

Mathematics Association of Nigeria, (2007). MAN Mathematics for Senior Secondary Schools 1 3rd Edition University Press PLC Ibadan, Nigeria.

Mayer, R. E. (2001). *Multimedia learning.* Cambridge, United Kingdom: CambridgeUniversity Press.

Mayer, R. E., &Chandler, P. (2001). When learning is just a click away: Does simple user interaction foster deeper understanding of multimedia messages? *Journal of Educational Psychology, 93,* 390-397.

Mayer, R. E., &Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist, 38,* 43-52.

Mayer, R., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. *Journal ofEducational Psychology, 93,* 187-198.

Meteethan, P. (2001). Case Study of Cooperative Learning by Using Jigwa Technique with Second Year English Major Students at Naresuan University. M.A. Dissertation Mahidol: Mahidol University.

Microsoft ® Encarta ® 2009. © 1993-2008 *Microsoft Corporation*.

Microsoft Corporation, (2006). *Encarta encyclopedia*

Mintzes,J.,Wandersee, J. and Novak, J. D. (eds.) (2000).Assessing Science Understanding: A human Constructivist View. *San Diego ,CA: Academic Press*

Mohammed, A.M and Ekpunobi, E.N. (2003).The role of ICT in Teacher Training *STAN proceedings of the 44th Annual Conference 2003, 268-271.*

Mohammed, M. K. (2004). A Comparison of Traditional Method and Computer Assisted Instruction on Students Achievement in General Science. Unpublished M. Ed Thesis Lahore: University of the Punjab.

Mukhtar, A. U (2008). The Effect of Geometrical Model as Instructional Material in Teaching Geometrical Plane Shapes in Junior Secondary Schools in Mokwa Local Government Area, Niger State. Unpublished B.Tech. Project Minna: Federal University of Technology.

Naobi, A. F. (2003). Enhancing Students performance in Using Computer Assisted Instruction (CAI) in Tertiary Institution. In Akale, Mag (Ed). Proceedings of the 44th Annual Conference of Science teachers Association of Nigeria (STAN).

National Policy on Education (2004).

National Science Foundation (1992).

National University Commission (NUC 2000). Management of Information System for Nigerian Universities. Abuja: Atman Ltd

NECO, (2006) National Examination Council.

NECO, (2007) National Examination Council.

Nekang, F. N. (2011). Differential Effects of Reda's and Rusbult's Problem-Solving Strategies on Male and Female Students' Achievement and Interest in Trigonometry in Cameroon. Unpublished Ph.D Thesis Nsukka: University of Nigeria.

NITDA, (2003). National Information Technology and Development Agency Project. Retrieved 12th July, 2007 from http://www.nitda.org.

Njoku, Z. C. (2007). Engendering Learning Equality in Science and Technology Classroom for Sustainable Development. 50th Annual Conference Proceeding of STAN (24 – 31).

Nsofor, C. C. (2006). Assessing the Effects of Designed Instructional Model on Students Performance in Science. 2nd School of Science and Science Education Conference FUT Minna. 391- 398.

Nsofor, C. C. (2009). Effects of Developed Instructional Media on Niger State Secondary School Students Achievements in Biology. Unpublished Ph. D Thesis Minna: Federal University of Technology.

Nsofor. C. C (2001).Cultural Impediments on Women in Science, Technology and Mathematics Education.*42nd Annual Conference Proceeding of STAN.Ilorine,154-160.*

Nwachukwu, P. O. (2006). Appraising the Relationship between ICT Usage and Integration and the Standard of Teacher Education Programs in a Developing Economy International Journal of Education Development Using ICT. 2(3). Retrieved on 29th April 2007 from http://iject. Uwi.Educ/index. Php.

Nwamuo, C. N. (2006). *Psychology of learning theories and practice.*Enugu: Jibaco Press.

Nwosu, A. A. (2001).Gender and acquisition of science process skills among secondary school students: Implication for science teaching;*42nd conference proceeding of theteachers association of Nigeria,206-209.*

Nyanga, E. (2002). Africa's technology corridor P C world West Africa 2 (2).WWWPC World Africa (February 2002).

Obodo, G. C. (2000). "Mathematics a language for computers in the new millennium, Implication for Nigeria". *Proceedings of Annual conference of Mathematical Association of Nigeria.*

Obodo, G. C. (2001). Promoting Mathematical Teaching and Learning in School. An Essential Factor for UBE in Nigeria. *Proceeding of Animal Conference of Mathematical Association of Nigeria.*

Obodo, G. C. (2002). *Developing Positive Attitude and Interest Mathematics Students in Nigeria Secondary Schools.* A Paper presented at NMC Abuja during the summit workshop 4-6th Oct.

Ogbonna, C. C. (2007). A Comparative study of the effectiveness of two constructivist instructional model on students' academic achievement and retention in JSS mathematics. *Unpublished Ph.D Thesis,* University of Nigeria, Nsukka.

Ogbonna, C. C. (2007). Effects of Two Constructivist Based Instructional Moodel on Students Achievements and Retention in Number and Numeration. Unpublished Ph.D Thesis Nsukka: University of Nigeria.

Ogunleye, A.O. (2000). Towards the Optimal Utilization and Management of Resources for the Effective Teaching and Learning of Physics in Schools 41st Annual *Conference Proceedings of STAN (313- 322).*

Ogwumu, O. D (2008). Voiced Computer Aided Instruction Package and its Impact on the Teaching of Set Theory at Senior Secondary Level in Minna. Unpublished B. Tec. Project Minna: Federal University of Technology.

Ojo, C.O. (2002), Courses of Mass Failure in Mathematics in Senior Secondary School Certificate. Unpublished B. SC Project Ado Ekiti: University of Ado Ekite.

Okafor, P. N. (2001). Participation of Women in Science and Cultural Issues: Which Way Forward? 42nd STAN Annual Conference Proceedings, Lagos 22(27), 59- 61.

Olaofe, I. A. (2005).Nigerian Educational Emancipation: Roadmap from crisis to Resurgence *Faculty of Education seminar series No1 AhmaduBelloUniversity. Zaria.*

Olarinoye, R.D. (2000). Strategies for Effective Teaching of Modern Physics. Unpublished Key Note Address Delivered at STAN National Workshop Held at Government College, Katsina, 24- 29 April.

Olatunji, A. B (2008). Effects of Combining Computer Animation, Modelling and Lecture Method on the Achievement of Students in Senior Secondary Mathematics in Minna. Unpublished B. Tech. Project Minna: Federal University of Technology.

Olorukooba, S. B. (2007). Science, Technology and Mathematics (STM) Education is for all Students; Promoting Effective Teaching of STM Subjects in our Schools through Teacher Preparation. Proceedings of the 50th Anniversary Conference of Science Teachers Association of Nigeria, 3-6.

Olorukooba, S.B. (2002). The Relative Effects of Cooperative Instructional Strategy and Traditional Method on the performance of senior secondary school chemistry students. *An Unpublished Ph.D thesis A.B.U Zaria.*

Olsen, R. V. (2002).Introducing quantum mechanics in upper secondary school: A study in Norway, *International Journal of Science Education 2*4, 565-574

Olson, V. E. (2002). Gender Differences and the Effects of Cooperative Learning in college Level mathematics. *Unpublished PhD, Thesis. Curtin University of Technology, Perth, Western Australia*.

Onasanya, S. A. (2000). Effects of Computer Graphics on University Students' Performance in Media Design *Journal of Nigerian Association of Teachers of technology (JONATT), 3(2*), 372-384.

Onasanya, S.A, Daramola, F.O. and Asuqwo, E. N. (2006). Effects of Computer Assisted Instructional Package on Secondary School Students Performance in Introductory Technology in Ilorin. Nigeria. *The Nigerian Journal of Educational Media and technology* 12(1).

Onyilofor,F.N.C.(2012).Counseling Implication of Attaining Vission20:20:20 through Entrepreneurship Education in Nigeria. *Journal of Research in Arts and Social Sciences(IJRSS)*.4(1).1984-1994.

Orabi, I.I. (2007).Gender differences in student academic performance and attitudes in an introductory engineering course. *American Society for Engineering Education Journal*

Oriaifo, S.O (2005). Teaching methodologies in science and technology education. In U.M.O Ivowi (ed) science and technology education for development Lagos: *NERDC press ,1-24.*

Osokoya, I. O. (2007).Effect of video-taped instruction on secondary school students achievement in history. *http//ojcs.suie.edu/ojs/index.php/.Retrieved on 3 may 2010.*

Osuala, S.L (2001).Internet service and connectivity library services and research potentials, In Kabiru et al (Eds).Teacher Education in the Technology Age. *Abuja NCCE publication,52-57*

Owoicho, O, Agunloye, D and Atabo, C. (2004). Information Technology: A Necessary Tools for Teaching and Learning Process in the 21st Century. In Abdulwahid and S.M. Chado (Eds). Teacher Education and National Development in the New Millennium (A Book of Reading) Abuja; Mat-Sunshine.

Owojori, A.A. (2000). Computer Literacy Education in Nigerian Secondary School System: Implication for Vocational Business Education Programme. The Nigerian Teacher Today 8(1&2). 29- 34.

Ozofor, (2001). Effects of two models of computer aided instruction on students' achievement and interest in statistics and probability. *Unpublished Ph.DThesis*University of Nigeria, Nsukka.

Parveen, Q. (2003). An Experimental Study on the Effects of Cooperative Learning on Social Studies Achievement among 8th Grade Students. A Master Level Thesis PAF College of Education for Women. Chacklala. Rawalpindi, Pakistan. P.105.

Patrick, L. T. (2003). Effects of Computer Assisted Instruction on Different Learners. The journal of Instructional Psychology 825- 830 (2), 137-143. Achievement technologies, Inc.

Paul, S.Y. & Babawuro, S. (2006). Information and communication technologies (ICTS) in Teachers Education: The way forward. *NATT 19th Annual National Conference Kwara 2006. 419-433*

Popoola, F. R. (2007). Gender – Related Differences in Opinion of the Level of Adequacy of Facilities for Teaching Mathematics. *Journal of Educational Research and Development* Ahmad Bello University Zaria 2(1), 26-32.

Rafiu, A. A and Adetona, A. A (2006). Obstacles Encountered by Students in Understanding; Basic Concepts of Physics and New Feeling Approach to Overcome them. *Proceedings of 2nd SSSE Conference*, FUT, Minna

Rahman, I. (2002). Strengthening Information Technology Infrastructure in Bangladesh. 42nd STAN Annual Conference Proceedings of CASTME. Africa.

Raimi, S. M & Adeoye, F. A. (2010).The effect of the use of Selvaratnam-Frazer model for solving chemistry problem on college students' achievement in volumetric analysis and acquisition of science practical skills. *Ilorin Journal of Education*.20(2)

Research Enstae.edu/dissertation/AA 13187984.

Richard, S., Michael, C. W., Lei ,B., and Edward, F. R**.***(1999). Invited presentation, NARST Annual Meeting March. MD, 20742-4111.Retrived 29th June 2009 from www.phys.ksu.edu/perg/papers/narst/)*

Sadiq, J. O. (2006). A Lead Paper Presented at the 38th Annual Conference of The Mathematics Association of Nigeria Held at Katsina Polytechnic

Salau, M. O. (2000). Options in Sustaining Mathematics as the Language of Science and Technology in the 21st Century. Proceedings of September, Annual Conference of Mathematical Association of Nigeria, 41- 60.

Sambo, A. A. (2008). Research Methods in Education. Stirling- Horden Publishers(Nig) Ltd Gaaf Building, 110-112 Oyo Road, Orogun, Off University of Ibadan Second Gate, Ibadan, Oyo State, Nigeria.

Seng,C.Y. (2007).The Effects of Incorporating Concept Mapping Into Computer Assisted *Instruction. Baywood Publishing Company Inc* .

Shehu, I. Y. (2006). The Challenge of ICT into Universal Basic Education Curriculum of Pre-Vocational and Technical Subject at Junior Secondary Schools Level. *NATT 19th Annual National Conference Held at Ilorin Pp 180- 185.*

Sule, A. O. (2003). Conceptual Frame Work for Up Grading Educational Learning Resource Centre in Nig, the NACOSS Magazine of Education, College of Education Ilorin 1(1), 21-24.

Tabassum, R. (2004). Effects of Computer Assisted Instruction (CAI) on the Secondary School Students Achievement in Science Ph.D Thesis Rawalpindi: University of Arid Agriculture. Retrieved 2nd January, 2009 from http://eprints. govpk/3501.

Tahir, G. (2006). Teacher Education in the 21st Century and beyond .Issues, Problems and Strategies for Improvement. A Key note address on the Annual National Conference of Mathematics Association of Nigeria at Bauchi, 28th August-1st September.

Taiwo, O. A. (2008). Relative Effectiveness of ICI and CCI Packages on the Performance of Students in Senior Secondary School Mathematics in Minna. Unpublished B. Tec. Project Minna: Federal University of Technology.

Thomas, O. O and Tinu, A. R. (2008).The Effects of two Programmed Instructional Strategies on Science Students Performance in Chemistry Lesson in Nigeria: *Research Journal of AppliedScience;3(2),99-102*

Trainees hand Book, (2001). Simeon Oduoye Computer Centre, Niger State College of Education, Minna.

Trinidad, S., Aldridge, J. And Fraser, B. (2005). Development, Validation and Use of the Online Learning Environment Survey. Australian "Journal of Educational Technology, 2(1) 60-81. Retrieved 3rd August, 2008 from http://www.world education forum.

Tsue, E. A. And Anyor, J. W. (2006). Relationship between Students Achievement in Secondary School Mathematics and Science s. Journal of Research in Curriculum and Teaching (JRCT). 1(1), 48- 54.

Umaru, J. (2003). Introduction to Computer Studies Book 2. Ilorin: Nathedex Publishers,

UNESCO,(2002). Information and Communication Technology in Teaching Education: A Planning Guide Division of Higher Education, USA.

West Africa Examination Council (2000). Annual Report Lagos.

West African Examination Council (2006), May/June Chief Examiner's Report.

West African Examination Council (2008), May/June Chief Examiner's Report.

West African Examination Council, (2004). May/June Chief Examiner's Report.

West African Examination Council,(2000). May/June Chief Examiner's Report.

West African Examination Council,(2002). May/June Chief Examiner's Report.

Yahaya, U. (2008). Position of Information and Communication Technology Education in the Current Educational Reform in Nigeria. Paper Presented at 6th Annual Conference of National Association for Promotion of Studies in Region Education, Languages and General Studies Held at Federal Capital Territory College of Education Zuba, March 2008.

Yakubu, M. and Finch, C. (2001). Effectiveness of Using Computer Assisted Instruction in Technical Education. A Meta- Analysis. In J. Kapes. (Ed).Occupational Education Forum/ Workforce Education Forum (OEF? WEF). 28 (2) 5-9. Retrieved from www.idosi.org.

Yar'adua, U. M. (2008). The Presidential Speech Retrieved 9th January, 2009 from *http://www.Centbank.org*

Yu, F. Y. (2001). Competition within Computer Assisted Cooperative Learning Environments: Cognitive, Affective and Social Outcomes. Journal of Computing Research, 24(2) 99-117.

Yusuf, M. O and Afolabi, A. O. (2010). Effects of Computer Assisted Instruction (CAI) on Secondary School Students Performance in Biology. The Turkish Online Journal of Education Technology; Volume 9, Issue 1.

Yusuf, M. O. (2005a). Integrating information and communication Technologies (ICTs) in Nigeria tertiary education. The African Symposium. An online journal of African Educational Research Network, 5(2), 42- 50. A publication of college of Education. Albany State University, Albany, United State of America, online at hptt://www2.nesu. edu/ncsu/aern/AERN_Journal_July 05. pdf.

Yusuf, M. O. (2005b). An Investigation into Teachers Self- Efficacy in Implementing Computer Education in Nigerian Secondary Schools. Meridian: A Middle School Computer Technologies Journal, 8(2). (A Publication of College of Education, North Caroline State University of Raleigh, North Carolina. United State of America), Online at http://www.ncsu.edu/meridian/sum 2005/computer ed nigeria schools/index.html.

Yusuf, M. O. (2006). Information and Communication Technology (ICT) and Education: Analyzing National policy for Information Technology, International Journal of Education 6(3), 316-321. Retrieved on 01/05/2008 from htpp: iiehlt.Finders. Edu.au/ education/iei/articles/v6n3/v63. Ph.D.

Yusuf, M. O. and Afolabi, A. O (2010). Effect of computer assisted instruction (CAI) on secondary school student's performance in biology. *The Turkish Online Journal of Educational Technology*; 9(12)

Yusuf, M. O. and Onasanya, S. A. (2004). Information and Communication Technology (ICT) and Teaching in Tertiary Institutions. A Paper Presented at the Workshop on Teaching for Newly Recruited University Lecturers Organised by Faculty of Education University of Ilorin.

Zura, P.B. (2002). Computer Science for Schools and Professional, *Media Mark lithographic and Co, Lagos.*

APPENDIX A (1)
PRETEST QUESTIONS BEFORE TREATMENT ON TOPIC COVERED BY OTHER TEACHERS
(SHORT ANSWER TYPE)

100 MARKS

INSTRUCTIONS : Answer all the questions.

Q1. Biology is the study of what?

Q2.The basic unit of life is called.

Q3. Botany is the study of what?

Q4. Zoology is the study of _____

Q5. The central dark part of cell is called _____

Q6. The nucleus contain _____

Q7. The chromosomes are made from _____

Q8. The nucleus is surrounded by a membrane called _____

Q9. The power home of a cell is called _____

Q10. Mitosis is responsible for growth in living things True/False.

Q11. Reproduction in Amoeba is by _____

Q12. Pseudopodia are used in Amoeba for _____

Q13. Feeding in Amoeba _____

Q14. Feeding in Euglena in sunlight is _____

Q15. Organisms that depends or others for food are called _____

Q16. Organisms that depends on one another _____

Q17. Having of chromosome number lead to _____

Q18. Mitosis lead to daughter with ____ numbers of chromosome of partners.

Q19. Duplication of chromosome is also known as replication True/False.

Q20. The process of which of a cell divide into 2 is known as _____ phase.

Q11. In Mitosis the chromosomes contend is _____

a. Haploid b. Triploid c. Diploid d. Tetraploid

Q12. In meiosis, the chromosome content is _____

a. Diploid b. Haploid c. Pentaploid d. Triploid

Q13. Mitosis is common to _____ a. Sex cells b. apical meristematic c. axial meristematic d. Pollen grain e. Brain

Q14. Meiosis is common to _____ a. meristematic regions of plants and animals b. Sex cells and pollen grain c. Parents and Children d. Parents and Grand Parents e. all of above.

Q15. The resting phase of mitosis is called _____

a. Telophase b. Anaphase c. Interphase d. Prophase e. Metaphase.

Q16. Cytoplasm organelles are formed during _____

a. Interphase b. Prophase c. Metaphase d. Anaphase e. Telophase.

Q17. Centrioles are formed during _____

a. Prophase b. Telophase c. Interphase d. Metaphase e. Anaphase

Q18. The Centromere is the regions where _____ a. Chromosome are joined b. chromatids are joined c. Chromosome separate d. Chromosome move down e. Chromosomes closes.

Q19. Chromatids that resemble each other are called _____

A .Father chromatids b. Brother Chromatids c. Uncle Chromatids

Q20. In prophase the spindle is formed? True/False.

Q21. The middle of the spindle is called the equator? True/False.

Q22. The end of each spindle is called the poles True/False.

Q23. During prophase the nucleus _____ a. Re-appear b. Disappears c. Blinks d. Runs e. Sleep.

Q24. Prophase ends with _____ a. Formation of nuclear membrane b. Breakdown of nuclear membrane c. None of the above.

Q25. In early Metaphase homologous chromosomes _____

a. Associates b. Does not associate c. Run away from each other d. Completely separate e. Non of above.

Q26. During separate the daughter centromere are orientated towards opposite poles of the spindle? True or False.

Q27. Chromosome are made from _____ a. D.N.A b. R.N.A c. A.N.D d. N.D.A e. N.R.D

Q28. Mitochondria are the _____ of the cell? A. Food basket b. Power house c. Digestive region d. Incubation e. Palpitation site.

Q29. Telophase starts with construction of _____a. Nuclear membrane b. Cytoplasm c. Plasma d. nuclear pores e. Nucleolus.

Q30. Telophase ends with reformations of various organelles? True/False.

Q31. If mitosis were to end without the cell diving the cell will now contain _____ a. Double the Number of chromosome b. 5times the number of chromosomes c. 4-times number of chromosomes d. all of above e. 4-times number of chromosomes

Q32. Mitosis is also the basis of _____ a. Sexual reproduction. B. Asexual reproduction c. Inter sexual reproduction d. Bi sexual reproduction e. none of the above.

Q33. Feeding in Amoeba is _____ a. holozoic b. Halophytic c. Autotrophic d. Heterotrophic e.non of the above.

Q34. Feeding, in Amoeba is _____ a. holozoic b. Halophytic c. Autotrophic d. Autotrophic c. Heterotrophic d. Holozoic e. Non of above

Q35. Photosynthesis is the manufacture of food by _____ a. Animal b. Insects c. Plants d. Amoeba e. Fly.

Q36. Binary fission result in _____ a. 2daugther cells b. 4cells c. 2cells d. 6cells e. None of the above.

Q37. Biology is the study of _____ a. Moon b. Life c. Compound d. Mite e. All of above

Q38. Meaning of D.N.A. is _____ a. Do Not Agree (b) De-Oxy Ribonucleic Acid c. Ribonucleic acid d. Denatured acid e. All of above

Q39. The meaning of R.N.A is _____ a. Ripe Nuclear Acid b. Ribena c. Ribonucleic d. Ribonucleic Acid e. All of above

Q40. The movement of Chromatids from the spindle-equator to the pole, require a great amount of energy? True or False.

The tables below show vividly the trends of fluctuating decreases in performance on yearly basis:

Table 1.1 Summaries of WAEC/ SSCE Biology Results 2004-2009

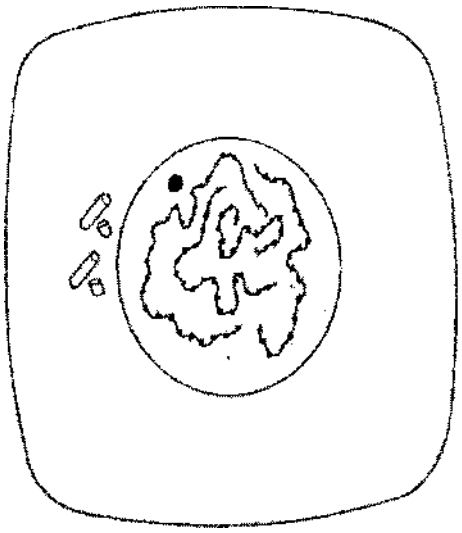
Year	No of candidates	% Pass	% Failure
2004	18156	38.72	58.84
2005	24751	29.50	69.16
2006	20759	31.41	68.44
2007	22827	33.71	66.18
2008	28304	33.16	65.91
2009	27085	32.04	67.15

Source: WAEC branch office Minna, Niger State 2013.

Table 1.2 Summaries of NECO SSCE Biology Results 2000-2010

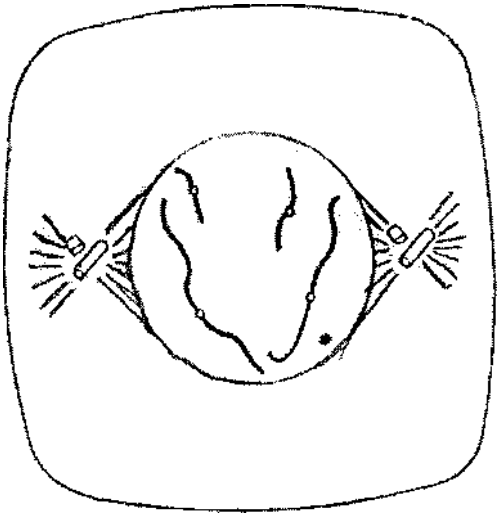
Year	No of candidates	%Pass	% Failure
2000	12891	40.52	59.44
2001	15706	29.34	70.66
2002	21092	50.88	45.67
2003	20949	36.73	59.93
2004	20257	44.76	48.97
2005	22297	20.03	70.53
2006	27087	30.99	59.47
2007	29047	31.30	53.92
2008	30489	65.54	30.35
2009	29490	25.57	66.86
2010	29021	28.71	62.45

Source: NECO National Headquarters Minna, 2013.



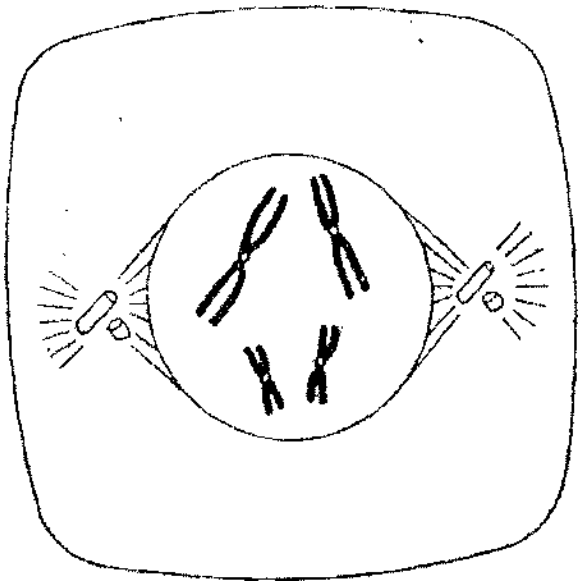
A Interphase

Cell has normal appearance of non-dividing cell condition chromosomes too threadlike for clear visibility.

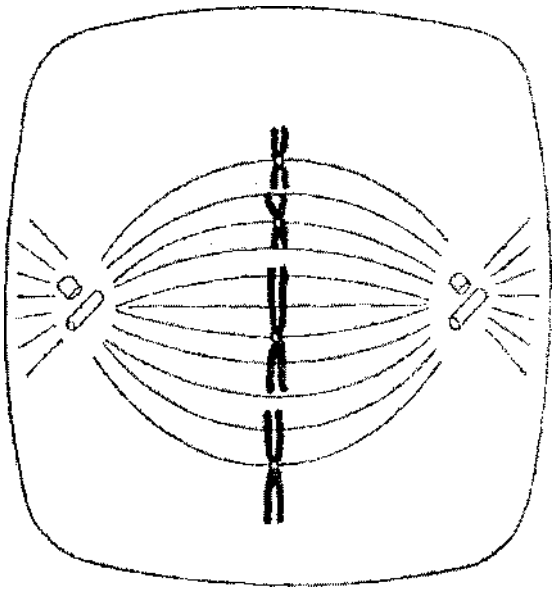


B Early Prophase

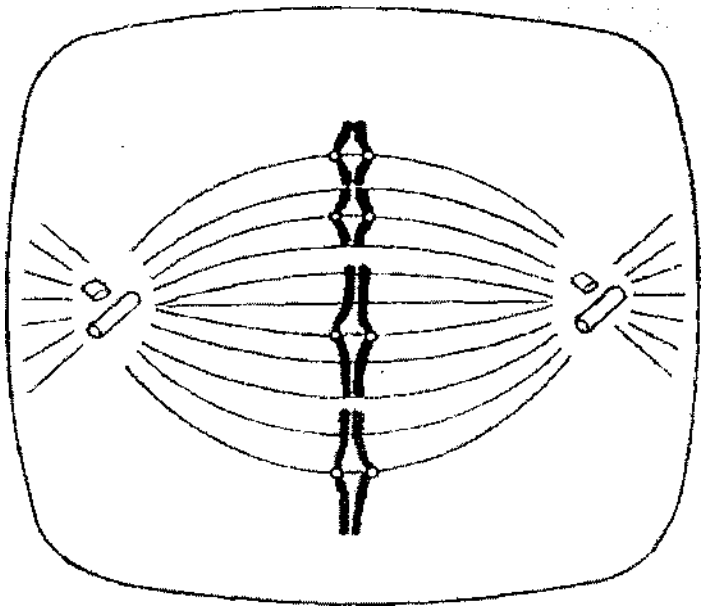
Chromosomes become visible as they contrast and nucleolus shrinks. Centrioles are at opposite sides of the nucleus. Spindle fibers start to form.



C Late Prophase
Chromosomes become shorter and fatter each seen to consist of a pair of Chromatids joined at the centromere.
Nucleolus disappears. Prophase ends with breakdown of nuclear membrane.

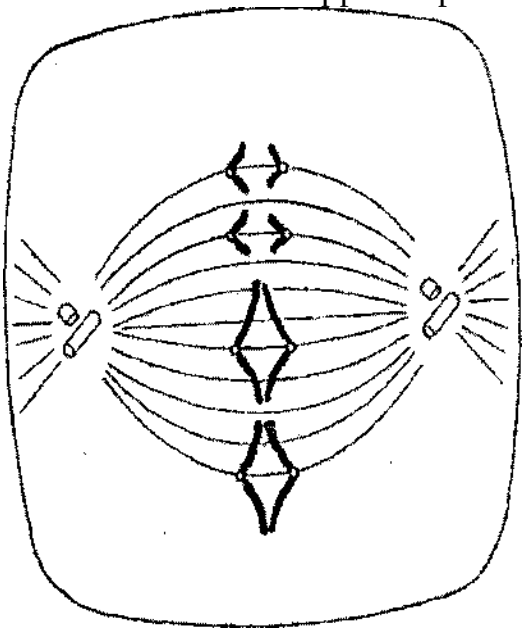


D Early Metaphase
Chromosomes arrange themselves on equator of spindle. Note that homologous chromosomes do no associate.



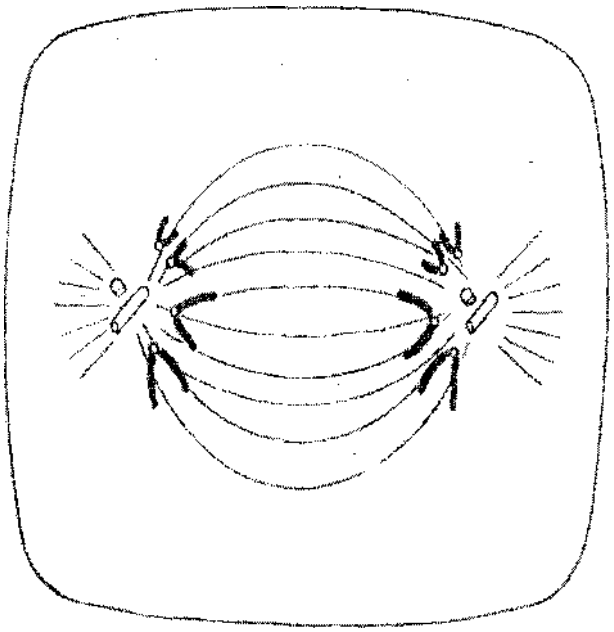
E Late Metaphase

Chromatids draw apart at the centromere region. Note that the daughter centromeres are orientated toward opposite poles of the spindle.



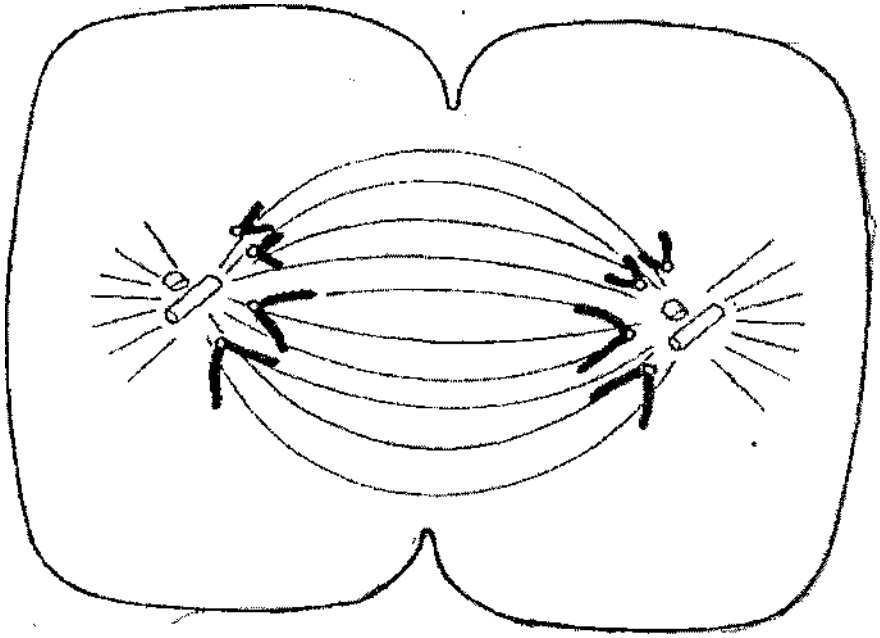
F Early Anaphase

Chromatids part company and migrate to opposite poles of cell, the centromere leading.



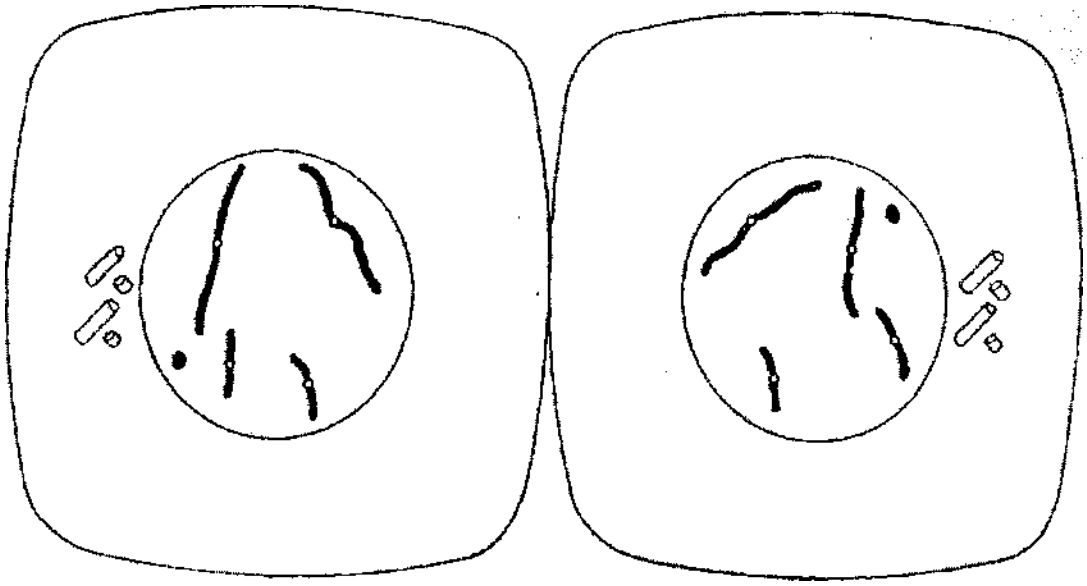
G Late anaphase

Chromosomes reach their destination.



H Early Telophase

The cell starts to constrict across the middle.



I. Late Telophase.

Constriction continues. Nuclear membrane and nucleolus reformed in each daughter cell. Spindle apparatus degenerate. Chromosomes eventually regain their threadlike form and the cell return to resting condition (Interphase).

Note that the daughter cells have precisely the same chromosome constitution as the original parent cell.